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**Затверджено Міністерством освіти і науки України
як підручник для студентів немовних факультетів вищих навчальних закладів**
(Лист № 14/18.2—1782 від 03.11.2003 р.)

Підручник з англійської мови (частина III) зорієнтований на особливості опанування її студентами інженерних, аграрних, медичних вищих навчальних закладів. З огляду на специфіку навчальних вимог до студентів, а також їх майбутньої фахової діяльності дібрано оригінальні тексти, коментарі до них, передбачено відповідні форми індивідуальної роботи. Зміст текстів не тільки сприятиме збагаченню фахової англомовної лексики, а й розвиватиме культуру мовлення студентів.

Для студентів інженерних, аграрних, медичних вищих навчальних закладів.

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ПІВДЕННИЙ ФІЛІАЛ
"КРИМСЬКИЙ АГРОТЕХНОЛОГІЧНИЙ
УНІВЕРСИТЕТ" НАУ
БІБЛІОТЕКА
м.СІМФЕРОПОЛЬ смт. Аграрне

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1. Section. Medicine

Text 1. Medicine as a Branch of Science

Medicine is a science and art of treating and preventing disease. The art, if not the science, undoubtedly began with man's first appearance on earth, for since man became capable of thought he has been seeking cures for illness. Of prehistoric medicine there is evidence only of those diseases that affected the bony structure. Prehistoric skulls found in Europe and South America indicate that Neolithic man was already able to trephine, or remove disks of bone from, the skull successfully, but whether this delicate operation was performed to release evil spirits or as a surgical procedure is not known. Nevertheless, those records available that concern early medicine reveal that many civilizations, amidst all the magic and incantation, had discovered scientific principles held valid today. Although earliest Egyptian medical papyri are replete with ritual prayers and spells against demons, a more rational, empirical practice also developed, involving the use of many potent drugs still in use today, such as castor oil, senna, opium, colchicine, and mercury. In spite of their skill in embalming, however, the Egyptians had little knowledge of anatomy. In Sumerian medicine the Laws of Hammurabi established the first known code of medical ethics and laid down a fee schedule for specific surgical procedures. In the absence of a strong lay professional caste, every Babylonian considered himself a physician and, according to Herodotus, gave advice freely to the sick man who was willing to exhibit himself to passersby in the public square. The Mosaic Code of the Hebrews indicated concerns with social hygiene and prevention of disease by dietary restrictions and sanitary measures.

Although ancient Chinese medicine was also influenced adversely by the awe felt for the sanctity of the human body, the Nei Ching, attributed to the emperor Huang-Ti (2698—2598 B.C.), contains a reference to a theory of the circulation of the blood and the vital function of the heart that presupposes some familiarity with anatomy.

The Chinese pharmacopeia was the most extensive of all the older civilizations. The Hindus seem to have been familiar with every surgical procedure except the use of ligature; they were skilled in such techniques as reconstructing the nose and cutting for removal of bladder stones. In Greek medicine, the impetus for the rational approach came largely from the speculations of the pre-Socratic philosophers and such philosopher-scientists as Pythagoras, Democritus, and Empedocles. Hippocrates taught the prevention of disease through a regimen of diet and exercise; he emphasized careful observation of the patient, the recuperative powers of nature, and a high standard of ethical conduct, as incorporated in the Hippocratic Oath. By the 4th century B.C., Aristotle had already stimulated interest in anatomy by his dissections of animals, and work in the 3d century B.C. on human anatomy and physiology was of such high quality that it was not equalled for fifteen hundred years. The Roman conquest was accompanied by a gradual decline in medical originality. However, through the construction of aqueducts, baths, sewers, and hospitals, the conquerors did much to improve sanitation and public health, and by dredging marshy areas they learned to control malaria. The encyclopedic writings of Galen constitute a final synthesis of the medicine of the ancient world. Revered by Arabic and Western physicians alike, his concepts were to stand virtually unchallenged until the 16th century. Unfortunately his prolific researches on anatomy and physiology were not invariably accurate, and reliance on them later impeded progress in anatomy. The gradual spread of Christianity, followed by the barbarian invasions and the Arab conquests, brought on a period of stagnation in European medicine and a resurgence of priestly medicine. With the destruction or neglect of the Roman sanitary facilities, there followed a series of local epidemics that culminated many centuries later in the great Plague of the 14th century known as the Black Death.

(To be continued)

Notes

medicine ['medsɪn] — *медицина*
to treat [tri:t] — *лікувати*
cure ['kjuə] — *ліки*
bone [boun] — *кістка*
skull [skʌl] — *череп*
surgical ['sə:dʒɪkəl] — *хірургічний*
procedure [prə'si:dʒə] — *процедура*
magic ['mædʒɪk] — *чарівний*

valid ['vælɪd] — *дійсний*
papyri [pə'paɪəraɪ] — *папірус*
replete [rɪ'pli:t] — *наповнений, перенасичений*
spell [spel] — *заклинання, чари*
potent ['poutənt] — *сильнодіючий*
drug ['drʌg] — *ліки; наркотики*
mercury ['mə:kjurɪ] — *ртуть*
to embalm [ɪm'bɑ:m] — *бальзамувати*
ethic ['eθɪk] — *етичний*
physician [fɪ'zɪʃn] — *лікар*
sanitary ['sænɪtərɪ] — *гігієнічний*
adversely [æd'və:slɪ] — *несприятливо*
ligature ['lɪgətʃuə] — *перев'язка*
bladder ['blædə] — *сечовий міхур*
impetus ['ɪmpɪtəs] — *імпульс, поштовх*
regimen ['redʒɪmen] — *режим*
recuperative [rɪ'kju:pərətɪv] — *відновлюючий*
dissection [dɪ'sekʃn] — *розріз*
decline [dɪ'klaɪn] — *занепад*
originality [ə,rɪdʒɪ'nælɪtɪ] — *виникнення, створення*
aqueduct ['ækwɪdʌkt] — *канал, прохід*
sewer ['sjuə] — *стічна труба*
invariably [ɪn'veərɪəblɪ] — *постійно*
to impede [ɪm'pi:d] — *перешкоджати*
stagnation [stæg'neɪʃn] — *застій*
resurgence [rɪ'sə:dʒəns] — *відродження*
plague ['pleɪg] — *чума*

Text 2. Medicine as a Branch of Science

(Continued)

During the Middle Ages certain monastic libraries, notably those at Monte Cassino, Bobbio, and St. Gall, preserved a few ancient medical manuscripts, and Arab and Jewish physicians such as Avicenna and Maimonides continued medical investigation. The first real breakthrough in the medical isolation of Europe came with the translation of many writings from the Arabic at Salerno, Italy, and through continuing trade and cultural exchange with Byzantium. By the 13th century there were flourishing medical schools at Montpellier, Paris, Bologna, and Padua. At Bologna a renewal of interest in surgery led to the first public dissec-

tion of the human body. The center of anatomical studies was Padua, where Vesalius proved that Galen had made anatomical mistakes. Prominent among those who pursued the new interest in experimental medicine were Paracelsus, Ambroise Paré, and Fabricius (who discovered the valves of the veins); others experimented with new drugs derived from plants. In the 17th century William Harvey, using careful experimental methods, demonstrated the circulation of the blood, a concept that met with considerable early resistance. The introduction of quinine marked a triumph over malaria, one of the oldest plagues of mankind. The introduction of the compound microscope led to the discovery of minute forms of life, and the discovery of the capillary system of the blood filled the final gap in Harvey's explanation of blood circulation. In the 18th century the heart drug digitalis was introduced, scurvy was controlled, surgery was transformed into an experimental science, and reforms were instituted in mental institutions. Edward Jenner introduced vaccination to prevent smallpox, laying the groundwork for the science of immunization. The 19th century saw the beginnings of modern medicine, with demonstration of the germ theory of disease; the use of disinfection and the consequent improvement in medical, particularly obstetrical, care; the use of inoculation; the introduction of anaesthetics in surgery and a revival of better public health and sanitary measures. A decline in maternal and infant mortality followed. Medicine in the 20th century has been characterized by the rise of chemotherapy, especially the use of antibiotics and sulfa drugs; increased understanding of the mechanisms of immunity and the increased prophylactic use of vaccination; utilization of knowledge of the endocrine system to treat diseases resulting from hormone imbalance, such as the use of insulin to treat diabetes; and increased understanding of nutrition and the role of vitamins in health. Much medical research is now directed toward such problems as cancer, heart disease, and organ transplantation. With the growth of general and specialized medical knowledge, the educational requirements of the medical profession have increased. In addition to the four-year medical course and the general hospital internship required almost everywhere, additional years of study in a specialized field are usually required. Similar progress and increased requirements in education are reflected in ancillary professions such as nursing. Modern medicine, characterized by growing specialization and a complex diagnostic and therapeutic technology, faces problems in the allocation of capital and personnel resources. Some authorities advocate an increase in the use of paramedical personnel to supervise the care of individuals with common, chronic, or terminal illnesses, leaving the physician in charge of treating curable disease. Others emphasize the physician's responsibility to help patients and families in the overall management of their health problems, many

of which are thought to reflect the social ills and concomitant emotional problems of urban, industrialized society. In some countries, e.g. Great Britain, medical care is under government control and is available virtually without charge to all. In the United States, medical practice is characterized by a patchwork mixture of government and private control.

Notes

breakthrough ['breɪkθru:] — *прорив*
to persue [pə'sju:] — *переслідувати*
valve ['vælv] — *клапан*
circulation [ˌsə:kju'leɪʃn] — *кругообіг*
scurvy ['skə:vɪ] — *цинга*
surgery ['sə:dʒərɪ] — *хірургія*
mental ['mentl] — *психіатричний; розумовий*
vaccination [ˌvæksɪ'neɪʃn] — *щеплення*
smallpox ['smɔ:lpɔks] — *віспа*
germ [dʒə:m] — *бактерія; мікроб; ембріон*
disinfection [ˌdɪsɪn'fekʃn] — *дезинфекція*
inoculation [ɪˌnɔkju'leɪʃn] — *запобіжне щеплення*
anaesthetic [ˌænɪs'θetɪk] — *анастезуючий*
mortality [mɔ:'tælɪtɪ] — *смертність*
hormone ['hɔ:moun] — *гормон*
diabetes [ˌdaɪə'bi:ti:z] — *діабет*
nutrition [nju:'trɪʃn] — *харчування*
cancer ['kænsə] — *рак*
ancillary [æn'sɪlərɪ] — *допоміжний*
nurse [nə:s] — *няня; медсестра*
diagnostic [ˌdaɪəg'nɔstɪk] — *діагностичний*
therapeutic ['θerə'pju:tɪk] — *терапевтичний*
to supervise ['sju:pəvaɪz] — *наглядати*
curable ['kjuərəbl] — *виліковний*
patient ['peɪʃənt] — *пацієнт; хворий*
concomitant [kən'kɔmɪtənt] — *супутній; супровідний*
virtually ['və:tjuəlɪ] — *фактично*
patchwork ['pætʃwə:k] — *штопання, латання*

Text 3. Diagnosis

Diagnosis is a determination of the nature of a disease or ailment. A clinical diagnosis based on the medical history and physical examination of the patient is used whenever laboratory tests for the dis-

ease cannot be made. Diagnosis by physical examination includes ascertaining temperature, pulse, and blood pressure and involves the use of palpation, or feeling, to detect enlarged organs and other abnormalities; percussion, or tapping, to delineate some of the internal organs; and auscultation, or listening, to interpret sounds from organs such as the heart and lungs. Instruments that facilitate physical examination include the sphygmomanometer for determining blood pressure; the stethoscope for listening to the heart and lungs; the otoscope for examination of the ear; the ophthalmoscope to disclose the inner eye; the laryngoscope and bronchoscope to view the larynx, windpipe, and other air passages; the esophagoscope and the gastroscope for viewing the esophagus and the stomach, and the proctoscope and sigmoidoscope, for inspecting the rectum and part of the large intestine. In diagnostic tests the blood, urine, tissues, and other excretions and secretions of the body are examined grossly and microscopically for evidence of chemical imbalance, cellular change, and the presence of pathogenic organisms. X-rays, electrocardiographs, and electroencephalographs (brain tracings) are other diagnostic aids. Exploratory surgery may be used as a last resort to arrive at a precise diagnosis.

Notes

diagnosis [ˌdaɪəgˈnousɪs] — *діагноз*
disease [dɪˈziːz] — *хвороба*
ailment [ˈeɪlmənt] — *хвороба, недуга*
to ascertain [ˌæsəˈteɪn] — *переконувати*
to delineate [dɪˈlɪnɪeɪt] — *окреслювати*
auscultation [ˌɔːskəlˈteɪʃn] — *прослуховування*
larynx [ˈlærɪŋks] — *гортань*
intestine [ɪnˈtestɪn] — *кишки*
excretion [eksˈkriːʃn] — *виділення*
secretion [sɪˈkriːʃn] — *секреція*
grossly — *вульгарно*
cellular [ˈseljulə] — *клітинний*

Text 4. Disease

Disease is an impairment of the normal state or functioning of the body as a whole or of any of its parts. Some diseases are acute, producing severe symptoms that terminate after a short time, e.g., pneumonia; others are chronic disorders, e.g., arthritis, that last a long time; and still others return periodically and are termed recurrent, e.g., malaria. One of the most common bases for classifying disease is according to cause. External factors that produce disease

are infectious agents, including both microscopic organisms (bacteria, viruses, rickettsias, protozoa) and macroscopic ones (fungi and various parasitic worms). Only infectious diseases can be transmitted — by humans, certain animals and insects, and infected objects and substances. Other external agents that can cause disease are chemical and physical agents (drugs, poisons, radiation), deficiency of nutrients in the environment, and physical injury. Diseases that arise from internal (endogenous) causes include hereditary abnormalities (disorders inherited from one or both parents), congenital diseases (disturbances in the development of a normal embryo), allergies (hypersensitive reactions to substances in the environment), endocrine disorders (generally either overfunctioning or underfunctioning of an endocrine gland), circulatory disorders (diseases of the heart and blood vessels), and neoplasms, or tumors (masses of abnormally proliferating cells). Degenerative diseases occur as a result of the natural aging of the body tissues. Finally, a wide range of diseases are attributed to, or at least influenced by, emotional disturbances. Psychoses and neuroses result in disturbed behavior; the so-called psychosomatic diseases (peptic ulcers, certain kinds of colitis, many forms of headaches) are thought to be brought about by emotional stress. Most diseases occur as a result of a combination of both internal and external conditions, i.e., an interaction between the body and its environment. Thus a person may be hereditarily predisposed to tuberculosis, although the tubercule bacillus (the infectious agent) must be present for the disease to occur. In ancient times disease was ascribed to supernatural, spiritual, and humoral factors. The discovery by Louis Pasteur and others of the role played by microorganisms in infection and the study of cellular pathology by Rudolf Virchow in the 19th centure were of the utmost importance in establishing the true nature of disease.

Notes

impairment [ɪmˈpɛəmənt] — *погіршення*
pneumonia [njuːˈmounjə] — *запалення легенів, пневмонія*
to term [təːm] — *називати*
recurrent [rɪˈkʌrənt] — *періодичний*
infectious [ɪnˈfekʃəs] — *інфекційний, заразний*
agent [ˈeɪdʒənt] — *фактор*
deficiency [dɪˈfɪʃnsɪ] — *дефіцит*
nutrient [ˈnjuːtrɪənt] — *поживний*
congenital [kənˈdʒenɪtl] — *природжений*
tumor [ˈtjuːmə] — *пухлина*
degenerative [dɪˈdʒenərətɪv] — *що вироджується*

ФІЛІАЛ "КРИМСЬКИЙ ІНЖЕНЕРНО-ПЕДАГОГІЧНИЙ УНІВЕРСИТЕТ" НАУ
БІБЛІОТЕКА
М.СІМФЕРОПОЛЬ смт. АГРАРНЕ

Text 5. Injection

Injection is an introduction of a fluid into the body, usually by means of a needle and syringe. The material injected may be a test substance (as in determining allergic sensitivity or immunity to a disease), an anaesthetic, a therapeutic drug, a nutrient (in cases where intravenous feeding is necessary), or blood or blood plasma (transfusion). An intracutaneous injection is the introduction of a small amount of fluid between the skin layers. A subcutaneous injection is directed to the tissues under the skin. When quicker absorption of a drug is required, injection is made into one of the muscles (intramuscular); even more rapid absorption is obtained by direct injection into a vein (intravenous). In certain emergencies involving the heart, such as cardiac arrest, a chamber of the musculature of the heart can be penetrated directly by injection (intracardiac). Anaesthetics are sometimes injected into the spine (spinal injection). In an injection by means of a jet injector gun, the fluid penetrates through the skin by means of air pressure and there is no visible puncture mark.

Notes

injection [ɪn'dʒekʃn] — *ін'єкція*
fluid ['flu:ɪd] — *рідина*
transfusion [træns'fu:ʒn] — *переливання*
syringe ['sɪrɪndʒ] — *шприц*
puncture ['pʌnktʃə] — *укол*

Text 6. Epidemic

Epidemic is an outbreak of disease that affects a much greater number of people than is usual for the locality or that spreads to regions where it is ordinarily not present. A disease that tends to be restricted to a particular region (endemic disease) can become epidemic if nonimmune persons are present in large numbers (as in time of war or during pilgrimages), if the infectious agent is more virulent than usual, or if distribution of the disease is more easily effected. Cholera and plague, endemic in parts of Asia, can become epidemic under the above conditions, as can dysentery and many other infections. A worldwide epidemic is known as a pandemic, e.g., the influenza pandemic of 1918. Epidemic disease is controlled by various measures, depending on whether transmission is through respiratory droplets, food and water contaminated with intestinal wastes, insect vectors, or other means. A disease is said to be sporadic when a few cases occur here and there in a given region.

Notes

outbreak ['autbreɪk] — *спалах*
virulent ['vɪrulənt] — *небезпечний*
cholera ['kɔlərə] — *холера*
plague [pleɪg] — *чума*
dysentery ['dɪsntrɪ] — *дизентерія*
respiratory [rɪs'paɪərətərɪ] — *респіраторний*
droplet ['drɔplɪt] — *крапелька*
sporadic [spɔ'rædɪk] — *спорадичний*

Text 7. Burn

Burn is an injury resulting from exposure to heat, electricity, radiation, or caustic chemicals. Three degrees of burn are commonly recognized. In first-degree burns the outer layer of skin, called epidermis, becomes red, sensitive to the touch, and often swollen. Medical attention is not required but application of an ointment may relieve the pain. Second-degree burns are characterized by the variable destruction of epidermis and the formation of blisters; nerve endings may be exposed. The more serious cases should be seen by a physician and care should be taken to avoid infection. Local therapy includes application of a chemical such as silver nitrate to produce a soft crust, reduce the threat of infection, and relieve the pain. Third-degree burns involve destruction of the entire thickness of skin and the underlying connective tissue. In the more severe cases underlying bones are also charred. The surface area involved is more significant than the depth of the burn. Shock must be prevented or counteracted; blood transfusion may be required to replace lost body fluids. Invasion of various bacteria must be prevented or cured by administering antibiotics and other drugs. Morphine may be employed to ease pain. Long-term treatment may include transplantation of skin tissue from other parts of the body.

Notes

burn [bə:n] — *опік*
sensitive ['sensɪtɪv] — *чутливий*
application [ˌæplɪ'keɪʃn] — *накладання, прикладання*
ointment ['ɔɪntmənt] — *мазь*
to relieve [rɪ'li:v] — *полегшувати*
blister ['blɪstə] — *пухи́р*
destruction [dɪs'trʌkʃn] — *руйнування, знищення*
to counteract [ˌkauntə'rækt] — *протидіяти*

Text 8. Smallpox

Smallpox is an acute, highly contagious disease causing a high fever and successive stages of severe skin eruptions. The disease occurs throughout the world where vaccination is not practiced and has occurred in epidemics throughout history. It is caused by a filterable virus that may be airborne or spread by direct contact. After an incubation period of about two weeks, fever, aching, and prostration occur, lasting two or three days. An eruption then appears and spreads over the entire body; the lesions become blisterlike and pustular within a week. The lesions then open and crust over, causing itching and pain. When the crusts fall off, usually in another one or two weeks, the extent of permanent damage to the skin (pockmarks) becomes evident. There is no specific treatment for smallpox; penicillin is administered to prevent secondary bacterial infection. Routine vaccination of children before they reach their first birthday has eliminated the scourge of smallpox in technically advanced countries. One of the projects of the World Health Organization has been to extend the benefits of vaccination to underdeveloped areas still without it. Edward Jenner demonstrated the practicability of vaccination with cowpox virus, which causes the production of antibodies that also protect the body against invasion by smallpox viruses.

Notes

smallpox ['smɔ:lpɔks] — *віспа*
contagious [kən'teɪdʒəs] — *заразний, інфекційний*
fever ['fi:və] — *гарячка, жар*
eruption [ɪ'rʌpʃn] — *висип*
vaccination [ˌvæksɪ'neɪʃn] — *щеплення*
prostration [prɔs'treɪʃn] — *знемога*
lesion ['li:ʒn] — *пошкодження*
pustular ['pʌstjulə] — *прищуватий*
crust [krʌst] — *кірка*
itch [ɪtʃ] — *сверблячка*
scourge [skə:dʒ] — *біда; лихо*
cow-pox ['kaupɔks] — *теляча віспа*

Text 9. Malaria

Malaria is an infectious parasitic disease that can be either acute or chronic and is frequently recurrent. It has been and still is a widespread disease; its victims at any given time are counted in the millions. Malaria is common in Central and South America, the Mediterranean countries, Asia, and many of the Pacific islands. In the United States it is found in the South and less frequently in the northern and western parts of the country. Malaria is usually transmitted by an Anopheles mosquito that has picked up the causative organism, *Plasmodium*, from the blood of an infected person and transferred it to that of a healthy person in the course of its feeding. At the onset of malaria, bouts of chills (ague) and fever lasting several hours and occurring every three or four days are the usual symptoms. If the disease is not treated, the spleen and the liver become enlarged, anemia develops, and jaundice appears. Death may occur from general debility, anemia, or invasion of the cerebral tissues. Quinine and cinchona, the specific drugs in the treatment of malaria for centuries, have been largely replaced since World War II by several superior synthetic antimalarials, among them chloroquine. Drainage of swamps and other breeding places of mosquitoes and education of the populace in the use of screens, netting, insecticides, and repellents have greatly diminished incidence of the disease; however, much preventive work remains to be done.

Notes

malaria [mə'lɛərɪə] — *малярія*
infectious [ɪn'fekʃəs] — *інфекційний, заразний*
recurrent [rɪ'kʌrənt] — *періодичний*
onset ['ɔnset] — *початок*
bout ['baut] — *раз*
ague ['eɪgju:] — *малярія*
spleen [spli:n] — *селезінка*
jaundice ['dʒɔ:ndɪs] — *жовтяниця*
debility [dɪ'bɪlɪtɪ] — *слабкість*
drainage ['dreɪnɪdʒ] — *дренаж*
populace ['pɔpjuləs] — *простий народ*
cinchona [sɪŋ'kounə] — *хінне дерево*
insecticide [ɪn'sektɪsaɪd] — *засіб проти комах*

Text 10. Artery

Artery is a blood vessel that conveys blood away from the heart. Except for the pulmonary artery, which carries deoxygenated blood from the heart to the lungs, arteries carry oxygenated blood from the heart to the tissues. The largest arterial trunk is the aorta, branches of which divide and subdivide into ever-smaller tubes, or arterioles, until they terminate as minute capillaries, the latter connecting with the veins. Other important arteries are the subclavian and brachial

arteries of the shoulder and arm, the carotid arteries that lead to the head, the coronary arteries that nourish the heart itself, and the iliac and femoral arteries of the abdomen and tower extremities. The walls of the large arteries have three layers: a tough elastic outer coat, a layer of muscular tissue, and a smooth, thin inner coat. Arterial walls expand and contract with each heartbeat, pumping blood throughout the body. The pulsating movement of blood, or pulse, may be felt where the large arteries lie near the body surface.

Notes

artery ['ɑ:tərɪ] — *артерія*
pulmonary ['pʌlmənərɪ] — *легеневий*
to terminate ['tə:mɪneɪt] — *завершувати, обмежувати*
carotid [kə'rɔtɪd] — *сонна артерія*
abdomen ['æbdəmən] — *живіт, черевна порожнина*
extremity [ɪks'tremɪtɪ] — *кінцівки (множ.)*
tough [tʌf] — *жорстокий; міцний*

Text 11. Depression

Depression in psychiatry is a painful emotional reaction characterized by intense feelings of loss, sadness, worthlessness, failure, or rejection not warranted by an objective view of events. It is distinguished from grief, which is a realistic response to actual loss or suffering. Depression is often a disproportionately intense reaction to difficult life situations, e.g., retirement, business loss, or physical disability. It may be accompanied by such physiological symptoms as tense posture, persistent frowning, slowing of motor and mental activity, fatigue, lack of appetite, and insomnia. The tendency toward self-recrimination, self-punishment, guilt, remorse, and shame, typical of depressed individuals, suggested to Freud that in depression the self becomes the target for anger that cannot be expressed toward others. Suicide, the terminal response to intense, psychoneurotic depression, is an extreme manifestation of destructive feelings that are turned against oneself. In manic depressive psychosis, periods of intense excitement alternate with periods of acute depression. There is some evidence connecting depressive states with a deficiency of the neurotransmitter substance norepinephrine in the limbic system of the brain.

Notes

depression [dɪ'preʃn] — *депресія*
worthlessness ['wə:θlɪsnɪs] — *нікчемність*

to warrant ['wɔrənt] — *виправдовувати*
posture ['pɔstʃə] — *положення*
frowning ['fraunɪŋ] — *хмурий погляд*
fatigue [fə'ti:g] — *втома*
insomnia [ɪn'sɔmnɪə] — *безсоння*
remorse [rɪ'mɔ:s] — *муки сумління*
target ['tɑ:gɪt] — *ціль, мішень*
tendency ['tendənsɪ] — *нахил; тенденція*
destructive [dɪs'trʌktɪv] — *руйнівний*
deficiency [dɪ'fɪʃənsɪ] — *недолік, дефіцит*

Text 12. Leptospirosis

Leptospirosis is a febrile disease caused by bacteria of the genus *Leptospirae*. The disease occurs in dogs, cattle; pigs; sheep, goats, and horses and is transmissible to man. It is most common in areas where the climate is warm and humid, soils are alkaline; and there is abundant surface water. The source of infection in farm animals is usually through pastures, drinking water, or feed, when contaminated by infected urine. Infection may also occur as result of contact with infected uterine discharges and aborted fetuses. Infected animals may pass the causative organism through the urine for as long as one year. Recovered animals can therefore act as carriers. In cattle, pigs, sheep, and goats, the disease is characterized by fever, depression, anemia, and abortion. Horses develop an ocular infection. In dogs the disease causes a severe kidney infection. Control of leptospirosis depends on the elimination of carrier animals, appropriate hygienic measures, and vaccination of susceptible animals.

Notes

genus ['dʒi:nəs] — *вид*
abundant [ə'bʌndənt] — *багатий*
urine ['juərɪn] — *моча*
fetus ['fi:təs] — *плод, ембріон*
causative ['kɔ:zətɪv] — *причинний*
kidney ['kɪdnɪ] — *нирка*
appropriate [ə'prouprɪɪt] — *відповідний*
hygienic [haɪ'dʒi:nɪk] — *гігієнічний*
susceptible [sə'septəbl] — *вразливий*

Text 13. Congenital Heart Disease

Congenital heart disease is any defect in the heart present at birth. There is evidence that some congenital heart defects are inherited. However, most commonly, the defect is caused by environmental conditions in the uterus like the presence of certain drugs or viruses that reach the fetus via the maternal circulation, e.g., infection of the mother with rubella (German measles) virus during the first trimester of pregnancy causes a high rate of congenital heart lesions and other malformations. Among the most common congenital heart disorders are malformations in the valves and the persistence of structures that are normally closed off at birth, i.e., the ductus arteriosis (fetal blood vessel that shunts blood from the pulmonary vein to the aorta, bypassing the heart) and the foramen ovale (opening between the left and right atria of the fetal heart). If the malformation is severe, it will produce various symptoms of insufficient heart function, such as cyanosis (bluish tinge to the skin), dyspnoea (difficulty in breathing), fatigue, and abnormal heartbeat; valvular deformities predispose the patient to bacterial infection of the endocardium. Less severe malformations may not produce noticeable symptoms until later in life, and some may not require any medical attention. Many congenital heart defects that are debilitating can now be corrected surgically. Other congenital anomalies, such as mongolism, are present in about 20% of cases of congenital heart disease.

Notes

congenital [kən'dʒenɪtl] — *природжений*
uterus ['ju:tərəs] — *матка; чрево*
valve ['vælv] — *клапан*
to shunt — *звертати(ся)*
pulmonary ['pʌlmənərɪ] — *легеневий*

Text 14. Congestive Heart Failure

Congestive heart failure is an inability of the heart to expel sufficient blood to keep pace with the metabolic demands of the body. In the healthy individual the heart can tolerate large increases of workload for a considerable length of time. Cardiac failure results from conditions, e.g., coronary, hypertensive and rheumatic heart disease, that interfere with the nutrition and oxygenation of the heart muscle itself. Congestive heart failure develops in 50% to 60% of patients with such disorders, and it can be either acute or chronic. If the

heart has time to compensate the heart muscle may become hypertrophic (enlarged). Eventually the great demand for oxygen by the heart muscle cells cannot be met, and cell death results. Either the left or right ventricle alone may fail first, although combined failure is most common and almost always eventually occurs. Left ventricular failure is marked by shortness of breath (dyspnoea), often accompanied by cough; pulmonary congestion and edema are evident. Failure of the right ventricle produces systemic edema, reflecting hepatic and visceral engorgement. Treatment of cardiac failure usually includes long-term restrictions on diet and activity. Digitalis is often prescribed to increase the speed and force of cardiac contractions. Diuretics are used to remove excess sodium and water from the body.

Notes

to expel [ɪks'pel] — *виганяти*
to keep pace with — *іти в ногу з*
nutrition [nju:'trɪʃn] — *харчування*
ventricle ['ventrɪkl] — *шлуночок*
cough [kɔf] — *кашель*
hepatic [hɪ'pætɪk] — *печінковий*

Text 15. Cerebral Palsy

Cerebral palsy is a disability caused by brain damage before or during birth, resulting in a loss of muscular control and coordination. Most cases are thought to be caused by oxygen deficiency during the birth process. The severity of the affliction is dependent on the extent of the brain damage. Those with mild cases may have only a few affected muscles, while severe cases can result in total loss of coordination or paralysis. Nowadays it is believed that there are six different forms of the disability, each caused by damage to a different area of the brain. The spastic type, accounting for over half of the cases, results from damage to the motor areas of the cerebral cortex and causes the affected muscles to be contracted and overresponsive to stimuli. Athetosis, caused by damage to the basal ganglia, results in sudden, exaggerated movements. The two types of ataxia cause either an impaired sense of balance or a lack of coordinated movements. In flaccid paralysis, the muscles are flabby and unresponsive; patients with spastic rigidity are unable to contract their muscles, while those with tremor suffer from repeated muscular contractions. About 25% of those affected suffer some degree of mental retardation. There is no cure for

the disorder and treatment usually includes physical, occupational, and speech therapy. Sometimes appliances such as braces are helpful, as well as certain surgical procedures.

Notes

palsy ['pɔ:lzɪ] — *параліч*
affliction [ə'flɪkʃn] — *нещастя*
paralysis [pə'rælɪsɪs] — *параліч*
cortex ['kɔ:teks] — *кора головного мозку*
ganglia ['gæŋgliə] — *нервові клітини (вузли)*
to impair [ɪm'peə] — *погіршувати(ся)*
flaccid ['flæksɪd] — *слабий*
flabby ['flæbɪ] — *в'ялий*
tremor ['tremə] — *тремтіння*
contraction [kən'trækʃn] — *стиснення*

Text 16. Arrhythmia

Arrhythmia is a disturbance in the rate or rhythm of the heartbeat. Various arrhythmias can be symptoms of serious heart disorders; however, they are usually of no medical significance except in the presence of additional symptoms. Tachycardia, or heartbeat faster than 100 beats per minute in the adult, can be precipitated by drugs, caffeine, anemia, shock, and emotional upset. Bradycardia, or slow heartbeat, is often present in athletes. Heart murmurs are abnormal sounds (clicks, rumbles, blowing noises) produced by the heart in addition to the normal heartbeat. Premature beats of the atria and ventricles are common and usually of no significance. Murmurs at the various valves sometimes indicate the presence of valvular deformities but also occur in normal hearts. Flutters, and the even faster fibrillations, are rapid, uncoordinated contractions of the atrial or ventricular muscles that usually accompany heart disorders. Ventricular fibrillation is a sign of the terminal stage of heart failure and is usually fatal unless defibrillation is achieved by application of electrical current or mechanical massage. The electrical impulse that is generated to stimulate the heartbeat travels from a clump of tissue on the right atrium called the sinoatrial node to the atria and then to the ventricles. In some cases where there is a disturbance in the conduction of this impulse, called sinoatrial or atroventricular block, rhythm can be maintained by implanted electrodes that act as artificial pacemakers.

Notes

click — *клацання*
rumble ['rʌmbl] — *гуркіт*
premature [ˌpremə'tjuə] — *передчасний*
flutter ['flʌtə] — *хвилювання*
muscle [mʌsl] — *мускул, м'яз*
clump [klʌmp] — *група*
to implant [ɪm'plɑ:nt] — *насаджувати*
artificial [ˌɑ:tɪ'fɪʃəl] — *штучний*
pace ['peɪs] — *темп, швидкість*

Text 17. Arteriosclerosis

Arteriosclerosis is a general term for a condition characterized by thickening, hardening, and loss of elasticity of the walls of the blood vessels. These changes are frequently accompanied by accumulations inside the vessel walls of lipids, e.g., cholesterol; this condition is frequently referred to as atherosclerosis. The deposition of calcium in the fatty material hardens the walls of the vessels. As the vessel walls thicken, the passageways through the vessels narrow, decreasing the blood supply to the affected region. Constriction of the coronary arteries may affect the heart. Cerebral arteriosclerosis is often responsible for senility in elderly persons. If the leg vessels are affected, there may be loss of movement of the extremities and an onset of gangrene. When there is total clotting of a vessel (thrombosis) the result may be a heart attack (if it occurs in the coronary arteries) or apoplexy (if in cerebral arteries). While there is no specific preventive or cure for arteriosclerosis, reduction of body cholesterol to normal levels through a restricted-fat diet, with the substitution of vegetable fats for animal fats is usually prescribed, although the relationship between the level of cholesterol in the bloodstream and arteriosclerosis is not yet fully understood.

Notes

elasticity [ˌelæs'tɪsɪtɪ] — *пружність, еластичність*
vessel [vesl] — *судина*
deposition [ˌdepə'zɪʃn] — *усунення*
affected [ə'fektɪd] — *уражений*
senility [sɪ'nɪlɪtɪ] — *старість*
gangrene ['gæŋgri:n] — *гангрена*
to clot — *запікатися (про кров)*
apoplexy ['æpəpleksɪ] — *параліч*

Text 18. Blood Pressure

Blood pressure is a force exerted by the blood upon the walls of the arteries. The pressure in the arteries is initiated by the pumping action of the heart, and pressure waves can be felt at the wrist and at other points where arteries lie near the surface of the body. Blood pressure is strongest in the aorta, where the blood leaves the heart. It diminishes progressively in the smaller blood vessels and reaches its lowest point in the veins.

Blood pressure is dramatically manifested when an artery is severed or pierced, and the blood (under pressure) ejects in spurts. Since the heart can pump blood into the large arteries more quickly than it can be absorbed and released by the tiny arterioles and capillaries, there is always considerable inner pressure in the arteries. The contraction of the heart (systole) causes the blood pressure to rise to its highest point, and relaxation of the heart (diastole) brings the pressure down to its lowest point. Since blood pressure varies in different arteries, the pressure in the brachial artery of the forearm is used as a standard. It is measured in millimeters of mercury by means of an instrument known as a sphygmomanometer. The normal readings in young people are about 120 mm for systolic pressure and about 80 mm for diastolic pressure, commonly written as 120/80 and read as "one-twenty over eighty".

With age, and the constriction of the small arteries and then the larger ones, blood pressure increases, so that at 50 years it is considered normal to have a systolic pressure between 140 and 150, and a diastolic pressure of about 90. Factors other than heart action and the condition of the arteries also influence blood pressure. Temporary high blood pressure usually occurs during or following physical activity, nervous strain, and periods of rage or fear. Therapy for persistent high blood pressure consists of sufficient rest, mild sedation (especially with pressure-reducing drugs), a diet low in salt and protein, and reduction in weight where there is obesity. Low blood pressure (hypotension) is considered to be advantageous if it is not caused by disease or injury.

Notes

pressure [ˈpreʃə] — *тиск*
aorta [eɪˈɔːtə] — *аорта*
to manifest [ˈmænɪfest] — *виявляти*
to pierce [ˈpɪəs] — *проникати*
to eject [iːˈdʒekt] — *виганяти*

spurt [spɔːt] — *ривок*
mercury [ˈmɔːkjurɪ] — *ртуть*
mild [ˈmaɪld] — *м'який*
sedate [sɪˈdeɪt] — *спокійний*
obesity [ouˈbiːsɪtɪ] — *огрядність*

Text 19. Pneumonia

Pneumonia is an acute infection of one or both lungs that can be caused by a bacterium or virus but is most frequently due to the pneumococcus bacterium. When one or more entire lobes of the lung are involved, the infection is considered a lobar pneumonia. When the disease is confined to the air spaces adjacent to the bronchi, it is known as bronchopneumonia. The pneumococci reach the lungs through the respiratory passages. Usually an upper respiratory infection precedes the disease. Chronic alcoholism, malnutrition, debility, inhalation of noxious gases, or long confinement to bed are predisposing factors. The symptoms are high fever, chill, pain in the chest, difficulty in breathing, cough, and a sputum that is pinkish at first and becomes rust-colored as the infection progresses. The skin may turn bluish because the lungs are not sufficiently oxygenating the blood. Complete bed rest and good supportive care are important. Oxygen helps to relieve severe respiratory difficulty. Penicillin is the most effective antibiotic in the treatment of pneumonia caused by bacteria and, with the other antibiotic and sulfa drugs, is responsible for the marked decline in the mortality figures for this disorder; viral pneumonia is generally milder than the bacterial form. Nevertheless, pneumonia is still a serious disease, especially in elderly persons or when complicated by bacterial invasion of the blood stream, or membranes of the heart, or of the central nervous system.

Notes

pneumonia [njuːˈmounjə] — *запалення легенів, пневмонія*
lobe [ˈloub] — *легенева частина*
adjacent [əˈdʒeɪsənt] — *сусідній*
malnutrition [ˈmælnjuːˈtrɪʃn] — *недоїдання*
debility [dɪˈbɪlɪtɪ] — *виснаження*
to inhale [ɪnˈheɪl] — *вдихати*
noxious [ˈnɔkʃəs] — *шкідливий*
confinement [kənˈfaɪnmənt] — *обмеження*

Text 20. Pneumothorax

Pneumothorax is a collapse of a lung with escape of air into the pleural cavity between the lung and the chest wall. The cause may be traumatic (e.g., gunshot or stab wound), spontaneous (rupture due to disease or localized weakness of the lung lining), or environmental (extreme change in atmospheric pressure). The only symptom may be a sudden pain in the chest. Physical and radiological examination reveal characteristic signs of lung collapse. Simple pneumothorax of only one lung generally requires only rest; the break in the pleura usually heals quickly after collapse of the lung has taken place. In tension pneumothorax (where there is high intrapleural pressure), or if both lungs are collapsed, it is advisable to remove the air from the pleural cavity immediately. An artificial pneumothorax is one deliberately induced, as in the treatment of tuberculosis of the lung before modern drugs became available, or in the diagnosis of lung disease.

Notes

collapse [kə'læps] — *руйнування*
escape [ɪs'keɪp] — *витік*
pleura ['pluərə] — *плевра*
traumatic [trɔ:'mætɪk] — *травматичний*
stab — *гострий біль*
spontaneous [spən'teɪnjəs] — *спонтанний*
rupture ['rʌptʃə] — *розрив*
cavity ['kævɪtɪ] — *порожнина*
deliberately [dɪ'lɪbərɪtlɪ] — *зважено*
to induce [ɪn'dju:s] — *спонукати*

Text 21. Diabetes or Diabetes Mellitus

Diabetes or diabetes mellitus is a chronic disorder usually caused by a deficient secretion of insulin, a hormonal substance produced by the endoctrine glands in the pancreas. The exact cause of pancreatic failure is not yet fully understood, but heredity seems to be a factor, as is obesity. Disorders of endocrine glands other than those in the pancreas can also bring on diabetes. The lack of insulin results in an inability to metabolize glucose. The capacity to store glycogen in the liver and the active transport of glucose across cell membranes are impaired. The symptoms are the appearance of sugar in the urine, an

increase of sugar in the blood, the passage of urine in large amounts, thirst, hunger, weakness, weight loss, and itching of the skin. Prolonged hyperglycemia (excess blood glucose) leads to increased protein and fat catabolism, a condition that can cause premature vascular degeneration and atherosclerosis. Uncontrolled diabetes leads to diabetic acidosis, which, if not treated promptly, can result in death. About 4% of women and 2% of men in the United States become diabetic. Although the incidence is less frequent among children and adolescents, the onset of diabetes in young people is usually more abrupt, more severe, and more difficult to control. In cases of severe diabetes the patient must generally inject daily doses of insulin. In some cases insulin therapy is either supplemented or replaced by oral medication, including sulfonylurea drugs and phenformin. A common complication of insulin therapy is insulin shock, a hypoglycemic condition that results from an oversupply of insulin in relation to the glucose level in the blood. The treatment of diabetes was revolutionized when F. G. Banting and C. H. Best isolated the hormone insulin in 1921. Until that time control could be attempted only in the mildest forms of the disease. Since the advent of insulin therapy the lives of diabetics have been greatly prolonged.

Notes

diabetes [ˌdaɪə'bi:ti:z] — *діабет*
deficient [dɪ'fɪʃənt] — *позбавлений*
secretion [sɪ'kri:ʃn] — *секреція*
metabolizm [me'tæbəlɪzm] — *обмін речовин*
to supplement ['sʌplɪmənt] — *доповнювати*
advent ['ædvənt] — *поява*

Text 22. Artificial Respiration

Artificial respiration is any measure that causes air to flow in and out of a person's lungs when natural breathing is inadequate or ceases, as in respiratory paralysis, drowning, electric shock, choking, gas or smoke inhalation, or poisoning. Respiration can be taken over by mechanical appliances such as the artificial lung (especially in respiratory paralysis), the pulmotor or any other type of mechanical respirator. In emergency situations, however, when no professional help is available, rescuers should undertake the mouth-to-mouth or sensitivity is not considered drug poisoning. Virtually all drugs, especially in large doses or when taken over long periods of time, can

initiate a toxic condition. Certain drugs used in combination, such as alcohol and barbiturates, result in an intensified alteration of physiological state that is frequently dangerous. Drugs that affect the nervous system often cause adverse reactions in high concentrations. Alcohol and other nervous system depressants such as barbiturates and narcotics, taken in sufficiently large doses, can result in coma and convulsions. Excessively high doses or stimulants such as amphetamines result in blurred vision, spasms, heart irregularities, and respiratory failure. In addition, both stimulants and depressants are dangerous because continued use can lead to addiction and tolerance for doses that are high enough to be toxic. Overdosage of an analgesic like aspirin can result in acidbase disturbances, spontaneous bleeding, and convulsions. Virtually all drugs produce some side effects. For example, side reactions with barbiturates may include respiratory depression and skin rashes. Other drugs cause adverse reactions when taken over long periods of time. The antibiotic streptomycin taken over long periods can result in deafness, and continued use of aspirin and other salicylates can result in kidney damage and anemia. Some drugs only have toxic effects on sensitive individuals. Psychotomimetic agents such as lysergic acid diethylamide (LSD) can result in hyperexcitability, coma, and prolonged psychotic states and can cause major personality changes in some users. In susceptible persons even moderate doses of phenothiazine tranquilizers, which are used to calm psychotic patients, can cause such toxic effects as low blood pressure, uncontrollable muscle movements, and various pigmentation and blood cell disorders.

Notes

to cease [si:s] — *зупиняти*
emergency [ɪ'mə:dʒnsɪ] — *непередбачений випадок*
available [ə'veɪləbl] — *придатний, корисний*
rescuer ['reskjuə] — *рятівник*
virtually ['və:tjuəlɪ] — *фактично*
toxic ['tɔksɪk] — *токсичний*
adverse ['ædvə:s] — *несприятливий*
excessively [ɪk'sesɪvlɪ] — *надмірно*
to blur [blə:] — *затьмарювати*
addiction [ə'dɪkʃn] — *звичка (погана)*
tolerance ['tɔlərəns] — *терпіння*
tranquil ['træŋkwɪl] — *спокійний*

Text 23. Anemia

Anemia is a condition in which the concentration of hemoglobin in the circulating blood is below normal. Such a condition is caused by a deficient number of erythrocytes (red blood cells), an abnormally low level of hemoglobin in the individual cells, or both these conditions simultaneously. Regardless of the cause, all types of anemia cause similar signs and symptoms because of the blood's reduced capacity to carry oxygen. These symptoms include pallor of the skin and mucous membranes, weakness, dizziness, easy fatigability, and drowsiness. Severe cases show difficulty in breathing, heart abnormalities, and digestive complaints. One of the most common anemias, iron-deficiency anemia, is caused by insufficient iron, an element essential for the formation of hemoglobin in the erythrocytes. In most adults (except pregnant women) the cause is chronic blood loss rather than insufficient iron in the diet, and, therefore, the treatment includes locating the source of abnormal bleeding in addition to the administration of iron. Pernicious anemia causes an increased production of erythrocytes that are structurally abnormal and have attenuated life spans. This condition rarely occurs before age 35 and is inherited, being more prevalent among persons of Scandinavian, Irish, and English extraction. It is caused by the inability of the body to absorb vitamin B_{12} (which is essential for the maturation of erythrocytes) from food and is treated by repeated injections of vitamin B_{12}. There are several conditions that cause the destruction of erythrocytes, thereby producing anemia. Allergic-type reactions to bacterial toxins and various chemical agents, among them sulfonamides and benzene, can cause hemolysis, which requires emergency treatment. In addition, there are unusual situations in which the body produces antibodies against its own erythrocytes; the mechanism triggering such reactions remains obscure. Any disease or injury to the bone marrow can cause anemia, since that tissue is the site of erythrocyte synthesis. Bone marrow destruction can also be caused by irradiation, disease, or various chemical agents. There are several inherited anemias that are more common among dark-skinned people. Sickle-cell anemia is inherited as a recessive trait almost exclusively among blacks; the condition is characterized by a chemical abnormality of the hemoglobin molecule that causes the erythrocytes to be misshapen. Thalassemia major (Cooley's anemia) is the most serious of the hereditary anemias that occur more frequently among those of Mediterranean, Middle Eastern, and Southern Chinese ancestry. The erythrocytes are abnormally shaped and many are nuclea-

ted. Symptoms include enlarged liver and spleen and jaundice. Thalassemia major usually causes death before adulthood is reached.

Notes

hemoglobin [ˌhi:mou'gloubɪn] — *гемоглобін*
erythrocyte [ɪ'rɪθrəsaɪt] — *еритроцит*
mucous ['mjukəs] — *сльозоточивий*
dizziness ['dɪzɪnɪs] — *запаморочення*
pernicious [pə:'nɪʃəs] — *шкідливий, згубний*
to attenuate [ə'tenjueɪt] — *виснажувати*
span — *короткий проміжок (часу)*
prevalent ['prevlənt] — *поширений*
extraction [ɪks'trækʃn] — *витягування*
benzene ['benzi:n] — *бензол*
to trigger ['trɪgə] — *пустити в хід*
obscure [əb'skjuə] — *нечіткий*
marrow ['mærou] — *кістковий мозок*
irradiation [ɪˌreɪdɪ'eɪʃn] — *освітлення*
recessive [rɪ'sesɪv] — *відступаючий назад*
to nucleate ['nju:klɪeɪt] — *формувати ядро*

Text 24. Drug Poisoning

Drug poisoning — toxic effects, caused by an administered drug. Reaction to a drug caused by an allergic sensitivity is not considered drug poisoning. Virtually all drugs, especially in large doses or when taken over long periods of time, can initiate a toxic condition. Certain drugs used in combination, such as alcohol and barbiturates, result in an intensified alteration of physiological state that is frequently dangerous. Drugs that affect the nervous system often cause adverse reactions in high concentrations. Alcohol and other nervous system depressants such as barbiturates and narcotics, taken in sufficiently large doses, can result in coma and convulsions. Excessively high doses of stimulants such as amphetamines result in blurred vision, spasms, heart irregularities, and respiratory failure. In addition, both stimulants and depressants are dangerous because continued use can lead to addiction and tolerance for doses that are high enough to be toxic. Overdosage of an analgesic like aspirin can result in acidbase disturbances, spontaneous bleeding, and convulsions. Virtually all drugs produce some side effects. For example, side reactions with barbiturates may include respiratory

depression and skin rashes. Other drugs cause adverse reactions when taken over long periods of time. The antibiotic streptomycin taken over long periods can result in deafness, and continued use of aspirin and other salicylates can result in kidney damage and anemia. Some drugs only have toxic effects on sensitive individuals. Psychotomimetic agents such as lysergic acid diethylamide (LSD) can result in hyperexcitability, coma, and prolonged psychotic states and can cause major personality changes in some users. In susceptible persons even moderate doses of phenothiazine tranquilizers, which are used to calm psychotic patients, can cause such toxic effects as low blood pressure, uncontrollable muscle movements, and various pigmentation and blood cell disorders.

Notes

to poison ['pɔɪzn] — *отруювати*
to administer [əd'mɪnɪstə] — *давати, призначати (ліки)*
condition [kən'dɪʃn] — *стан, становище*
disturbance [dɪs'tə:bəns] — *порушення*
spontaneous [spɔn'teɪnjəs] — *спонтанний*
bleeding — *кровотеча*
rash [ræʃ] — *висип*
deafness ['defnɪs] — *глухота*
cell [sel] — *клітина*

Text 25. Alcoholism

Alcoholism is the consumption of alcoholic beverages to a degree that interferes with bodily or mental health or with normal social and occupational behavior. Chronic alcoholism is a condition in which the drinker is physiologically dependent on alcohol, i.e., he is addicted. Alcoholism, either in the form of heavy steady drinking or in the form of occasional periods of intense drinking alternating with sober periods, is the most widespread drug addiction problem; it is estimated that about 9 million of the 95 million social drinkers in the United States are problem drinkers or alcohol addicts. Because alcohol can profoundly alter behavior (by blocking inhibitions, for example, and releasing aggressive behavior), it is one of the most dangerous addictive drugs. A large proportion of arrests in the United States are for drunkenness or for drunken driving, and a high proportion of crimes of violence (e.g., child beating, homicide, and suicide) are committed by people who have been drinking. Alcoholics cause one half of all

highway fatalities and are responsible for much lost work time and inefficiency on the job. Intoxication is produced by alcohol as it circulates in the blood and acts to depress the central nervous system. Alcohol, which requires no digestion, can pass directly into bloodstream. The absorption rate depends principally on the concentration of the drug in the stomach and small intestine; the presence of food in the stomach slows the absorption process. Alcohol is not stored in the body or excreted but is metabolized in the liver at a fixed rate of between 0.25 and 0.33 oz (7.1—9.4 grams) per hr, varying with the individual. Thus alcohol is found in the bloodstream and signs of intoxication appear when the rate of alcohol consumption is greater than the rate at which it is metabolized in the liver. At a blood level of about 05%, alcohol lowers alertness, increases appetite, and may relieve fatigue. In increasing doses, it causes exaggerated behavior, impairs muscular coordination and judgment, slows reflexes, and reduces negative feelings such as anxiety and guilt. Definite intoxication occurs at more than 15%, although 10% is frequently considered legal drunkenness. The lethal level, often given as .60%, may be as low as .40% in some people. Death results from respiratory failure as the medulla of the brain is depressed. The rapid ingestion of about a pint of absolute ethyl alcohol or its equivalent would be fatal for most individuals. In practice, most people become unconscious before they drink themselves to death. However, ingestion of adulterated alcoholic beverages containing methyl (wood) alcohol will cause damage to retinal cells and may lead to complete blindness within a few days. The effects of alcohol are similar to those of barbiturates, and the combination of the two is particularly dangerous.

The steps in the development of chronic alcoholism vary with the individual; it is usually not possible to determine which of a group of drinkers will become addicted. Although there is no such thing as an alcoholic personality, there are certain personality traits common in alcoholics, e.g., feelings of inadequacy and inability to tolerate frustration or deal with the demands of life. Many alcoholics may border on serious mental illness. Nearly half come from broken homes or have an alcoholic parent. Certain cultural groups, e.g., some North European peoples, and some groups where the social structure has been disrupted, e.g., Eskimos and North American Indians, seem to be more susceptible than others. In the United States, although the number of women drinkers has markedly increased in recent years, four out of five alcoholics are male. It is possible that a hereditary component exists, i.e., some people may experience a unique sense of gratification when intoxicated. A typical case of beginning alcoholism resembles ordinary social drinking, although drinking may be more intense and prolonged. Later the drinker may begin to drink in the morning to obliterate his guilt feelings and to relieve the physical discomfort of the hangover from the drinking of the night before. As the alcoholic becomes increasingly unable to control his drinking he becomes antisocial and disorganized. Severe chronic alcoholism may result in loss of job, home, and family. The treatment of alcoholism begins with medical efforts to achieve sobriety. Anti-anxiety drugs such as certain sedatives and barbiturates are used to ease withdrawal and delirium tremens. Medical treatment is usually followed by membership in a supportive group such as alcoholics anonymous, in which alcoholics commit themselves to change and work together to solve their drinking problems. Although most therapeutic methods emphasize complete abstinence, some experimental groups try to teach alcoholics to keep drinking under control. Psychoanalysis is not usually helpful. Some alcoholics are helped by hypnotic suggestion, methods of conditioning to avoid alcohol, or self-administration of drugs such as antabuse, which produces severe discomfort if present in the system when alcohol is consumed. An experimental treatment for severe drinking bouts is the use of lithium salts, presently used to treat manic-depressive illness.

Notes

consumption [kən'sʌmpʃn] — *споживання*
beverage ['bevərɪdʒ] — *напій*
to addict [ə'dɪkt] — *призвичатися*
homicide ['hɔmɪsaɪd] — *вбивство*
digestion [dɪ'dʒestʃn] — *травлення*
to excrete [eks'kri:t] — *виводити*
alertness [ə'lə:tnɪs] — *пильність*
lethal ['li:θəl] — *смертельний*
to ingest [ɪn'dʒest] — *ковтати*
to adulterate [ə'dʌltəreɪt] — *підмішувати*
to disrupt [dɪs'rʌpt] — *підривати, руйнувати*
to obliterate [ə'blɪtəreɪt] — *викреслювати*
hangover ['hæŋ,ouvə] — *пережиток*
sobriety [sou'braɪətɪ] — *тверезість*
delirium [dɪ'lɪrɪəm] — *маячення; нестяма*
abstinence ['æbstɪnəns] — *утримування*
to consume [kən'sju:m] — *споживати*

eased part of the body: hence, red poppies for blood disorder, spotted plants for skin eruptions, trefoil plants for heart trouble. Preventive medicine and ritual to produce sickness in one's enemies have also been popular in addition to curative methods. The Indians of South and Central America, among others, perform purification ceremonies and hold festivals for cleansing and to ward off the evil eye. Medicine men, shamans, and other doctors credited with magical powers generally massage, draw liquid off by suction, or blow upon the diseased area. They recite ancient formulas and incantations to cure or banish illness, both physical and mental. In all cultures most medicinal lore of this nature is handed down by word of mouth from one generation to the next. That which was written by the ancients formed the beginnings of medical science. In the United States in the 1960s and 70s, there occurred an enormous expanding interest in folk remedies, herbal medicines, vitamins, and so-called health foods and organic foods that are free of insecticides, and other pollutants. As a result the production of such foods became a growing business enterprise.

Notes

herb [hə:b] — *трава (лікарська)*
to conjure [kən'dʒuə] — *благати, заклинати*
witchcraft — *чаклунство*
malevolent [mə'levələnt] — *злорадний, недоброзичливий*
to devise [dɪ'vaɪz] — *придумувати, винаходити*
to coincide [ˌkouɪn'saɪd] — *збігатися*
efficacy ['efɪkəsɪ] — *дієвість, ефективність*
poppy ['pɔpɪ] — *мак*
eruption [ɪ'rʌpʃn] — *висип*
trefoil ['trefɔɪl] — *трилистник*
purification [ˌpjuərɪfɪ'keɪʃn] — *очищення*
to cleanse [klenz] — *очищати*
massage ['mæsɑ:ʒ] — *масаж*
to banish ['bænɪʃ] — *виганяти*

Text 29. Therapy

Coronary Artery Disease

A majority of patients with coronary artery disease exhibit increased carotid sinus sensitivity. Such enhanced responsiveness is more likely to be present during an acute myocardial infarction. About

half the patients who experience angina pectoris have increased responsiveness, which is more marked during an episode of pain.

The patient with coronary artery disease is especially prone to develop asystole after brief carotid sinus massage. This results from several factors: depression of the sinoatrial node, atrioventricular block, and delayed nodal or ventricular escape. Advanced degrees of heart block are prominent manifestations. Generally carotid sinus sensitivity varies directly with the degree of coronary artery disease and with the individual's age.

Massage of the carotid sinus may relieve acute pulmonary edema in patients with hypertensive and coronary artery disease. Relief is immediate, in the majority it is associated with a drop in blood pressure. Fear, dyspnea, and chest oppression disappear, perspiration lessens, and pallor vanishes. Pulmonary rales decrease or clear entirely, respirations become less labored, heart sounds diminish in intensity, and the apex impulse becomes less forceful. The episode frequently is completely reversed. If it recurs, it may be controlled for as long as carotid sinus stimulation is continued. When the reflex becomes exhausted on one side, a good response may be achieved by stimulating the opposite side. Such massage has been carried out for as long as 30 minutes. A great advantage of the procedure is that the physician can control the changes in heart rate and blood pressure by varying the duration and intensity of stimulation.

Carotid sinus stimulation will reduce the period of fatigue and the objective manifestations of cardiac overload in patients with heart disease.

Both angina pectoris and acute pulmonary edema are helped by carotid sinus massage and nitroglycerin. Angina pectoris and chronic atrial fibrillation infrequently coexist. Similarly, acute paroxysmal pulmonary edema is rare in the presence of established atrial fibrillation; when it does occur, carotid sinus stimulation is without effect. These observations are of considerable theoretical importance. The effectiveness of carotid sinus stimulation in the treatment of pulmonary edema needs further clinical elaboration.

Notes

artery ['ɑ:tərɪ] — *артерія*
carotid sinus [kə'rɔtɪd 'saɪnəs] — *пазуха сонної артерії*
to enhance [ɪn'hɑ:ns] — *збільшувати*
responsiveness [rɪs'pɔnsɪvnɪs] — *чутливість*
angina pectoris [æn'dʒaɪnə 'pektərɪs] — *грудна жаба*
heart block ['hɑ:t 'blɔk] — *блокада серця*
to relieve [rɪ'li:v] — *полегшувати*

apex impulse [ˈeɪpəks ˈɪmpʌls] — *поштовх серцевої верхівки*
heart rate [ˈhɑːt ˈreɪt] — *кількість ударів на хвилину*
angina [ænˈdʒaɪnə] — *ангіна*

Text 30. Pediatrics

Construction and Maintenance of a Nursery

Since infant-to-infant spread of infection may occur, steps should be taken to minimize this possibility.

1. The number of infants sharing a common air supply should be small, obviously the smaller the better. Four to six infants in a unit would appear to represent a good compromise between such factors as economy of space, nursing time, ease of observation, and safety.

2. The infants should be separated widely within the unit; a space of 30 square feet per infant probably represents the minimum as long as there are only 4 babies per unit. It would appear that the greater the number of infants in a given space, the more square feet per infant are necessary to protect them from each other.

3. A ventilating system should be provided which is capable of supplying at least 12 to 15 draft-free changes of clean air per hour. This system should also produce a slight positive pressure within the nursery so that contaminated air from public corridors, mothers' rooms, etc, does not blow into the unit when the doors are opened.

4. In hospitals with obstetrical services of sufficient size, a cohort or rotation system of admission and discharge of infants should be provided. All infants born within a single fixed time period (*usually 24 hours*) are admitted to Unit 1. These infants represent the "cohort". All infants born in the next time period are admitted to Unit 2, the following group to Unit 3, etc. When the infants in Unit 1 are ready for discharge, they are sent home as a group. The unit is cleaned, restocked with fresh linen and other supplies, and a new cohort admitted. Any infant that remains in the hospital longer than other members of his group is transferred to an isolation or observation unit. With this system, a continuous direct chain of infection from infant-to-infant cannot occur; each cohort has no contact with any other cohort.

These measures will minimize the change of successful infant-to-infant transmission of infection. The problem of attendant carriers is, of course, quite different and must be approached separately.

1. The infants should have contact with the smallest number of attendants needed for adequate nursing care. Nursing assignments should be arranged in such a manner that the same nurse cares for the same infants throughout their stay in the nursery. Obviously, the more attendants are available, the fewer infants each would have contact with, and an attendant who is carrier of a pathogenic staphylococcus will succeed in infecting the smallest possible number of infants.

2. All personnel who have direct contact with infants should have cultures taken at frequent intervals in order to detect carriers of phase types of staphylococci known to be pathogenic.

3. Any attendant with suspected staphylococcal disease must be excluded rigidly from contact with the infant. Similarly, in the presence of any type of respiratory infection, the individual must be excluded from the nursery.

In order to obtain reliable data about the success of these methods in reducing the incidence of infection with staphylococci and other organisms, it is desirable to have in operation at all times some systematic device for follow-up of infants discharged from the nursery. This would give an indication of any untoward incidence of some particular type of disease occurring after discharge.

Notes

maintenance [ˈmeɪntɪnəns] — *підтримка, утримання*
compromise [ˈkɔmprəmaɪz] — *компроміс*
safety [ˈseɪftɪ] — *безпека*
to discharge [dɪsˈtʃɑːdʒ] — *звільняти, випускати*
obviously [ˈɔbvɪəslɪ] — *очевидно, ясно*
rigidly [ˈrɪdʒɪdlɪ] — *суворо*
similarly [ˈsɪmɪləlɪ] — *подібно*
to exclude [ɪksˈkluːd] — *вилучати*
to reduce [rɪˈdjuːs] — *зменшувати*
indication [ˌɪndɪˈkeɪʃn] — *вказівка, ознака*
untoward [ʌnˈtouəd] — *нещасливий, несприятливий*

Text 31. We Study Physiology

The Heart

The heart is a hollow organ. One septum devides the heart into two chambers. Each chamber has the atrium and the ventricle. The left cardiac chamber discharges blood received from the pulmonary

circulation. This blood is discharged out through the aorta to the systemic circulation.

The right heart chamber discharges blood received from the systemic circulation. This blood is discharged to the lungs through the pulmonary arteries.

The valves are located at the entrance and exit of each ventricle. The sounds heard in the heart are produced by the closing of the valves.

The heart is made up of the cardiac muscle, which contracts during the whole period of life. Cardiac arrest means death.

In the adult the heart usually makes from 70 to 75 beats (contractions) per minute.

The amount of blood discharged from the heart during a single contraction is called the systolic volume.

The heart wall consists of three layers: the epicardium, the myocardium and the endocardium.

The epicardium and the endocardium consist of connective tissue. The cardiac muscle or the myocardium produces the contractions of the heart.

The heart is lying in the cardiac sac or the pericardium.

Breathing

We breathe with the lungs. The lungs form a pair of organs lying in the chest. Each lung is conical in shape. The lungs exactly fill both sides of the chest. The lungs rest on the diaphragm. The left lung consists of two lobes. The right lung consists of three lobes. Air enters the lungs through the trachea.

The trachea is divided into two branches. Each lung is enveloped in a membrane. The space between the lungs is called the mediastinum.

When one breathes in oxygen is inspired; when one breathes out carbon dioxide is expired. Carbon dioxide is produced in the human body as a result of body metabolism.

The adult makes 16-20 respiratory movements per minute. Respiratory metabolism takes place in the pulmonary alveoli.

Notes

hollow ['hɔlou] — *пустий; глухий*
ventricle ['ventrɪkl] — *шлуночок*
pulmonary ['pʌlmənərɪ] — *легеневий*
valve ['vælv] — *клапан*
exit ['eksɪt] — *вихід*

cardiac ['kɑ:dɪæk] — *серцевий*
arrest [ə'rest] — *зупинка*
contraction [kən'trækʃn] — *скорочення*
tissue ['tɪsju:] — *тонка перегородка*
muscle ['mʌsl] — *м'яз*
lung [lʌŋ] — *легеня*
conical ['kɔnɪkl] — *конусоподібний*
trachea [trə'ki:ə] — *трахея*
membrane ['membreɪn] — *перегородка, плівка*
alveolus ['ælvɪələs] — *альвіола*
alveoli ['ælvɪəlaɪ] — *альвіоли*

Text 32. Ophthalmology

Foreign Bodies and Perforating Wounds of the Eyeball

Perhaps the most commonly encountered ocular injury is the minor but annoying disturbance caused by the retention of a small foreign body beneath the upper lid. It should be remembered that these usually lodge in a narrow sulcus near the lid margin and can be removed by everting the upper lid. The latter maneuver can be embarrassingly difficult at times but if the examiner will remember to have the patient look extremely downward and will pull the lid outward before folding it upward, the procedure will be greatly facilitated. It should also be noted that many foreign bodies give the sensation of being in the upper lid when they are embedded in the corner. Their presence is frequently missed because the examination is improperly performed. Oblique illumination from a small concentrated light source will immediately reveal the foreign body. Removal can usually be effected with a cotton tipped applicator or by irrigation from a syringe. Embedded foreign bodies which do not wipe off readily should be handled by a specialist.

Any injury in which there is actual or suspected perforation of the eyeball with or without a retained foreign body, is an extremely serious situation demanding immediate attention. No such injury can be treated by one not specifically trained. If a foreign body is thought to have entered an eye, as might occur in rifle shooting in the presence of a defective breech mechanism, it may be helpful to save a piece of the original material from which the foreign body is thought to have fragmented. It may, for example, be helpful to determine the degree of magnetism of the material in order to estimate the chances of its

removal. Precise localization of an intraocular foreign body requires specialized equipment.

It should be emphasized that any perforating injury demands immediate attention. Most physicians are aware of the peculiar entity, sympathetic ophthalmia, which seems to have no counterpart in other organs of the body. In this disease a severe inflammatory process develops in the injured eye, which after a varying period of time may be reproduced in the uninjured eye. Quite frequently the disease in the sympathizing or uninjured eye may be far more severe than in the originally injured eye. Until the advent of steroid drugs, treatment was notoriously unsatisfactory. Even now treatment of the condition can be a harrowing one to the physician and patient alike, so that prevention rather than cure should be the aim.

In general, unless an eye is obviously injured beyond all repair, the course usually followed is immediate repair of the injured eyeball followed by close observation for a period of ten days or so. If at the end of this time the patient has reasonably good vision, and the inflammatory process seems to be subsiding, it is generally considered good judgement to assume the calculated risk which follows any perforating injury and continue observation and treatment. If, on the other hand, at the end of the ten-day period, the eye is blind, soft, and shows evidence of increased inflammatory response, further delay should not be permitted but the eye should be removed immediately.

Notes

foreign body ['fɔrɪŋ 'bɔdɪ] — *чужерідне тіло*
perforating wound ['pə:fə,reɪtɪŋ 'wu:nd] — *поранення наскрізь*
wound ['wu:nd] — *рана*
eyeball ['aɪbɔ:l] — *очне яблуко*
ocular ['ɔkjulə] — *очний*
injury ['ɪndʒərɪ] — *пошкодження*
retention [rɪ'tenʃn] — *збереження, утримання*
lid — *повіка*
to remove [rɪ'mu:v] — *витягувати*
to facilitate [fə'sɪlɪteɪt] — *полегшувати*
to embed [ɪm'bed] — *вставляти*
oblique [ə'bli:k] — *похилий, непрямий*
irrigation [,ɪrɪ'geɪʃn] — *зрошення*
syringe ['sɪrɪndʒ] — *шприц*
immediate [ɪ'mi:djət] — *негайний*
peculiar [pɪ'kju:ljə] — *особливий*
counterpart ['kauntəpɑ:t] — *двійник*

inflammatory [ɪn'flæmətərɪ] — *запальний*
advent ['ædvənt] — *поява*
notoriously [nou'tɔ:rɪəslɪ] — *загальновідомо*
reasonably ['ri:znəblɪ] — *достатньо*
vision ['vɪʒn] — *зір*
to subside [səb'saɪd] — *падати*
response [rɪs'pɔns] — *реакція*
delay [dɪ'leɪ] — *зволікання*

Text 33. Surgery

Neurosurgery

Neurosurgery one of the youngest branches of medicine, has greatly advanced. By entering the brain or spinal cord the peripheral or vegetative nervous systems, neurosurgeons are successfully doing away with disorders that were formerly considered incurable.

Specialists in various fields — neurology, roentgenology electrophysiology and therapeutics — work in the laboratories equipped with the finest and often unique instruments.

A detailed and minute study of each patient makes it possible to avoid unforeseen accidents and detect the specific peculiarities of the affected nervous system.

Certain types of tumours reach large dimensions and weigh 200—250 grams or more, making up approximately 15—20 percent of the weight of the brain. In growing the tumour presses upon the surrounding tissues and vital nerve centres. A person gradually loses his power of speech, eyesight, sense of smell and hearing.

In such cases, there is only one way out: surgery.

That the outcome be successful it is extremely important, that the location of the tumour and its exact size be predetermined.

Any tumour differs from the healthy tissue both in form and size of the blood vessels which nourish it.

In order to find them and get a clear picture of the illness a contrasting substance, which the X-rays cannot penetrate, is introduced into the patient's carotid artery. Through the blood stream it reaches the brain and is retained there for several seconds. In this short space of time, a special apparatus takes approximately forty pictures, which present a sufficiently clear picture of the brain's affliction.

There is yet another effective method of diagnosis — electro-encephalography.

Supersensitive and extremely complex apparatus detect and chart the bioccurrents of the brain.

The electro-encephalogram is a summary chart of the brain's biocurrents, taken from 16, 20 and even 32 different points and produced on a paper ribbon. However, to make exact analysis of the illness, even this data is insufficient.

The apparatus has an analyser and an integrator which determine the amount of electrical energy each rhythm emits. Thus the task of diagnosing is considerably speeded up and made easier: the location and size of the tumour can be determined with great accuracy.

The latest problem facing neurosurgeons is finding a cure for Parkinson's disease, which usually afflicts people who have had encephalitis. The hands and legs begin to shake; there is a general stiffness of movement, and a person can no longer walk, eat or dress unaided. In order to bring the patient back to normal a small section deep within the brain must be "shut off." Working on precise calculations and X-rays it is now possible to "hit the mark", and introduce a thin nylon pipe into the brain and let in through it some absolute alcohol into the necessary area of the subcortical centres.

Operations performed during the past two years allow us to state that this method of neurosurgical interference in illnesses formerly considered incurable is extremely effective.

Any operation results in a loss of blood. The smaller the loss, the quicker the patient recovers. In order to cut down the loss of blood, substances which temporarily dilate the capillaries are widely used. By introducing these substances into the body, we greatly increase the capacity of the patient's blood vessels and thus lower his arterial pressure. Neurosurgical operations are performed with practically no loss of blood.

The human brain has a wonderful capacity for compensating disrupted functions. In many cases, even after very large tumours were removed, the various functional disorders disappeared entirely and the patients could actually return to work.

Notes

spinal ['spaɪnl] — *спинний*
cord ['kɔ:d] — *зв'язка*
peripheral [pə'rɪfərəl] — *зовнішній пристрій*
tumour ['tju:mə] — *пухлина*
to predetermine ['pri:dɪ'tə:mɪn] — *вирішувати наперед*
to nourish ['nʌrɪʃ] — *живити*
carotid artery [kə'rɔtɪd 'ɑ:tərɪ] — *сонна артерія*

approximately [ə'prɔksɪmɪtlɪ] — *приблизно*
to remove [rɪ'mu:v] — *витягувати, виводити*
affliction [ə'flɪkʃn] — *нещастя, біда*
diagnosis [ˌdaɪəg'nousɪs] — *діагноз*
to detect [dɪ'tekt] — *виявляти*
to emit [ɪ'mɪt] — *виділяти, випромінювати*
accuracy ['ækjurəsɪ] — *точність*
Parkinson's disease ['pɑ:kɪnsənz dɪ'zi:z] — *хвороба Паркінсона*
to afflict [ə'flɪkt] — *засмучувати*
stiffness ['stɪfnɪs] — *упертість*
alcohol ['ælkəhɔl] — *спирт, алкоголь*
temporarily ['tempərərɪlɪ] — *тимчасово*
to dilate [daɪ'leɪt] — *розширювати(ся)*
capillary [kə'pɪlərɪ] — *капілярний*
pressure ['preʃə] — *тиск*

Text 34. The First Aid

The Ambulance

Trauma has been with us since antiquity and will be here at the millennium. Since the first injury was sustained by man, it has been necessary to transport him to a place where he could be fed and sheltered, and his wounds treated.

The quality of transportation of the injured in our modern civilization leaves much to be desired.

For many years transportation of the injured has consisted essentially of putting the victim on a cart and transporting him to the hospital as quickly as possible. No effort was made to evaluate the injuries nor to follow any of the principles which would make for a safer ride. This situation, however, has gradually changed in many areas because of the efforts of the medical profession. Distinct efforts have been made to educate the ambulance attendant as to the fundamental principles of transporting the injured.

In many cases, poor transportation of the injured can do more harm than the original accident.

An educational program is needed to educate the ambulance attendants as to proper methods of transportation.

The following is a teaching outline used in the ambulance attendant training program.

Position of Victim. Keep patient in comfortable position, head level with body, until the nature of the injury is known.

Examination. Look for and treat serious bleeding and respiratory arrest. Find and splint all fractures and dislocations. Cover wounds and burns with sterile dressings.

Shock. Maintain body heat. Transport comatose patient in supine position. Handle gently.

Control of Bleeding. Direct pressure over wound. Know pressure points. Use tourniquet as last resort. A poorly applied tourniquet may cause great damage. Place sterile dressing over all open wounds and bandage in place.

Internal Injuries. Maintain body heat. Keep victim perfectly quiet. Move only when absolutely necessary and in supine position. Turn head to one side if victim is vomiting. Handle gently.

Failure of Respiration. If victim is not breathing, start artificial respiration immediately. Use oxygen when victim starts to breathe. Severe injuries of the chest require specialized attention.

Fractures. Splints should be used in all suspected fractures during transportation of victim. Fractures may be either open or closed.

In an open fracture the broken bone sometimes presents through the wound to the surface of the skin. These fractures are often more serious than the closed type. Check for serious bleeding or shock, and treat. Wounds should be covered with sterile dressings and splinted as in closed fractures. Pillow splints are used if the wound contains foreign material. Do not push protruding bones inside.

Thoracic Injuries. Fractures of the ribs: If no internal injury is suspected, the patient is moved on his back with head and thorax slightly elevated.

Internal thoracic injuries may follow fracture of the ribs or external puncture. Cover open and sucking wounds with sterile gauze so that outer air cannot enter chest cavity. Place victim on injured side and make him as comfortable as possible. Sandbag any areas showing paradoxical motion.

Dislocations. The pillow splint is comfortable for transportation of the patient.

Burns. Cover burned areas with sterile dressing and bandage in place. If large area of body is burned, wrap in clean sheet.

Injuries to the Head. Cover all open wounds with sterile dressings. Avoid pressure at site of injury. Transport victim in prone or side position.

Notes

ambulance ['æmbjuləns] — *машина швидкої допомоги*
trauma ['trɔ:mə] — *травма, рана*
antiquity [æn'tɪkwɪtɪ] — *античність*
millennium [mɪ'lenɪəm] — *тисячоліття*
to sustain [səs'teɪn] — *підтримувати, витримувати*
victim ['vɪktɪm] — *жертва*
cart ['kɑ:t] — *віз, повозка, візок*
to evaluate [ɪ'væljueɪt] — *оцінювати*
fracture ['fræktʃə] — *перелом*
dislocation [ˌdɪslə'keɪʃn] — *вивих, порушення*
burn [bə:n] — *опік*
sterile ['steraɪl] — *стерильний*
dressing — *пов'язка*
to maintain [men'teɪn] — *підтримувати*
tourniquet ['tuənɪkeɪ] — *турникет*
injury ['ɪndʒərɪ] — *пошкодження*
to vomit ['vɔmɪt] — *блювати*
to breathe ['bri:ð] — *дихати*
to protrude [prə'tru:d] — *стирчати*
thorax ['θɔ:ræks] — *грудна клітка*
to elevate ['elɪveɪt] — *піднімати, підвищувати*
puncture ['pʌŋktʃə] — *укол, пункція*
gauze [gɔ:z] — *газ, марля*
prone ['proun] — *розпростертий*

Text 35. Rupture of the Thoracoacromial

Artery in Anterior Dislocation of the Shoulder

The patient, a forty-seven-year-old schoolteacher, was seen in the clinic with a history of dislocating her left shoulder. At the time of admission she complained of severe pain in the left shoulder. X-ray examination confirmed the diagnosis of anterior dislocation. Her past history revealed a shoulder dislocation six years prior to this accident. Reduction was attempted with the patient under local anaesthesia. Immediately following reduction a bluish discoloration appeared along the anterior axillary area. Examination revealed no loss of sensation and a radial pulse of good volume. Because the patient was experiencing severe pain and also because of the unusual find-

ings of ecchymosis and tension in the axillary area she was admitted to Nankin Hospital. At 7.00 p. m. (six hours after admission) the patient showed progressive symptoms of shock for which she received a blood transfusion. Following the transfusion the patient felt well for a short time, but symptoms of shock reappeared with concomitant evidence of spreading of the ecchymosis and increase of tension in that area. All these findings suggested surgical intervention. With the patient under anaesthesia, an incision was made over the upper portion of the pectoral and brachial areas. Proper surgical procedures having been made, the wound was closed in layers with drainage. The patient was returned to her room in good condition and recovery progressed satisfactorily.

Notes

rupture [ˈrʌptʃə] — *перелом; грижа*
anterior [æn'tɪərɪə] — *попередній*
dislocation — *вивих, порушення*
ecchymosis — *крововилив*
transfusion [træns'fu:ʒn] — *переливання*
concomitant [kən'kɔmɪtənt] — *супутний; супровідний*
evidence [ˈevɪdns] — *підстава; доказ*
intervention [ˌɪntə'venʃn] — *втручання*
incision [ɪn'sɪʒn] — *надріз*
drainage [ˈdreɪnɪdʒ] — *дренаж; осушення*

2. Section. Sports

Text 1. Sports

Sports are athletic games or tests of skill undertaken primarily for the diversion of those who take part or those who observe them. The range, including both individual and competitive sports, is great. Usually, however, sports as a term is restricted to any play, pastime, exercise, game, or contest restricted by prescribed rules and performed under those rules indoors or outdoors, on an individual or a team basis, with or without competition, but requiring skill and physical prowess. Sports may be divided according to type (such as ball games), but the basis of enjoyment for all types is the same, whether one is taking part or merely a spectator. Track athletics are a matching of skill against time and space; sports such as hockey depend on the stimulus of team competition, while archery is individual and as a sport a one-to-one competition. Some sports, such as hunting, fishing, and swimming, have their origins in man's primitive life, but as developed sports they have extreme sophistication in such things as highly developed sports guns, fly casting, and skin diving. The origins of most sports remain obscure. It is definitely known that basketball was invented in the United States in 1891 by James Naismith, but this is an exception. The origins of some sports, notably baseball, are still the subject of much controversy. In ancient times the outstanding organized sports activities were the Olympic Games. Several sports that developed in medieval Europe were organized by and for the royalty and nobility (e.g., court tennis), while other sports took root among the masses. The disintegration of the feudal structure and the coming of the Industrial Revolution brought about profound changes in sports.

While court tennis, archery, and other pastimes of the nobility went into decline, croquet, boxing, and shooting increased in popularity. Cockfighting, bare-fist boxing, and bull baiting, considered barbarous by many, were gradually banned by legislation, as the general desire to do away with crude brutalities in sports became more widespread. Equipment was standardized, local and national organizations were set up to govern the sports, and distinctions were made between amateur and professional. In the late 19th century — when the Olympic games were revived — tennis, volleyball, handball, bowling, racquets, and squash tennis came to the fore, while polo was introduced from Asia to Europe. Sports that were traditionally played in various countries became, by legislative act or general acceptance, national sports — baseball in the United States, bullfighting in Spain and Mexico, cricket in England, and ice hockey in Canada. Moves were made to minimize the effects of gambling on sports, particularly in horse racing. In the 20th century, colleges led the way in emphasizing sports as an essential part of a person's education. Rowing, fencing, track and field athletics, and gymnastics became popular participation sports on the campus as well as in the athletic club. College authorities, however, were soon subjected to severe criticism for commercializing spectator sports, especially football, and for the questionable amateur status of some of their athletes. Sports, participant and spectator, had a tremendous growth in the 20th century in those countries where a good percentage of the population had leisure time. International sports have also become instruments of political action. For example, Rhodesia was excluded from the 1972 Olympic games because of its separatist racial policies, and the visit of a U.S. table tennis team to Communist China was used to signal the start of improved Sino-American relations in the early 1970s. Several of the most popular spectator sports are today big businesses.

Notes

diversion [daɪ'vɜ:ʃn] — *розвага*
range ['reɪndʒ] — *сфера; діапазон*
to restrict [rɪs'trɪkt] — *обмежувати*
pastime ['pɑ:staɪm] — *розвага, гра*
contest [kən'test] — *змагання, конкурс*
athletics [æθ'letɪks] — *атлетика*
archery ['ɑ:tʃərɪ] — *стрілянина з лука*
hunting — *полювання*
sophistication [sə,fɪstɪ'keɪʃn] — *фальсифікація*
to dive ['daɪv] — *стрибати у воду*

exception [ɪk'sepʃn] — *виняток*
controversy ['kɔntrəvə:sɪ] — *дискусія*
disintegration [dɪs,ɪntɪ'greɪʃn] — *розпад*
barbarous ['bɑ:brəs] — *варварський, жорстокий*
to ban [bæn] — *забороняти*
legislation [,ledʒɪs'leɪʃn] — *законодавство*
crude [kru:d] — *грубий*
brutality [bru:'tælɪtɪ] — *жорстокість*
bowl [boul] — *кеглі; келих*
to the fore ['fɔ:] — *уперед*
campus ['kæmpəs] — *університетський двір (містечко)*

Text 2. Table Tennis

Table tennis is a game played, usually indoors, by two or four players; it is more or less a miniature form of lawn tennis. It is also called Ping-Pong, after the trade name for a kind of table tennis. The regulation game is played on a table that measures 9 ft by 5 ft (2.74 m by 1.52 m) and stands 2.5 ft (76.2 cm) from the floor. A transverse net 6 in. (15.24 cm) high divides the surface, which is generally dark in color, edged with light stripes, and halved longitudinally (for doubles play) by another light stripe. The celluloid ball is hollow, seamless, and about 1.5 in. (3.81 cm) in diameter, with a weight of .1 oz (2.8 grams); the racket is a wooden paddle with a handle 3 in. (7.62 cm) long and a round blade about 6.5 in. (16.5 cm) long, often covered with rubber or sandpaper. In the service (unlike tennis) the ball must bounce once before clearing the net and again bounce once on the near surface. After the service (only one is allowed, not two as in tennis), the returns should go over the net without bouncing on the near surface. A point is scored when a service goes foul or when a player fails to return the ball properly. Each player in turn serves consecutively five times until the winning score of 21 is reached. (If the score is tied at 20-all, play must continue until a 2-point margin is earned.) In double matches partners rotate in units of five consecutive services, and the server must deliver the ball into the diagonally opposite box. Table tennis probably originated in the late 19th century. First popular in England, it spread to several European countries and to the United States in the early 20th century. The International Table Tennis Federation was founded (1926) to standardize the rules and equipment of the game. It also sponsors team and individual world championships every two years. The group is composed of over 70 national governing

bodies, including the U.S. Table Tennis Association (founded 1933). Primarily a recreational sport in the United States, table tennis is a major competitive sport in the Orient and parts of Europe. In 1971 the sport achieved a great measure of publicity when, while touring Japan, a U.S. table tennis team was invited to play in Communist China, thereby initiating the first officially sanctioned Chinese-American cultural exchange in almost twenty years.

Notes

longitudinally [ˌlɔndʒɪ'tju:dɪnəlɪ] — *вздовж*
stripe [straɪp] — *смуга*
celluloid ['seljulɔɪd] — *целулоїдний*
hollow ['holou] — *пустий, порожній*
paddle — *весло*
blade — *лóпать*
sandpaper — *наждачний папір*
bounce ['bauns] — *стрибок*
point — *очко*
foul ['faul] — *нечесно*
consecutively [kən'sekjutɪvlɪ] — *послідовно*
diagonally [daɪ'ægənəlɪ] — *по діагоналі*
the Orient ['ɔ:rɪənt] — *Схід, країни Сходу*
to sanction ['sæŋkʃn] — *схвалювати, затверджувати*

Text 3. Racquets

Racquets is a game played by two or four persons on a court 60 by 30 ft (18.3 m by 9.1 m); it is surrounded by three walls 30 ft (9.1 m) high and a backwall 15 ft (4.6 m) high. The ball, 1 in. (2.54 cm) in diameter, is made of polyethylene with an adhesive tape cover. The gut-strung racket is 30 in. (76.2 cm) long, has a circular head about 8 in. (20 cm) in diameter, and weighs 8 to 10 oz (about 25 kg). A service line is painted horizontally across the front wall a little over 9.5 ft (2.9 m) from the ground, and a short-line is painted 36 ft (11 m) from, and parallel to the front wall. A line also extends from the center point of the short-line into two service courts. The rules of the game are similar to those of squash racquets. The hardness and speed of the ball makes racquets one of the fastest and most dangerous games. It originated in 18th-century England, probably in debtors' prisons, but was soon adopted by the wealthier classes. Expensive racquets courts were built in England, and racquets was introduced

into the United States in the 19th century by way of Canada. The United States Racquets Association annually conducts national championship matches.

Notes

adhesive [əd'hi:sɪv] — *липкий*
service ['sə:vɪs] — *робота*
to conduct [kən'dʌkt] — *керувати*

Text 4. Gymnastics

Gymnastics is exercises for the balanced development of the body, practiced usually in a room or building called a gymnasium. In Greece the gymnasium was originally a place of training for the Olympic Games and other athletic contests; the Lyceum and Academy of Athens were large enough for cavalry parades, besides containing a running track, pits for jumping, and ranges for throwing the discus and javelin. By the end of the 4th century B.C. the gymnasium became an educational and cultural center for Greek youths. Modern gymnastics date from the early 19th century, when Ludwig Jahn established several *Turplätze* in Berlin. Gymnastics spread on the Continent, to England, then to the United States, and became part of the modern Olympic meets. Gymnastics became part of the American school curriculum, were adopted by the army, and became a featured college sport in the United States. Besides free calisthenics, the principal gymnastic events in the United States are the side and long horse, the parallel and horizontal bars, trampoline, rope climbing, the flying rings, and tumbling. Except for rope climbing, which is scored on speed, events are scored on the basis of form, execution, and difficulty of optional exercises. There are competitions for women as well as for men. All around champions are selected on the basis of excellence in a number of events. Team competitions are scored on the basis of total points for all events. The Amateur Athletic Union holds annual national championship meets for men and women.

Notes

gymnastics [dʒɪm'næstɪks] — *гімнастика*
gymnasium [dʒɪm'neɪzjəm] — *гімнастичний зал*
curriculum [kə'rɪkjuləm] — *курс навчання, програма*
featured ['fi:tʃəd] — *показовий*
horizontal [ˌhɔrɪ'zɔntl] — *горизонтальний*
tumbling — *перекидання*

execution [ˌeksɪ'kju:ʃn] — *виконання*
optional ['ɔpʃnəl] — *необов'язковий*

Text 5. Volleyball

Volleyball is an outdoor or indoor ball and net game played on a level court. An upright net, the top of which stands 8 ft (2.44 m) from the ground, divides the court — 60 ft (18.29 m) long and 30 ft (9.14 m) wide — in half. Smaller courts are generally used when women or children play the game. Three forwards and three backs, covering equal areas of the court, compose a volleyball team. The inflated rubber or leather volleyball, about 27 in. (69 cm) in circumference, is served from behind the back lines of the court. The ball is batted with the open hand or fist and must clear the top of the net; it may go into any part of the opponents' court. Only one try is allowed on the serve. The ball must be returned without allowing it to touch the ground and must be volleyed within the boundaries of the court. Any part of the body may be used to bat the ball, and a maximum of three hits (in passing the ball from player to player on one team) is permitted before the ball is returned. Only the team that is serving scores, and if the receiving team wins the volley, it gains the next serve after the players rotate their positions clockwise. The team scoring 15 points first wins the game, but if the score is tied at 14, the first team to lead by two points wins. Volleyball was originated (1895) by William G. Morgan at Holyoke, Mass. The game was fostered by the Young Men's Christian Association in its early years, but since 1928 the governing body in the United States has been the U.S. Volleyball Association. The association is a charter member of the International Volleyball Federation (founded 1947). In 1955 volleyball was included in the Pan American games, and since 1964 it has been included in the Olympic games.

Notes

upright ['ʌp'raɪt] — *вертикальний*
forward ['fɔ:wəd] — *нападаючий*
back — *захисник*
to inflate [ɪn'fleɪt] — *надувати*
circumference [sə'kʌmfərəns] — *коло*
to bat — *бити*
to volley — *ловити м'яч*
clockwise — *за стрілкою годинника*
to foster ['fɔstə] — *сприяти*
Mass. = Massachusetts [ˌmæsə'tʃu:sets]

Text 6. Track and Field Athletics

Track and field athletics is sports of foot racing, hurdling, jumping, vaulting, and weight throwing. They are usually separated into two categories — track, the running events; field, the throwing and vaulting events. The events, contested between individuals or teams, usually are conducted on a field comprising an oval track that surrounds an infield equipped for various field events. In the United States the most popular events include the 100-, 220-, and 440-yard dashes; the half-mile (880-yard), mile, and 2-mile runs; the 120-yard high-hurdle and 200-yard low-hurdle races; the mile relay; the long jump, the pole vault, the shot put, the discus throw, the javelin throw, and the hammer throw. The cross-country and distance races, though not performed on the field, are usually classed with these events, as are the marathon and walking races. Winter indoor meets are popular in major cities and include running events (from 60 yd to 2 mi), high hurdles (60 yd), and field events. In the modern Olympic Games and many other international meets, track events include the 100-, 200-, 400-, 800-, 1,500-, 5,000-, and 10,000-meter runs; a marathon run (26 mi 385 yd/ 42.20 km); the 110- and 400-meter hurdle races; the 400- and 1,600-meter relay; the 3,000-meter steeplechase; and the 20,000- and 50,000-meter walks. The Olympic games include, in addition to the field events already named, the triple jump, formerly known as the running hop-step-and-jump. The decathlon is the major composite event contested in Olympic track and field competition, while the pentathlon is contested in the U.S. national championships. All the events described are primarily men's events. There are also equivalent events for women in U.S. and Olympic games competition. In ancient Greece track and field athletics dominated the original Olympic games and other games; there were also less important and separate games for women. Such organized contests were also popular in Rome but lapsed in the early Middle Ages. In England they were revived in the 12th century and thereafter steadily increased in popularity. The first college track and field meet occurred in England (1864) between Oxford and Cambridge. Other European countries soon turned to the sport. Track and field athletics in the United States date from the 1860s. The Intercollegiate Association of Amateur Athletes of America, the nation's first national athletic group, held the first collegiate meet in 1876, and in 1888 the Amateur Athletic Union held its first championships. Those two groups, along with the National Collegiate Athletic Association, regulate the sport in the United States. The mid-20th century has been marked by a continuous improvement in track and field accom-

plishments. Performances previously considered unattainable, such as the 4-minute mile, are now common. Other major track and field accomplishments include the 70-foot shot put, the 7-foot high jump, the 29-foot long jump, and the 18-foot pole vault. Professional track and field was begun (1973) by the International Track Association, the world's first professional track and field group.

Notes

track and field athletics [æθ'letɪks] — *легка атлетика*
foot racing — *змагання у ходьбі*
hurdling ['hə:dlɪŋ] — *бар'єрний біг*
vaulting ['vɔ:ltɪŋ] — *стрибок із жердиною*
to comprise [kəm'praɪz] — *охоплювати*
to dash [dæʃ] — *кидати, метати*
relay [rɪ'leɪ] — *естафета; зміна*
pole ['poul] — *жердина*
to put — *кидати; штовхати; метати*
discus ['dɪskəs] — *диск*
javelin ['dʒevlɪn] — *дротик*
steeplechase ['sti:pltʃeɪs] — *біг з перешкодами*
triple ['trɪpl] — *потроєний; потрійний*
pentathlon [pen'tæθlən] — *п'ятиборство*
composite ['kɔmpəzɪt] — *складний*
to lapse [læps] — *втрачати чинність*
thereafter [ðeər'ɑ:ftə] — *після цього*
steadily ['stedɪlɪ] — *постійно*
collegiate [kə'li:dʒɪɪt] — *університетський; колегіальний; студент*
unattainable ['ʌnə'teɪnəbl] — *недосяжний*

Text 7. Cricket

Cricket is a summertime ball and bat game played chiefly in Great Britain and the Commonwealth countries. It is played by two opposing teams of 11 men each on a level, closely cut, green turf preferably measuring about 525 ft (160 m) by about 550 ft (170 m). Two wickets are placed 66 ft (20.12 m) apart near the middle of the field. A wicket consists of two small wooden crosspieces known as bails resting on three wooden stumps 28 in. (71.1 cm) high. At each wicket stands a batsman. If the bowler of the opposing team knocks down the bails of the wicket opposite him, the batsman defending that wicket is retired. In bowling the hard, leather-covered ball, the bowler may not bend his arm, and the ball usually approaches the batsman on one bounce. When the bowler has bowled the ball six times (eight in Australia and South Africa) to the batsman at one wicket, an umpire (there is one at each wicket) calls "over," and another bowler begins bowling to the batsman's partner at the other wicket. The players in the field shift their positions according to which batsman is batting. For his part, the batsman tries to hit the ball with his paddleshaped bat far enough so that he and his partner may run to exchange places, thereby scoring a run. When the ball is hit for a long distance (in any direction, since there are no foul lines in cricket), several exchanges or runs may be made. (If the ball reaches the boundary of the field on the ground, four runs are scored without the batsmen having to run; similarly, if the ball clears the boundary in the air, six runs are added to the score.) However, if the opposing team recovers the ball in time to knock down the bails of a wicket before the batsman reaches it, he is out. A batsman is also retired if the ball he hits is caught on the fly (as in baseball), and he may be retired for several other more technical reasons. An outstanding batsman may score more than 100 runs, a "century," before being retired, and totals in the 400s have been posted. A game consists of two innings; in one inning all the men of each team bat once in a fixed order (unless a team chooses to retire without completing its batting order); it may take several days to complete one game. The team scoring the most runs wins. Except in case of serious injury, no substitutions are allowed. The origin of cricket is obscure. Some contend that it was invented in France as a derivative of croquet. Most evidence, however, suggests that cricket was developed in medieval England (about 12th-13th century). In 1744 the London Cricket Club drew up the first authoritative set of rules. The Marylebone Cricket Club (founded 1787) is one of the world's oldest cricket organizations and is still the international governing body of the game. In Great Britain the principal cricket matches are those between the universities (especially Oxford and Cambridge) and between the largely professional teams representing the English counties. International, or test, matches are played annually, the most famous contest being that between Australia and Britain for the "Ashes." After Australia's surprising victory in the 1882 competition, London's *Sporting Times* displayed an obituary for British cricket whose final lines read: "The body will be cremated, and the ashes taken to Australia." The following year the British vowed to retrieve "the ashes;" thus was born the unusual name of this famous sporting event. In the United States the game was supplanted in popular favor by baseball, a sport derived in part from cricket.

Notes

cricket ['krɪkɪt] — *крикет* **wicket** ['wɪkɪt]— *хвіртка*
turf [tə:f] — *дерен* **bail** ['beɪl] — *ручка*
stump [stʌmp] — *пень; недокурок; "кінь"*
batsman ['bætsmən] — *той, хто відбиває*
bowler ['boulə] — *ігрок, який подає м'яч*
bounce ['bauns] — *стрибок*
umpire ['ʌmpaɪə] — *суддя; посередник*
thereby ['ðɛə'baɪ] — *таким чином, у зв'язку з цим*
foul ['faul] — *безчесний*
innings ['ɪnɪŋz] — *черга подачи м'яча*
to contend [kən'tend] — *твердити; боротися*
croquet ['kroukeɪ] — *крокет*
obituary [ə'bɪtjuərɪ] — *некролог*
to cremate [krɪ'meɪt] — *спалювати (трупи)*
to vow ['vau] — *давати клятву*
to retrieve [rɪ'tri:v] — *виправляти*
to supplant [sə'plɑ:nt] — *виживати*

Text 8. Golf

Golf is a game of hitting a small hard ball with specially made clubs over an outdoor course sometimes called a links. The object is to deposit the ball in a specified number of cups, or holes, using as few strokes as possible. Although its origin is unknown, the game is identified with Scotland, where as early as 1457 it was banned as a threat to archery practice, which was considered vital to national defense. The Royal and Ancient Golf Club of St. Andrews, Scotland (founded 1754), became the international shrine of golf, and its basic rules are accepted throughout the world. The first British championship was held in 1857, when 11 clubs participated at St. Andrews, and three years later the annual British Open Tournaments were begun with a match at the Prestwick course in Scotland. Canada's Royal Montreal Golf Club (formed 1873) was the first golf club in the Western Hemisphere. There is evidence that golf was played in America in the 17th century, but it was not until 1888 that the first permanent golf club, the St. Andrews Golf Club of Yonkers, N.Y., was organized by John G. Reid, a Scot. A dispute between the sponsors of two "national" championships led American golfers to found (1894) the United States Golf Association (USGA) as the nation's governing body for golf. The USGA was also charged with conducting annual tournaments, including the National Amateur and National Open (which has both amateur and professional players). The first of these championships followed in 1895. In 1916 the United States Professional Golf Association (PGA) was founded and the annual PGA championship was inaugurated. Another important annual tournament for professionals is the Masters, held annually in Augusta, Ga. Famous international competitions include the Walker Cup (amateur), the Ryder Cup (professional), the Curtis Cup (women amateurs) between British and U.S. teams, and the World Championship (amateur) among teams from all over the world. Golf is one of the few sports that is popular on both the participant and spectator levels. Moreover, unlike many other sports, golf is enjoyed by both men and women, and its self-regulating pace allows it to be played by persons of all ages. Because of such advantages, the growth in golf's popularity has been phenomenal, especially in the United States. Between 1891 and the outbreak of World War II the number of golf courses in the United States grew from fewer than 10 to more than 5,700. Professionals have also benefitted from golf's popularity. Today it is not unusual for a top-ranking professional golfer to earn $100,000 or more in a year. The standard golf course, usually more than 6,000 yd (about 5,500 m) around, is divided into 18 consecutively numbered "holes," each marked by a tall flag and measuring 4.5 in. (11.43 cm) in diameter and 4 in. (10.16 cm) in depth. Each hole is located in a green, a smooth surface of closely cropped grass. The ball is initially driven toward the hole from the tee, a rectangular area approximately 7 ft (2.4 m) long and 3 ft (.9 m) wide. Between the tee and the green is the fairway, often bounded by tall grass and trees (the rough) and containing natural or artificial obstacles (hazards), such as water, sand pits, and mounds (traps). Fairways vary in length from 100 to 650 yd (90-600 m). At present there are two types of ball in use. Americans play with a ball that measures 1.68 in. (4.27 cm) or more in diameter. The British and most others use a ball whose diameter is 1.62 in. (4.11 cm) or more. Both types of ball weigh 1.60 oz (45 grams) or less, and each has a pitted rubberlike surface with a steel or liquid core. A complete set of golf clubs consists of 4 woods, used for long drives; 10 irons, used for shorter shots; and a putter, used for the short distances on the green. Formerly, each of the woods and irons had a name. Now they are simply standardized with the numbers 1 through 4 and 1 through 10 respectively. Play may be for two (a twosome), three (a threesome); or four individuals (a foursome), each using a separate ball. Inmatch play, as in the U.S. amateur tournaments, the winner is determined on the basis of the number of holes won from an opponent; in medal

play, as in the U.S. Open tournament, victory is decided by the lowest stroke total for all holes. Competition in both match and medal play may be at 18, 36, 54, or 72 holes as the precontest rules determine. Golf is popular in Australia, Canada, and South Africa, in addition to the United States and Great Britain.

Notes

club — *кий, палиця*
link [lɪŋk] — *зв'язок; ланка*
shrine ['ʃraɪn] — *місце поваги, храм*
to charge [tʃɑ:dʒ] — *доручати*
to inaugurate [ɪ'nɔ:gjureɪt] — *урочисто відкривати*
consecutively [kən'sekjutɪvlɪ] — *послідовно*
rectangular [rək'tæŋgjulə] — *прямокутний*
tournament ['tuənəmənt] — *турнір*
Ga = Georgia *(штат)*

Text 9. Soccer

Soccer is an outdoor ball and goal game, also called association football or simply football. The first recorded soccer game probably took place on a Shrove Tuesday in Derby, England, as part of a festival to celebrate the victory of English soldiers over a contingent of Roman troops (A.D. 217). By 1175 the annual Shrove Tuesday soccer game was a regular event. The sport remained popular for many centuries in England under the name football. But the advent of rugby (1823) as a variant led to confusion in names. The London Football Association was formed (1863) to further the game that emphasized only the kicking of the ball. The game became known as association football and then, through use of the abbreviation of *association*, as *soccer*. It gained tremendous popularity in Great Britain and was rapidly adopted by the continental countries, where it still generally goes under the name football. Played in more than 140 countries, soccer is unquestionably the most popular international sport, although it is a secondary sport in the United States because of the development of American football, a descendant of soccer and rugby. The U.S. Soccer Football Association (formed 1913) is the organizing body for both amateur and professional soccer in the United States. International competition is regulated by the Fédération Internationale de Football Association (founded 1940), which sponsors the quadrennial World Cup competition and whose membership is larger than that of the United Nations. Soccer has been an Olympic event since 1900. The

game is played on a grassy field preferably measuring 120 yd by 75 yd (110 m by 70 m). Centered on each end line is a goal, 8 yd (7.3 m) wide by 8 ft (2.4 m) high, backed with netting. A soccer team consists of 11 men — a goalkeeper, two fullbacks, three halfbacks, and five forwards. No substitution is allowed, and play is continuous through two 45-min periods. Overtime is played in case of ties. The object of the game is to advance a round, inflated leather ball — about 28 in. (71 cm) in circumference — to the opponent's goal. The ball is kicked (often dribbled with short kicks) or may be advanced by other parts of the body such as the head and chest, but only the goalkeeper may use his hands. Each goal counts one point. Penalties meted out by a referee, who is assisted by linesmen, are various types of free kicks, depending on the infraction. Perhaps the greatest soccer player of all time is Brazil's Edson Arantes do Nascimento, better known as Pelé, the most popular and highest paid athlete in the world.

Notes

soccer ['sɔkə] — *футбол*
confusion [kən'fju:ʒn] — *плутанина*
association [ə,sousɪ'eɪʃn] — *товариство, асоціація*
descendant [dɪ'sendənt] — *нащадок*
fullback — *захисник*
halfback — *напівзахисник*
forward — *форвард*
substitution [,sʌbstɪ'tju:ʃən] — *заміна*
overtime — *додатковий час*
tie — *нічия*
goal ['goul] — *гол*
penalty ['penltɪ] — *покарання*
penalty-kick — *одинадцятиметровий удар*
to mete [mi:t] — *визначити*
referee [,refə'ri:] — *суддя, арбітр*
to assist [ə'sɪst] — *допомагати*
infraction [ɪn'frækʃn] — *порушення*

Text 10. Rugby

Rugby is a game that originated (1823) on the playing fields of Rugby in England. It has many of the characteristics of soccer and American football. The game is said to have been started quite by accident when a Rugby student playing soccer picked up the ball and

ran downfield with it instead of kicking it. Games of that sort were soon seen frequently at Rugby, and when other English schools and universities adopted the style of play in the mid-19th century, the name rugby was given to the game. In 1871 the English Rugby Union was formed to standardize the game, and the sport was soon organized in other sections of the British Isles. The game was introduced (1875) into the United States, where it made relatively little headway. The rugby field is roughly 160 yd (146 m) long and 75 yd (69 m) wide, with goal lines 110 yd (101 m) apart and two in-goals (corresponding to football's end zones) 25 yd (23 m) deep. A halfway line divides the field, which is further subdivided by other lines parallel to the goal line. The goal posts have measurements similar to those used in American football, and the ball, although larger and more rounded; is similar to the American football. A team consists of 15 players (8 forwards and 7 backs), and no substitution is permitted. If a player is seriously injured, the team must play shorthanded. The ball may be kicked, carried, or passed (to the sides or to the rear); though tackling is permitted, blocking is forbidden. Unlike American football, play is almost continuous in rugby; after penalties and out-of-bounds plays, however, a scrum (in which the two opposing lines of forwards kick the ball thrown between them) starts play again. A try (carrying the ball into the opponent's in-goal) counts three points, a conversion (kicking the ball between the goal posts after a try is scored) two points, a field goal kick three points, and a penalty kick three points. A rugby match is divided into halves of 40 min, and there is no overtime period in case of a tie. Professional rugby, known as Rugby league, was organized in England in 1895. It is played by 13-man teams, and has somewhat different rules from the amateur Rugby union game. It is played chiefly in the North of England and in Australia, New Zealand, and France.

Notes

rugby ['rʌgbɪ] — *регбі*
by accident ['æksɪdənt] — *випадково*
to standardize ['stændədaɪz] — *стандартизувати*
headway ['hedweɪ] — *просування вперед, успіх*
apart [ə'pɑ:t] — *на віддалі*
shorthanded — *з невистачаючим складом*
to tackle ['tækl] — *схопити*
scrum [skrʌm] — *бійка*
conversion [kən'və:ʃn] — *перетворення, обернення*

Text 11. Swimming

Swimming is a self-propulsion through water, usually as a competitive sport or recreation. One of man's oldest activities, it probably dates back to prehistoric times. It is mentioned in many of the classics in connection with heroic acts or religious rites. The first book on the methods of swimming was Nicolas Wynman's *Dialogue Concerning the Art of Swimming* (1538). Swimming calls more muscles into play with exact coordination than most other sports, and its high repetition of movement makes it extremely beneficial to the cardiovascular system. Swimming strokes should be accomplished with the least possible resistance to water; there should be a minimum of splashing so that the forward motion is smooth and not jerky. The stroke most commonly used to attain speed in swimming is the crawl stroke, standardized in Australia (hence sometimes called the Australian crawl) and perfected in the United States. In the crawl the body is prone; alternating overarm strokes and the flutter kick are used, and the head alternates from side to side at water level. The trudgen stroke (named for the man whose speed in using it made it famous), popular in Spain, Latin America, and then England, also involves alternate overarm strokes from a prone position, but a scissors kick is used and the head remains on one side. The backstroke is done in a supine position and in racing requires alternate over-the-head strokes and a flutter kick. For endurance swimming, the backstroke involves alternation of the frog kick with simultaneous strokes of the arms, which are extended at shoulder level and moved in an arc toward the hips. The sidestroke, a relaxing movement, entails a forward underwater stroke with the body on one side and a scissors kick. The breaststroke can also be a restful stroke and is accomplished in a prone position; frog kicking alternates with a simultaneous movement of the arms from a point in front of the head to shoulder level. The most difficult and exhausting stroke is the butterfly. Second only to the crawl in speed, the butterfly is done in a prone position and employs the dolphin kick with a windmill-like double arm movement. It is mastered by only the best swimmers. The dog paddle, a very simple stroke that takes its name from the way a dog swims, is done by reaching forward with the arms underwater and by a modified flutter kick. In free-style swimming any stroke may be used, but the crawl, considered the speediest, is most favored. No matter what the stroke, however, the breathing should be easy and natural, since the specific gravity of the human body, although it varies with the individual, is almost always such that the body floats if the lungs are functioning normally. In races, facility in diving from a firm surface is

essential. Swimming, a universal practice that claims many participants in all sections of the world, became organized as an amateur sport in the late 19th century in several countries. Its popularity increased with the development and improvement of the swimming pool, and at the first modern Olympic Games (1896) swimming became part of the meet. Olympic swimming meets for women were included in 1912. Today Olympic swimming events comprise 100-, 400-, 800-, and 1,500-meter freestyle races; 400- and 800-meter freestyle relay races; the 400-meter medley (mixed stroke) relay; 100- and 200-meter backstroke, breaststroke, and butterfly races; 200- and 400-meter individual medley races; springboard and high diving events; and water polo. The United States and (to a lesser extent) Australia excel in Olympic and other international swim meets. Among the more successful American Olympic swimmers have been John Weissmuller, Buster Crabbe, Esther Williams, Don Schollander, and Mark Spitz. Spitz's domination of the 1972 Olympics was remarkable. He won four individual and three team gold medals to set an Olympic record of seven. His time of 51.22 sec for the 100-meter freestyle event made Spitz the fastest swimmer in history. For many decades swimming the English Channel has been highly publicized. The first successful attempt was made (1875) by Matthew Webb of England, and Gertrude Ederle of the United States was the first woman to perform (1926) this feat.

Notes

propulsion [prə'pʌlʃn] — *просування, поштовх*
rite ['raɪt] — *обряд; звичай*
to call — *вимагати*
muscle ['mʌsl] — *мускул, м'яз*
exact [ɪg'zækt] — *точний*
coordination [kou,ɔ:dɪ'neɪʃn] — *координація*
beneficial [,benɪ'fɪʃl] — *вигідний, корисний*
stroke ['strouk] — *удар*
resistance [rɪ'zɪstəns] — *опір*
jerky ['dʒə:kɪ] — *ривками*
crawl [krɔ:l] — *плавання стилем "кроль"*
prone ['proun] — *розпростертий*
to alter ['ɔ:ltə] — *мінять*
scissors ['sɪzəz] — *ножиці*
to flutter ['flʌtə] — *махати*
to trudge [trʌdʒ] — *ледве йти*
supine [sju:'paɪn] — *лежачий на спині*
hip — *стегно*

to entail [ɪn'teɪl] — *викликати, спричиняти*
butterfly ['bʌtəflaɪ] — *батерфляй*
to paddle [pædl] — *ляпати по воді*
gravity ['grævɪtɪ] — *серйозність, важливість*
facility [fə'sɪlɪtɪ] — *легкість; здібність*
to claim ['kleɪm] — *вимагати*
medley ['medlɪ] — *змішаний*
springboard ['sprɪŋbɔ:d] — *трамплін*
to excel [ɪk'sel] — *переважати*
feat [fi:t] — *подвиг*

Text 12. Diving, Springboard and Platform

Diving, springboard and platform is a sport of entering the water from a raised position, often while executing tumbles, twists, and other acrobatic maneuvers. In most dives the upper part of the body enters the water first, and the diver's arms are extended straight out over the head into the water. Body rigidity, vertical entrance into the water, and precise timing are necessary for reasons of safety and form. A poorly executed dive can result in injury ranging from mild skin irritation to bone fracture, depending on the height of the dive. Diving probably originated with the first prehistoric swimmers adventurous enough to take a headfirst plunge into the water. The earliest recorded major diving feat took place in 1871 in England, with competitors diving off London Bridge. Since then competitive diving has become an essential part of most aquatic sports meets. Men's diving became an Olympic event in 1904, and women's diving was added to the program in 1912. As in the related field of swimming, the U.S. diving teams have dominated Olympic competition for many years. Springboard diving takes place on a flexible plank made of wood, aluminum, or steel and measuring 14 to 16 ft (4.3-4.9 m) long by 20 in. (50.8 cm) wide. It extends horizontally over the water at a height of either 1 or 3 m (about 3 ft 3 in. or 9 ft 7 in.). The flexibility of the board allows the diver to jump high into the air and execute a number of acrobatic maneuvers before entering the water. Platform diving (also called high diving) usually occurs on a tower 10 m (32 ft 10 in.) high that is not flexible and does not extend over the water's surface. The height of the tower enables the competitor to perform acrobatics during his descent. It also poses considerable danger to him, because he enters the water at approximately 32 mi (51.5 km) per hr. Both types of diving can be done from a standing or

running start, and in competition both are scored on the basis of form, execution, and degree of difficulty of the particular dive. All dives involve one of three basic positions that the diver assumes while executing his twists and somersaults. In the layout, or straight, dive the body is rigidly extended at all times. In the pike, or jackknife, there is bending at the hips but none at the knees. In the tuck position both the knees and hips are bent so that the body assumes a ball shape. In all dives the final entrance position should be rigid and vertical. The racing dive, used for speed in competitive swimming, involves no acrobatics and has a nearly horizontal entrance.

Notes

to dive ['daɪv] — *пірнати, стрибати (у воду)*
tumble [tʌmbl] — *падіння*
twist — *поворот*
maneuver [mə'nu:və] — *маневр*
to extend [ɪks'tend] — *простягати(ся)*
rigidity [rɪ'dʒɪdɪtɪ] — *суворість; негнучкість*
precise [prɪ'saɪs] — *точний*
fracture ['fræktʃə] — *перелом*
adventurous [əd'ventʃərəs] — *ризикований*
to plunge [plʌndʒ] — *поринати*
aquatic [ə'kwætɪk] — *водяний*
flexible ['fleksəbl] — *гнучкий*
descent [dɪ'sent] — *спуск, зниження*
somersault ['sʌməsɔ:lt] — *акробатичний трюк*
layout ['leɪaut] — *план, схема*
tuck [tʌk] — *складка*

Text 13. Fencing

Fencing is a sport of dueling with foil, épée, and saber. Fencing with swords was a method of deadly combat long before the Christian era, but it was first developed as a sport by the Germans in the 14th century. Not until the 16th century, however, when the light Italian rapier replaced the heavy German sword, did the sport become widespread. Fencing schools, or *salles*, frequented by young aristocrats, soon sprang up all over Europe, and points of personal honor often came to be settled by a fencing duel. In the late 19th century, after many countries had outlawed the duel, fencing became an organized sport, and in 1896 it was included in the first modern Olympic games. The weapons and rules of modern fencing evolved from combat weapons and their usage. The foil — a light, flexible thrusting weapon with a blunted point—was originally a practice weapon. The épée, or dueling sword, is a straight, narrow, and stiff thrusting weapon without cutting edges. The saber is a light version of the old cavalry broadsword and has a flexible, triangular blade with theoretical cutting edges along the entire front and one third of the back edge. Fencing matches may be conducted among individuals or between teams; a team is generally composed of nine players, three for each weapon. International rules stipulate that fencers must attack and parry on a strip that is 14 m (about 46 ft) long and 2 m (about $6\,^1/_2$ ft) wide. The strip is marked off by two parallel lines, beyond which the fencer may not step without receiving a warning or a penalty. In foil the warning lines are 1 m (about $3\,^1/_4$ ft) from each end, and in saber and épée they are 2 m from the ends. Protective clothing includes heavy canvas jackets, wire-mesh masks (introduced in the 18th century), and gloves. A button blunts the weapon's tip, and points are made by touching the opponent. Foil and épée touches are made with the point; in foil the torso is the target area, in épée it is the whole body. Winning touches are five in foil, three in épée. Saber touches are made both by the point and the cutting edges. The saber target is any part of the body above the waist, and five touches win. All fencing bouts are ruled by a jury of which one man is the director and two or four others are judges. Because of the high speed of action, foil and épée contests are now scored electrically — an electrical circuit is closed when a valid touch is scored. Women, too, engage in fencing, but use only the foil; four touches are needed to win a women's match. The Amateur Fencers League of America (formed 1891) regulates the sport in the United States. Along with the fencing federations of 27 other nations, it is an affiliate of the Fédération Internationale d'Escrime (founded 1913), which serves as fencing's world governing body. Prior to the 1960s, France and Italy dominated international competition in foil and épée, while Hungary dominated in saber.

Notes

fencing ['fensɪŋ] — *фехтування*
to duel ['djuəl] — *змагатися, боротися*
foil ['fɔɪl] — *рапіра*
saber ['seɪbə] — *шабля*
sword [sɔ:d] — *меч, шабля*
rapier ['reɪpɪə] — *рапіра*
to frequent ['fri:kwent] — *часто відвідувати*
combat ['kɔmbət] — *бій*

to thrust [θrʌst] — *проколювати*
to blunt [blʌnt] — *притуплювати*
cavalry ['kævlrɪ] — *кавалерія*
to stipulate ['stɪpjuleɪt] — *зумовлювати*
strip — *смужка*
mesh — *сітка*
tip — *наконечник*
torso ['tɔ:sou] — *тулуб*
valid ['vælɪd] — *дійсний*
to affiliate [ə'fɪlɪeɪt] — *приєднуватися*

Text 14. Wrestling

Wrestling is a sport in which two unarmed opponents grapple with one another. The object is to secure a fall, i.e., to pin the opponent's shoulders to the floor, through the use of body grips, strength, and adroitness. One of the most primitive and universal sports, wrestling probably was known to prehistoric man. In ancient Greece wrestlers were rated second only to discus throwers as popular Olympic heroes. The Greeks practiced two forms of wrestling — upright and ground. Wrestling also was included in the pentathlon and the pancratium (combined with boxing); the most famous Greek wrestler was Milo of Crotona. Homer's account of the match between Ajax and Ulysses (*Iliad*, XXIII) is one of the world's greatest wrestling stories. Wrestling tournaments were held in medieval Europe, and the sport has remained popular throughout history. Distinctly different styles of wrestling exist today. Greco-Roman wrestling, most popular in continental Europe, permits no tripping and no holds below the waist, and takes place mostly on the ground. It has no relation to classical wrestling, despite its name, but derives from French wrestling schools. Freestyle wrestling is most popular in the United States, Great Britain, and other parts of the world. This form permits tackling, tripping, leg holds, and other rough features and is a legitimate descendant of ancient Greek wrestling. Two different wrestling styles are popular in Japan — *sumo* and *jujitsu*. Sumo is quasi-religious in nature and involves much ritual. Most of its participants weigh 300 to 400 lb (135—180 kg). The earliest organized wrestling in the United States was in Greco-Roman style. Freestyle wrestling developed rapidly in popularity among professional wrestlers, but by the end of the 1930s professional wrestling had deteriorated into exhibitions of feigned competition and histrionic performances rather than legitimate athletic contests. Amateur wrestling, however, has maintained excellent standards. Olympic (initiated 1896) and annual world championships decide international titles in Greco-Roman and freestyle wrestling, while in the United States the Amateur Athletic Union and National Collegiate Athletic Association hold competitions annually. In amateur wrestling contestants are classified by weight. The contest itself is conducted on a mat 24 ft (7.32 m) square with a circle 10 ft (3.05 m) in diameter drawn in the center. Three periods of 3 min each compose a match. A fall (pinning both shoulders to the mat for 2 sec) ends the match. Points are scored during the match for certain maneuvers, and the highest accumulated total wins if there is no fall.

Notes

wrestling ['reslɪŋ] — *боротьба*
to grapple ['græpl] — *зчепитися*
object ['ɔbdʒɪkt] — *мета, об'єкт*
grip — *стискування*
adroitness [ə'drɔɪtnɪs] — *винахідливість, спритність*
pentathlon [pen'tæθlən] — *п'ятиборство*
account [ə'kaunt] — *звіт, доповідь*
to trip — *підставляти ногу; падати*
legitimate [lɪ'dʒɪtɪmɪt] — *законний*
to deteriorate [dɪ'tɪərɪəreɪt] — *погіршувати(ся), псувати(ся)*
to feign ['feɪn] — *удавати, прикидатися*
histrionic [ˌhɪstrɪ'ɔnɪk] — *театральне видовище*
to accumulate [ə'kju:mjuleɪt] — *акумулювати*

Text 15. Judo

Judo is a sport of Japanese origin that makes use of the principles of jujitsu, a weaponless system of self-defense. Jujitsu was developed over a period of 2,000 years by Buddhist monks in China, Japan, and Tibet as a system of defense that could be used against armed marauders and yet would not be in conflict with their religion. Judo was created (1882) by Jigoro Kano, a Japanese jujitsu expert, who modified or dropped many holds that were too dangerous to be used in sport. It depends for success upon the skill of using an opponent's weight and strength against him, thus enabling a weak or light individual to overcome a physically superior opponent. A method of applying pressure to sensitive parts of an opponent's body, usually by means of blows with the side of the hand, is also used.

This art, known in judo as *atemi*, has been separately developed and is known as karate. A judo match begins with a ceremonial bow, after which each player grasps the other by the collar and sleeve of his jacket, or *gi*. A point is scored when a player forcefully throws the other onto his back, when one is held down for 30 seconds, when one is caught in a judo "choke," or when a player is forced to submit because of a twisted elbow joint. Proficiency in judo is indicated by the color of a player's belt; white indicates a beginner, black an expert. There is a wide range of color in between. Jujitsu, the unmodified form of judo, has been taught to military and police forces. In 1953 judo was recognized in the United States as a sport by the Amateur Athletic Union, and annual championships are now held. Numerous schools throughout the world now teach judo.

Notes

marauder [mə'rɔ:də] — *мародер*
expert ['ekspə:t] — *знавець*
to modify ['mɔdɪfaɪ] — *видозмінювати*
hold — *захват*
superior [sju:'pɪərɪə] — *кращий*
bow ['bau] — *поклін, уклін*
forceful — *сильний*
to submit [səb'mɪt] — *підкорятиˊ(ся)*
proficiency [prə'fɪʃənsɪ] — *досвідченість, вправність*

Text 16. Boxing

Boxing is a sport of fighting with fists, also called pugilism and prizefighting. Mentioned by Homer and included in the ancient Olympian games, boxing is one of the oldest forms of competition known to man. It was popular with the Romans, who bound the fists with a knotted, and often metal-weighted, leather band, or cestus. The sport died out after the fall of Rome. It was revived in England in the early 18th century, helped by royal patronage in the form of betting on or offering prizes to the contestants, as well as by the ring prowess of James Figg, the first British champion (1719—30), and the first set of rules, drawn up by Jack Broughton (1743). Its popularity soon spread to other countries. The use of bare fists declined after the marquess of Queensberry introduced (1865) his celebrated code of boxing rules, which became standard by 1889. The code called for boxing gloves, a limited number of 3-min rounds, the forbidding of gouging and wrestling, a count of 10 sec before a floored man is

called the loser, and various other features of modern boxing. In the United States boxing was illegal for many years. New York was the first state to legalize it (1896), and others soon followed suit. Today, professional boxing is regulated in each state by athletic or boxing commissions, most of which are members of the World Boxing Association (WBA), founded in 1921. However, several states do not accept WBA rulings, and on occasion more than one champion reigns. Professional boxers, wearing gloves weighing at least 5 oz (141.75 grams) each, fight in a roped-off area, or ring, about 20 ft (6.1 m) square. Boxing reached its peak of popularity in the 1920s and 30s. Since World War II boxing has declined in popularity; rising admission prices and the influence of television have been the main factors in the decline. Most major championship fights are now telecast only on closed-circuit networks in theaters. Other injurious influences have been scandals, ring injuries and deaths, and monopolistic practices by promoters. The largest purse in boxing history was the $10 million split by George Foreman and Muhammad Ali in their 1974 bout in Zaïre, in which Ali regained the championship. Largely drawn by Ali, one of boxing's most colorful and controversial figures, many millions of people throughout the world watched his victory on either satellite or cable television. Amateur boxing in the United States is regulated by the Amateur Athletic Union. The National Collegiate Athletic Association championships and the Golden Gloves competition are other important amateur bouts. Boxing became part of the modern Olympic games in 1904. Olympic weight divisions correspond closely to those used in professional boxing.

Notes

pugilism ['pju:dʒɪlɪzm] — *кулачний бій*
knot [nɔt] — *вузол*
band — *пасок*
patronage ['pætrənɪdʒ] — *опікування*
prowess ['prauɪs] — *відвага*
marquess ['mɑ:kwɪs] — *маркіз*
round ['raund] — *раунд*
to gouge ['gaudʒ] — *видовбувати*
illegal [ɪ'li:gl] — *незаконний, нелегальний*
to legalize ['li:gəlaɪz] — *узаконювати*
to regulate ['regjuleɪt] — *регулювати*
reign ['reɪn] — *панування*
split — *розкол*
to regain [rɪ'geɪn] — *повертатиˊ(ся)*
controversial [ˌkɔntrə'və:ʃl] — *спірний, дискусійний*

Text 17. Skating

Skating is a gliding along an ice surface on keellike runners known as ice skates. The earliest skates (about 9th century) were made of bone, which gave way to wood, probably in the 14th cent. These materials frequently proved fragile under strain, and wooden skates shod with iron came into use. Skates made entirely of iron were introduced in the 17th century. Steel skates, with straps and clamps to fasten them to the shoes, were first made in the 1850s, and later came the skate permanently attached to the shoe. Skating has long been a means of travel in countries with long, cold winters, such as Norway, Sweden, Finland, Russia, and especially Holland. There are references to skating in English books as early as the 12th century. By the 17th century skating was not only a means of travel but also a well-established sport. It was introduced early into America by European colonists and became a popular sport in the Northern United States and Canada. Skating, besides being an important form of winter recreation and the essential skill in the game of ice hockey has developed as a sport for exhibition along two lines — speed skating and figure skating. In Europe many skating contests are held at St. Moritz, Oslo, while in North America, Montreal, Toronto, Lake Placid, Sun Valley, Colorado Springs, and Squaw Valley are well-known centers for skating events. There are also many indoor skating rinks, where ice is artificially produced. Since 1924 figure-skating contests for women and men, as well as 500-, 1,500-, 5,000-, and 10,000-meter speed-skating events, have become an important part of the Olympic winter games. Olympic speed-skating events, in which participants may reach speeds as high as 30 mi (48 km) per hr, are usually won by athletes from Scandinavia, the United States and other states. Figure skating, invented by Jackson Haines (1860s), an American, is generally considered one of the most beautiful and graceful events in all sport. Olympic figure skating is divided into compulsory and free skating sections. In the compulsory round, contestants are judged for the precision with which they execute specified patterns. In free skating, also known as ice dancing, skaters choreographically interpret music that they have chosen. Sonja Henie did much to bring skating to wide public notice in the United States, and after she turned (1936) professional, the ice carnival became a favorite American amusement. The ice carnival has attracted other successful Olympic skaters, including Peggy Fleming and Dick Button. Considered one of the most outstanding men's figure skaters of all time, the latter won five straight world, seven consecutive U.S., and two Olympic championships before turning professional in 1952. In 1960 the National Ice Skating Hall of

Fame was established at Newburgh, N.Y. **Roller skating**, gliding on a hard, smooth, durable surface on skates with rollers or wheels, in recent years has become a popular adult sport. Skates mounted on wooden rollers date from the 1860s, and soon wooden wheels replaced the rollers. The ball-bearing skate wheel was invented in the 1880s. The origin of roller skates is obscure (perhaps they were first used in Holland), but the sport became popular among children throughout the world. When figure skating and dance movements were adopted from ice skating, roller skating gained a large adult following. Numerous roller-skating rinks were built in the United States in the 20th century, and several roller-skating tournaments are now held annually. Following World War II, a spectator sport called the roller derby gained prominence, due primarily to television. More a staged theatrical event than a sport, roller derby involves team competition on banked indoor tracks.

Notes

to glide ['glaɪd] — *ко́взати*
fragile ['frædʒaɪl] — *ламкий*
strain ['streɪn] — *напруження*
strap ['stræp] — *ремінь*
clamp [klæmp] — *скоба*
permanently ['pə:mənəntlɪ] — *постійно*
essential [ɪ'senʃəl] — *істотний, необхідний*
compulsory [kəm'pʌlsərɪ] — *обов'язковий*
round ['raund] — *круг*
precision [prɪ'sɪʒn] — *точність*
carnival ['kɑ:nɪvl] — *карнавал*
consecutive [kən'sekjutɪv] — *послідовний, наступний*
durable ['djuərəbl] — *міцний, тривалий*
ball-bearing ['bɔ:l 'bɛərɪŋ] — *шарикопідшипник*
tournament ['tuənəmənt] — *турнір*
prominence ['prɔmɪnəns] — *видатне становище; виступ*
banked — *оточуваний*
track — *трек*

Text 18. Field Hockey

Field hockey is an outdoor stick and ball game similar to soccer. Field hockey, of ancient origin, was played in England for several centuries, and after it was standardized by the Wimbledon Hockey Club (organized 1883), it spread to other countries. Field hockey

for men has been played in the United States since 1890, but the Field Hockey Association of America, which regulates men's play, was not formed until 1930. Field hockey for men enjoys limited popularity in the United States and is played on the amateur level only. The sport became an Olympic event in 1908, and competition has since been dominated by India, Great Britain, and Pakistan. Field hockey for women has been a popular amateur sport in the United States, especially among college girls, since 1901; the U.S. Field Hockey Association (formed 1921) governs the women's game. Rules for men and women are essentially the same. The game is played on a level field, measuring 50 to 60 yd by 90 to 100 yd (46 to 55 m by 82 to 91 m), by two teams of 11 players each (five forwards, three halfbacks, two fullbacks, and a goalkeeper). A face-off in the center of the field starts the game. Teams direct their play toward advancing the ball—made of cork and twine, covered with white leather, and about 9 in. (23 cm) in circumference — down the field with their sticks (wooden, with a flat head on only one side of the striking surface). A point is scored by delivering the ball past the goalkeeper through the goal posts, which are 7 ft (2.13 m) high, 12 ft (3.66 m) apart, and joined by a net. Illegal use of the stick and roughness are penalized by temporarily relegating a player to the penalty corner.

Notes

field hockey — *хокей на траві*
essentially [ɪ'senʃəlɪ] — *по суті*
cork [kɔ:k] — *пробка*
twine ['twaɪn] — *мотузка*
roughness ['rʌfnɪs] — *грубість*
to penalize ['pi:nəlaɪz] — *карати*
temporarily ['tempərərɪlɪ] — *тимчасово*
to relegate ['relɪgeɪt] — *висилати*

Text 19. Ice Hockey

Ice hockey is a winter skating sport in which players use sticks to propel a rubber disk into a net-enclosed goal area. Ice hockey, played exclusively by men, originated in Canada in the 1870s and later spread to the United States. There are at present two major professional ice hockey conferences, each with teams in both the United States and Canada. The National Hockey League (founded 1917) is the older

group and is made up of 18 teams in two conferences, the Clarence Campbell conference and the Prince of Wales conference. Each conference, in turn, is divided into two divisions. The Lester Patrick division of the Campbell conference consists of the Atlanta Flames, New York Islanders, New York Rangers, and Philadelphia Flyers. The Conn Smythe division of the Campbell conference includes the Chicago Black Hawks, Kansas City Scouts, Minnesota North Stars, St. Louis Blues, and Vancouver Canucks. The James Morris division of the Prince of Wales conference includes the Detroit Red Wings, Los Angeles Kings, Montreal Canadians, Pittsburgh Penguins, and Washington Capitals. The Charles F. Adams division of the Prince of Wales conference contains the Boston Bruins, Buffalo Sabres, California Golden Seals, and Toronto Maple Leafs. The World Hockey Association was formed (1971) as a rival league. By 1975 it consisted of 14 teams. Because amateur and school-age hockey is poorly developed in the United States, most players in both professional leagues are Canadian. The Stanley Cup, now signifying world professional hockey supremacy, was first awarded (1893) for the Canadian amateur championship. From 1912 to 1925 it was awarded to the winner of competition between champions of the Pacific Coast League and Eastern League, but since 1926 it has been decided by a play-off among the best teams of the National Hockey League. Amateur hockey is a popular international sport and has been played in the Winter Olympic Games since 1920. The International Ice Hockey Federation (founded 1908), the world governing body for amateur ice hockey, also sponsors an annual world championship. Although Canada has an elaborate system of amateur hockey leagues, as well as many college teams, the country has not excelled in international amateur hockey since the early 1950s, mainly because the best Canadian amateurs quickly become professional and thus ineligible for amateur competition. In the United States, amateur ice hockey is generally confined to northern areas, such as New England and the Great Lakes region. Ice hockey is played on a rink that may vary from 184 to 200 ft (56-61 m) in length, and from 85 to 98 ft (26—30 m) in width. Six players — a goalie, a center, two defensemen, and two forwards — all of whom are on ice skates, make up a team. The rink is surrounded on all sides by walls 3 $^1/_2$ to 4 ft (1.06—1.22 m) high. The goal nets are 4 ft (1.22 m) high and 6 ft (1.83 m) wide and are set 10 ft (3.05 m) out from each end of the rink, which is divided by colored lines under the ice into three zones (attacking, neutral, and defending), each 60 ft (18.29 m) long. A vulcanized rubber puck, 1 in. (2.54 cm) thick and 3 in. (7.62 cm) in circumference, is used, and the

weight, size, and shape of ice-hockey sticks are standardized. After the face-off, teams concentrate on defending their own goals or, when in possession of the puck, on hitting it into the attacking zone and from there maneuvering it past the opposing defense into the net. Each goal counts one point. The game is divided into three 20-min periods; overtime periods in case of ties are only used in Stanley Cup play-off games. In this fast and bodybruising game, players use heavy protective equipment, and unlimited substitution is allowed.

Notes

to propel [prə'pel] — *просувати вперед*
exclusively [ɪks'klu:sɪvlɪ] — *виключно*
Canuck [kə'nʌk] — *француз з Канади*
buffalo ['bʌfələu] — *бізон*
sabre ['seɪbə] — *шабля*
seal ['si:l] — *тюлень*
rival [raɪvl] — *суперник*
league [li:g] — *спілка*
supremacy [sju'preməsɪ] — *панування*
ineligible [ɪn'elɪdʒəbl] — *непідходящий*
width [wɪdθ] — *ширина, широта*
to vulcanize ['vʌlkənaɪz] — *вулканізувати*

Text 20. Skiing

Skiing is a sport of sliding over snow on skis—long, narrow, flexible runners. Skis, made of highly polished wood, of metal, or even of plastic, average 6 $^1/_2$ ft (about 2 m) in length, 3 in. (7.62 cm) in width, and $^3/_4$ in. (1.91 cm) in thickness under the foot. Novice skiers sometimes start with skis that are only about 3 ft (91 cm) long, and then gradually move up to the regular size skis. The binding, which attaches the boot to the ski, is made of metal or leather. To aid himself in accelerating, turning, and balancing, the skier uses a pair of poles, each of which has a leather wriststrap on the top, a sharp metal tip on the bottom, and a circular ring about 4 in. (10 cm) from the tip to prevent it from sinking into the snow. Although its origin is obscure, skiing is known to have been a vital means of transportation in Scandinavia for many centuries. Skis more than 4,000 years old have been discovered in parts of Scandinavia. They are thought to have been made from the smoothed-down bones of large animals. In the Middle Ages skiing was used by the Swedes in warfare, and its

use as a military technique has continued and spread to other countries. Ski troops were widely used by the Finns in the Russo-Finnish War (1939—40). Skiing was introduced into Central Europe at the close of the 16th century. It began as an organized sport in Norway in the last half of the 19th century and is now Norway's national sport. Competitive skiing comprises four events: the downhill (the most dangerous), a straight, steep descent in a race against time; the slalom (the most graceful), raced on a sharply twisting course marked off by flags; the ski jump (the most spectacular), in which each contestant leaps twice from specially prepared jump slopes, attempting to score the highest point total judged on distance and form; and the cross-country (the most grueling), over a long course (ranging from 10 to 50 km in Olympic games), in which the natural terrain and obstacles test the skier's stamina and maneuverability. The first two are referred to as the Alpine events, the last two as the Nordic events. Women compete only in downhill, cross-country, and slalom events. It is uncertain whether Americans learned skiing from the Indians or whether it was brought to America by Norwegian and Swedish immigrants in the mid-19th century. At any rate, the first U.S. ski club was formed in 1872, and the National Ski Association was founded in 1904. Twenty years later (1924) the *Fédération Internationale de Ski* was founded, and skiing was added to the Winter Olympics program. Skiing (mainly downhill) has enjoyed a tremendous boom as a recreational sport since the 1930s, spurred by the Winter Olympics at Lake Placid, N.Y. (1932), and Squaw Valley, California (1960), and by the development of ski tows and ski lifts. Skiers now reach the summit of a ski run in minutes, whereas formerly it took hours. Artificial snow-making machines and the construction of runs of varying levels of difficulty have also contributed to the sport's expansion. It is estimated that in 1920 no more than 4,000 Americans skied. By 1970 this number had increased a thousand-fold and was still growing by some 15% a year. Water skiing is a warm-weather sport in which a skier is towed through the water by a motor-propelled craft.

Notes

flexible — *гнучкий*
novice ['nɔvɪs] — *початківець*
binding ['baɪndɪŋ] — *кріплення (лиж)*
to attach — *прикріплювати*
to accelerate [æk'seləreɪt] — *прискорювати*
strap — *ремінь*
warefare ['wɔ:fɛə] — *війна*

steep — *крутий*
descent [dɪ'sent] — *спуск*
contestant [kən'testənt] — *конкурсант*
to leap [li:p] — *стрибати*
to gruel ['gruəl] — *суворо карати*
terrain ['tereɪn] — *місцевість, територія*
to spur [spə:] — *підбурювати*
to tow [tou] — *тягти*
to propell [prə'pel] — *приводити в рух*
craft — *човен*

Text 21. Rowing

Rowing is an art of propelling a boat by means of oars operated by hand. Boats propelled by oars (e.g., the galley) were used in ancient times for both war and commerce. Rowing is now generally used only for propelling small boats or for sport. One of the oldest continuous sporting events in the world is the Doggett's Coat and Badge rowing race, held in London every year since 1716 and named for Thomas Doggett, a popular actor of early 18th century, England. The most famous of all rowing races are the Thames River competitions between Oxford and Cambridge, first held at Henley in 1829. The first collegiate rowing regatta in the United States took place in 1852 between Harvard and Yale. In modern racing, each member of the rowing team, or crew, uses both hands to pull one oar through the water. The oars, attached to riggings jutting out from the side of the boats to increase leverage, are positioned alternately on opposite sides of the vessel. The boat, or shell, is sometimes steered by a coxswain, who sits at the back of the vessel and manipulates tiller ropes attached to a rudder; the coxswain also directs the speed and rhythm of the crew's strokes. Sculling is a variant of rowing in which the oarsman controls two oars, one in each hand. Sculling teams consist of one, two, or four members; rowing crews have two, four, or eight members, with or without a coxswain. Rowing and sculling events have been included in the Olympic games since 1900.

Notes

rowing — *веслування*
oar [ɔ:] — *весло*
galley ['gælɪ] — *галéра*
collegiate [kə'li:dʒɪɪt] — *університетський*

regatta [rɪ'gætə] — *парусне змагання*
to rig — *оснащувати*
to jut [dʒʌt] — *виступати*
leverage ['li:vərɪdʒ] — *підйомна сила*
coxswain ['kɔkswein] — *старшина, рульовий*
to steer ['stɪə] — *керувати*
rudder ['rʌdə] — *кермо*
to scull [skʌl] — *грести одним веслом*

Text 22. Canoeing

Canoeing is a sport of propelling a canoe through water. John MacGregor, an English barrister and founder of the Royal Canoe Club (est. 1865), is generally credited with being the initiator of modern sport canoeing. Between 1849 and 1869, MacGregor wrote a number of highly popular books in which he described his experiences on long canoe trips throughout Europe. Sport canoeing today may either involve recreational journeys or fixed-distance racing. Racing canoes are propelled by either sails or paddles. The International Challenge Cup, one of the oldest existing canoeing trophies, was originally offered by the New York Canoe Club (1885) as a perpetual challenge sailing prize. Canoe racing with paddles first became an official Olympic event at the Berlin games in 1936. The two types of Olympic canoe races are those among kayaks and Canadian canoes. The kayak, a buoyant arctic canoe that is completely covered except for its cockpit(s), is raced by both men and women. The Canadian, the typical North American canoe, is raced only by men. Hunters, fishermen, and outdoorsmen use canoes as combination recreation-transportation vehicles. This type of canoeing is especially popular in the North United States. White-water canoeing, in which the vessel is navigated through rapids, is quite popular in the West United States, especially along the Colorado River.

Notes

canoe [kə'nu:] — *човник; каное, байдарка*
sail — *вітрило, парус*
paddle [pædl] — *весло*
trophy ['troufɪ] — *трофей*
perpetual [pə'petjuəl] — *вічний, постійний*
buoyant ['bɔɪənt] — *плавучий*
cockpit — *кабіна пілота; кубрик*

Text 23. Motorboating

Motorboating is a sport of navigating a machine-powered vessel on the water. It is done on either fresh or salt water and may be competitive or recreational. The first successful motorboat travelled (1887) a few yards on the Seine River in Paris. As the growth of technology improved the internal-combustion engine, the motorboat became a practical means of transportation and motorboating became a popular sport. In 1903 the Harmsworth Trophy Race, one of the sport's most prestigious international competitions, was inaugurated in Great Britain. In the following year the Gold Cup Race, the premier U.S. competition, was first held. Motorboating did not become popular as a recreational sport until after World War II. Since then, however, it has grown tremendously, as greater affluence, increased leisure time, and inexpensive mass-production techniques made it possible for more and more people to own motorboats. The smaller-sized motorboats, generally called runabouts, range from 10 to 22 ft (3-6.7 m) in length; the larger cabin cruisers, often equipped with facilities for cooking, dining, and sleeping, may be from 20 to 60 ft (6.1—18.3 m) long. The larger and more luxurious cabin cruisers are often called yachts. Recreational boats are powered by a gasoline or diesel engine that turns a submerged propeller located behind the boat. Engines may either be of the outboard or inboard type. Outboard engines, generally found in smaller boats, are located at the back of the craft, which is steered by rotation of the engine. The larger inboard-type vessels have their engine located in the middle of the boat and use a rudder for steering; the engine of such a boat is attached to the propeller by means of a drive shaft that lies beneath the craft. Certain classes of racing boats are jet-powered and are able to attain speeds of 250 mph (402 kph). The fastest propeller-driven racing boats can travel about 175 mph (282 kph).

Notes

combustion [kəm'bʌstʃn] — *згоряння*
affluence ['æfluəns] — *достаток, приплив*
runabout ['rʌnəbaut] — *моторний човен*
luxurious [lʌg'zjuərɪəs] — *розкішний*
yacht [jɔt] — *яхта*
gasolene ['gæsəli:n] — *бензин*
rudder ['rʌdə] — *кермо*
beneath [bɪ'ni:θ] — *внизу*
craft [krɑ:ft] — *майстерність; судно, човен*

3.

Section. Food Industry

Text 1. Wheat

Wheat is a cereal plant, a major food and an important commodity on the world grain market. It was one of the first of the grains domesticated by man. Its cultivation began in the Neolithic period. Bread wheat is known to have been grown in the Nile valley by 5000 B.C., and its apparently later cultivation in other regions (e.g., the Indus and Euphrates valleys by 4000 B.C., China by 2500 B.C., and England by 2000 B.C.) indicate that it spread from Mediterranean centers of domestication. The civilizations of Western Asia and of the European peoples have been largely based on wheat, while rice has been more important in Eastern Asia. Since agriculture began, wheat has been the chief source of bread for Europe and the Middle East. It was introduced into Mexico by the Spaniards about 1520 and into Virginia by English colonists early in the 17th century. For its early growth, wheat thrives best in cool weather. The wheat plant is an annual, probably derived from a perennial; the ancestry of and precise distinctions between species are no longer always clear. Modern wheat varieties are usually classified as winter wheats (fall-planted and unusually winter hardy for grain crops) and spring wheats. Approximately three fourths of the wheat grown in the United States is winter wheat. Flour from hard wheats contains a high percentage of gluten and is used to make bread and fine cakes. The hardest-kerneled wheat is durum (*durum*); its flour is used in the manufacture of macaroni, spaghetti, and similar pasta products. White-and soft-wheat varieties are paler in color and have starchy kernels; their flour is preferred for piecrust, biscuits, and breakfast foods. Wheat is used in the manufacture of whiskey and

beer, and the grain, the bran (the residue from milling), and the vegetative plant parts make valuable livestock feed. Before the introduction of maize into Europe, wheat was the principal source of starch for sizing paper and cloth. Although in many regions wheat is still harvested and threshed by hand and stone-milled, in the United States, and increasingly elsewhere, it is combine-harvested and mechanically milled. It is susceptible to many pests and diseases. All wheat-producing countries carry on breeding experiments to improve existing varieties or to obtain new ones with such dominant characteristics as disease resistance, increased hardiness under specific environments, and greater yield.

Notes

cereal ['sɪərɪəl] — *хлібні злаки*
commodity [kə'mɔdɪtɪ] — *товар*
to domesticate [də'mestɪkeɪt] — *акліматизувати*
to thrive ['θraɪv] — *процвітати, досягати успіхів*
perennial [pɪ'renjəl] — *багаторічний*
ancestry ['ænsɪstrɪ] — *походження*
species ['spi:ʃi:z] — *вид*
gluten ['glu:tən] — *клейковина*
kernel ['kə:nl] — *зерно*
flour ['flauə] — *борошно*
starchy ['stɑ:tʃɪ] — *який містить крохмаль*
bran [bræn] — *висівки*
residue ['rezɪdju:] — *залишок*
vegetative ['vedʒɪteɪtɪv] — *рослинний*
maize ['meɪz] — *кукурудза*
to mill — *молоти*
to thresh — *молотити*
pest — *паразит; шкідник*
susceptible [sə'septəbl] — *вразливий*
rust — *іржа*

Text 2. Flour

Flour is a finely ground, usually sifted, meal of grain, such as wheat, rye, corn, rice, or buckwheat. Flour is also made from potatoes, peas, beans, peanuts, etc. Usually it refers to the finely ground and bolted (i.e., sifted through a fine sieve) flour of wheat, which forms the largest proportion of all flour milled in the United States, Canada, and Western Europe. Millet is ground in India, Ukraine and

China. Rye is much used for bread in Northern Europe, buckwheat in the Netherlands and Ukraine, and corn in the United States. Rice may be used for bread in combination with other grains richer in gluten. Wheat and rye flour can be used in baking leavened bread, as they contain gluten in sufficient amount to retain the gas formed by the action of yeast. Corn flour, rich in fats and starches, is a favorite for making quick breads. Graham, or whole-wheat, flour contains the whole grain, unbolted. This flour will not keep long, as the germ contains fats and ferments that cause deterioration when exposed to the air. Wheat flour is separated into grades by milling. In the United States, patent flour, freed of the bran and most of the germ, is the highest grade; clear flour is the second grade; and red dog, a low-grade residue, is used mainly for animal feed. The composition of flour depends on the type of wheat and the milling processes; gluten is the chief protein, and starch the principal carbohydrate, although some sucrose, invert sugar, and dextrin may be present. On the market are prepared flours, such as the self-rising, which contains a leavening agent, and numerous cake, pancake, and pastry mixes requiring only the addition of water. Flour improves if stored from six to nine months under conditions permitting the enzyme action that gives better baking qualities. Good flour, rich in gluten, has a creamy color and adhesive quality. Bleaching, which is accomplished by the addition of chemicals to flour to improve its appearance and baking qualities, was begun about 1900. The bleaching of flour has been a controversial issue since its beginning, with charges that it destroys valuable nutrients or is injurious to health; some bleaching agents have been banned (e.g., nitrogen trichloride), but new ones have been introduced. Bleached flours must be so labeled.

Notes

flour ['flauə] — *борошно*
to grind (ground) [graɪnd] — *молотити*
to sift — *просіювати*
rye [raɪ] — *жито*
corn [kɔ:n] — *кукурудза (амер.)*
rice ['raɪs] — *рис*
buckwheat ['bʌkwi:t] — *гречка*
millet ['mɪlɪt] — *просо*
leaven [levn] — *дріжджі*
yeast [ji:st] — *дріжджі*
germ [dʒə:m] — *бактерія*
adhesive [əd'hi:sɪv] — *липкий*

Text 3. Macaroni

Macaroni is a generic name for shaped and dried doughs prepared from selected wheat flour, and water, originally peculiar to Italy. Macaroni noodles are made from dough mixed with eggs or egg solids, rolled thin and sliced. Similar flour and rice pastes have been known in Asia for a long time and are believed to have been introduced into Europe during the Mongol invasions in the 13th century. The basic ingredient of macaroni is semolina, a durum wheat flour, coarsely ground and free from bran; farina, similarly prepared from other varieties of hard wheat, is also used. The sifted flour is moistened with hot water, kneaded to a stiff dough, forced through holes of the desired size and shape, then slowly dried in a current of warm air. In modern factories open-air drying has been replaced by the use of air-conditioned rooms. Long-cut macaroni is hung to dry on racks or sticks. Short-cut pastes are dried on trays. The dough is made in various shapes, ribbons, tubes, and disks, and may be twisted or ribbed. Thinner forms of the same material are known as spaghetti (cords of medium diameter) and vermicelli (fine strands). The increased use of alimentary pastes in the United States in the 20th century has led to widespread cultivation of durum wheat and to the establishment of factories producing quantities sufficient for export as well as for domestic use.

Notes

generic [dʒɪ'nerɪk] — *загальний*
dough ['dou] — *тісто*
noodle ['nu:dl] — *локшина*
paste ['peɪst] — *тісто*
semolina [ˌsemə'li:nə] — *манна крупа*
farina [fə'raɪnə] — *борошно; манна крупа*
moisten ['mɔɪsn] — *змочувати, зволожувати*
to knead [ni:d] — *місити, замішувати (тісто)*
cord [kɔ:d] — *шнур*
alimentary [ˌælɪ'mentərɪ] — *харчовий, поживний*

Text 4. Pudding

Early writers on cookery class puddings and dumplings together. The earliest puddings were boiled in a bag or cloth. Later they were placed in a buttered bowl, covered with a cloth, and steamed. The baked or chilled puddings evolved even later. Puddings are classed as

those served with meat, such as Yorkshire pudding (batter baked under the meat or in the drippings), or which form the meat course, such as Sussex pudding (a large dumpling filled with meat instead of fruit), and those served as a sweet or dessert, such as almond, cabinet, and suet puddings, plum or Christmas pudding, and Indian pudding, as well as puddings made with milk, eggs, rice, sago, tapioca, arrowroot, cornstarch, bread crumbs, and fruit. Custards are included by some writers, and jellied fruits by others. An early use of the word, as in black pudding or white pudding referred to forms of sausage.

Notes

dumpling ['dʌmplɪŋ] — *клецка*
almond ['ɑ:mənd] — *мигдаль*
suet ['sjuɪt] — *сало*
crumb ['krʌm] — *крихта (хліба)*
custard ['kʌstəd] — *крем*
sausage ['sɔsɪdʒ] — *ковбаса, сосиска*

Text 5. Pancake

Pancake is a thin, flat cake, made of batter and baked on a griddle or fried in a pan. Pancakes, probably the oldest form of bread, are known in different forms throughout the world. The relative ease of baking on hot stoves or on a griddle has resulted in a variety of pancakes. Old English batter was mixed with ale. German and French pancakes, leavened by eggs and much beating, are baked very thin and served with jam or jelly. The French crepe suzette is folded or rolled and heated in a sauce of butter, sugar, citrus juice, and liqueur. Russian blintzes usually prepared with buckwheat, are thin, crisp pancakes, and commonly served with caviar and sour cream or folded over and filled with cream cheese or jam. Mexico has its tortilla, which is often served folded over a bean or meat filling and topped by tomato sauce. In the United States pancakes are sometimes called battercakes, griddlecakes, or flapjacks and are usually leavened with baking powder or baking soda and are served with syrup. A pioneer favorite, still surviving in some localities, is the buckwheat cake.

Notes

pancake ['pænkeɪk] — *млинець, оладка*
batter ['bætə] — *збите тісто*
ale ['eɪl] — *пиво, ель*

leaven ['levn] — *дріжджі*
jelly ['dʒelɪ] — *желе*
crepe [kreɪp] — *креп (тонка матерія)*
to fold ['fould] — *складати*
to roll ['roul] — *скручувати, загортати*
sauce [sɔ:s] — *підлива*
citrus ['sɪtrəs] — *цитрус*
liquor ['lɪkə] — *напій*
flapjack ['flæpdʒæk] — *млинець, оладка*
syrup ['sɪrəp] — *сироп*

Text 6. Pie

Pie is meat, fish, fowl, fruit, or vegetables baked with a crust of pastry, or pastry shells filled with custard or pudding. The pies of the Romans, especially at banquets in the days of the empire, were often elaborate concoctions, such as the showpieces in which were enclosed live birds. In England meat and fish pies had become common by the 14th century, and fruit pies, often called tarts, by the 16th century. The mince pie was an important feature of the Christmas festivities and was called superstitious pie by the Puritans in protest against what seemed to them a pagan manner of celebrating a holy feast. The mincemeat filling was a finely chopped, cooked mixture including raisins, currants, apples, suet, sugar, spice, and often meat, brandy or cider, candied peel, and other ingredients. The English settlers in North America retained their taste for pie and adapted it to their new conditions, creating the pumpkin and the cranberry pies. Pie has remained a popular dessert in the United States. In Italy, pie, or pizza consists, in its most basic form, of a spread of dough covered with tomatoes and mozzarella cheese and baked in an oven.

Notes

fowl ['faul] — *свійська птиця*
crust [krʌst] — *скоринка*
pastry ['peɪstrɪ] — *пиріг, тістечко*
banquet ['bæŋkwɪt] — *бенкет*
empire ['empaɪə] — *імперія*
to elaborate [ɪ'læbəreɪt] — *детально розроблятиˊ*
concoction [kən'kɔkʃn] — *варивоˊ "байки"*
tart [tɑ:t] — *кислий*

superstitious [ˌsju:pə'stɪʃəs] — *забобонний*
pagan ['peɪgən] — *язичеський*
mincemeat ['mɪnsmi:t] — *фарш, начинка*
to chop — *різати*
raisin ['reɪzn] — *ізюм*
currant ['kʌrənt] — *смородина*
spice ['spaɪs] — *спеція*
pumpkin ['pʌmpkɪn] — *гарбуз*
cranberry ['krænberɪ] — *клюква*

Text 7. Rice

Rice is a cereal grain. It has been cultivated in China since ancient times and was introduced to India before the time of the Greeks. Chinese records of rice cultivation go back 4,000 years. In classical Chinese the words for agriculture and for rice culture are synonymous, indicating that rice was already the staple crop at the time the language was taking form. In several Eastern languages, the words for rice and for food are identical. Many ceremonies have arisen in connection with planting and harvesting rice, and the grain and the plant are traditional motifs in Oriental art. Thousands of rice strains are now known, both cultivated and escaped, in India and China, and the original form is not known. Rice cultivation has been carried into all regions having the necessary warmth and abundant moisture favorable to its growth, mainly subtropical rather than hot or cold. Modern culture makes use of irrigation, and a few varieties of rice may be grown with only a moderate supply of water. The plant is an annual, from 2 to 6 ft. (61—183 cm) tall, with a round, jointed stem, long, pointed leaves, and seeds borne in a dense head on separate stalks. It has been estimated that half the world's population subsists wholly or partially on rice. Almost 90% of the world crop is grown in India, China, and Japan, and most of it is consumed domestically. Rice is the only major cereal crop that is primarily consumed by man directly as harvested. Only wheat and corn are produced in comparable quantity. In densely populated parts of the East all the original forest has been cleared for rice growing. Methods of growing differ greatly in different localities, but in most Asian countries the primitive methods of cultivating and harvesting rice, which have been followed for centuries, are still practiced. The fields are prepared by plowing (typically with simple plows drawn by water buffalo), fertilizing (usually with dung or sewage), and smoothing (by dragging a

log over them). The seedlings are started in seedling beds and, after 30 to 50 days, are transplanted by hand to the fields, which have been flooded by rain or river water. During the growing season, irrigation is maintained by dike-controlled canals or by handwatering. The fields are allowed to drain before cutting. Rice when it is still covered by the brown hull is known as paddy; rice fields are also called paddy fields or rice paddies. Before marketing, the rice is threshed to loosen the hulls — mainly by flailing, treading, or working in a mortar — and winnowed free of chaff by tossing it in the air above a sheet or mat. The practice of polishing the natural brown rice to a creamy whiteness is standard in the West but less common in the Orient. Brown rice has a greater food value than white, since the outer brown coatings contain the proteins and minerals; the white endosperm is chiefly carbohydrate. As a food, rice is low in fat and (compared with other cereal grains) in protein. In recent years, the so-called miracle rices have been developed by plant breeders; there is a much higher yield of grains that are richer in protein than the old varieties. In the East rice is eaten with sauces made from the soybean which supply the lacking elements and prevent the deficiency diseases that a wholly rice diet would otherwise induce in greater measure. Since rice is deficient in gluten, it cannot be used to make bread unless it is mixed with the flour of other grains. In the United States and in many parts of Europe, rice cultivation has undergone the same mechanization at all stages of cultivation and harvesting as have other grain crops. The resulting decrease in the cost of growing has enabled these countries to undercut the world market prices of Oriental rice, which is raised by cheap coolie labor. Rice was introduced to the American colonies in the mid-17th century and soon became an important crop. Although U.S. production is less than that of wheat and corn, rice is grown in excess of domestic consumption and has been exported, chiefly to Europe, South America, and the West Indies. North American average annual consumption is about 6 lb. (2.7 kg) per person, as compared with 200 to 400 lb. (90—181 kg) per person in the Orient. Chief production areas of the United States are in the South, especially in Arkansas, Louisiana, Texas, and California. For feeding domestic animals the bran, meal, and chopped straw are useful, especially when mixed with the polishings or given with skim milk. The polishings are also an increasingly important source of furfural and other chemurgic products. The straw, which is soft and fine, is plaited in the East for hats and shoes, and the hulls supply mattress filling and packing material. Laundry starch is manufactured from the broken grain, which is also used by distillers. A distilled liquor called arrack is sometimes prepared from a rice infusion, and in Japan the beverage sake is brewed from rice. Rice paper is made from a plant of the ginseng family.

Notes

staple ['steɪpl] — *головний*
motif [mou'ti:f] — *основна ідея; мотив*
strain ['streɪn] — *нахил; стиль*
irrigation [ˌɪrɪ'geɪʃn] — *зрошення, іригація*
to joint ['dʒɔɪnt] — *розчленовувати*
stem — *стовбур*
stalk — *стебло*
to subsist [səb'sɪst] — *існувати, жити*
to plough ['plou] — *орати, борозниті*
buffalo ['bʌfəlou] — *буйвол*
dung [dʌŋ] — *гній*
sewage ['sju:ɪdʒ] — *каналізаційні води*
seedling ['si:dlɪŋ] — *сіянець; розсада*
dike ['daɪk] — *стічна канава; дамба*
hull [hʌl] — *шкарлупа; шкірка*
paddy — *рис (у шкарлупі)*
to flail ['fleɪl] — *молотити*
to tread [tred] — *топтати*
mortar ['mɔ:tə] — *ступка*
to winnow ['wɪnou] — *відсівати; віяти*
chaff [tʃɑ:f] — *полова*
to toss — *підкидати*
coating ['koutɪŋ] — *шар*
carbohydrate ['kɑ:bou'haɪdreɪt] — *вуглеводень*
deficiency [dɪ'fɪʃnsɪ] — *відсутність, нестача*
to induce [ɪn'dju:s] — *спонукати*
gluten ['glu:tən] — *клейковина*
coolie ['ku:lɪ] — *кулі (носильник)*
excess [ɪk'ses] — *надлишок*
consumption [kən'sʌmpʃn] — *споживання*
to chop — *кришити*
to plait ['pleɪt] — *заплітати*
infusion [ɪn'fju:ʒn] — *настій*
beverage ['bevərɪdʒ] — *напій*
sake ['sɑ:kɪ] — *саке (японська горілка)*
to brew [bru:] — *варити*

Text 8. Milk

Milk is a liquid secreted by the mammary glands of female mammals as food for their young. The milk of the cow is most widely used by humans, but the milk of the mare, goat, ewe, buffalo, camel, ass, zebra, reindeer, llama, and yak is also used. Milk, an almost complete food, consists of fats, proteins (mainly casein), salts, and sugar (lactose), as well as vitamins A, C, and D, certain B vitamins, and lesser amounts of others. Commercial dairies sometimes supplement the natural vitamin D with a vitamin D concentrate. The mineral content of milk is chiefly calcium and phosphorus. The composition of milk varies with the species, breed, feed, and condition of the animal. Jersey and Guernsey cows produce milk of high butterfat content; Holsteins produce larger quantities of milk but with a lower butterfat content. Milk prepared for sale is often homogenized; in this process it is pumped under pressure through small, openings to break up the milk fat globules, thus ensuring an equal distribution of fat throughout the milk rather than permitting it to rise to the top as cream. In most countries where milk is a commercial product, it is subject to regulations concerning its composition, i.e., the proportion of butterfat and other solids; its nonadulteration; and its purity, with sanitary measures in force that cover milk handlers, herds, plant, and equipment; dairy herds are also commonly disease tested. Pasteurization (partial sterilization by heating) checks bacterial growth, thereby making milk safer to drink and increasing its keeping qualities and range of transportation. The consumption of concentrated milk, both whole and skim, has steadily increased since its commercial production was inaugurated. A patent was issued for the production of dried milk in Great Britain in 1855, and for concentrated milk in the United States to Gail Borden in 1856. The two types of concentrated milk are condensed and evaporated; condensed milk is a sweetened product (over 40% sugar); while evaporated is unsweetened. The latter is preserved by sterilization, the former by the high sugar content. Dried, or powdered, milk is made by passing a film of partially evaporated milk over a heated drum or by spraying it into a heated chamber in which the particles dry as they fall to the floor. Maled milk is a dried mixture made of milk and the liquid from a mash of barley malt and wheat flour. Skim milk is valuable in fat-free diets; although much of the nutritive value of milk remains, most of the vitamin A is removed in the cream.

Notes

mammal ['mæml] — *ссавець*
mare ['meə] — *кобила*

ewe [ju:] — *вівця*
camel ['kæml] — *верблюд*
ass [æs] — *осел*
reindeer ['reɪndɪə] — *північний олень*
yak [jæk] — *як*
phosphorus ['fɔsfərəs] — *фосфор*
globule ['glɔbju:l] — *крапля, кулька*
concerning [kən'sə:nɪŋ] — *відносно, щодо*
solid ['sɔlɪd] — *суцільний*
to adulterate [ə'dʌltəreɪt] — *підмішувати*
to condense [kən'dens] — *згущати(ся)*
to evaporate [ɪ'væpəreɪt] — *випаровувати*
sterilization [ˌsterɪlaɪ'zeɪʃn] — *стерилізація*
film — *плівка*
drum — *барабан*
to malt [mɔ:lt] — *солодити*

Text 9. Dairying

Dairying is an industry concerned with producing, processing, and distributing milk and milk products. Ninety percent of the world's milk is obtained from cows; the remainder comes from goats, buffaloes, sheep, reindeer, yaks, and other ruminants. In the United States, 20% of the gross national income from agriculture is derived from dairying; Wisconsin, Minnesota, and New York are the most important dairy states. About one third of the milk produced is used for butter, almost as much for market milk, and the remainder is devoted to farm uses and the making of cheese, concentrated milks, ice cream, and by-products such as dried milk solids (e.g., lactose and casein). Commercial dairy products are processed or manufactured and then marketed by creameries, some of which, especially in Denmark, are farmers' cooperatives. Modern dairying dates from 1850, its development paralleling the growth of urban populations. Large-scale dairying was stimulated by the invention of specialized machines, notably the cream separator; by research in chemistry, physics, and bacteriology; by the discovery of pasteurization; by the introduction of the test devised by American agricultural chemist S.M.Babcock for determining the fat content of milk; by improved refrigeration and transportation; by the increase in output resulting from the scientific study of the breeding and feeding of cattle; by the greater consumption of dairy products resulting from increased knowledge of their nutritional value; and by the discovery of new uses for the by-products of factory operation.

Notes

dairy [ˈdɛərɪ] — *молочарня*
to process [ˈprousəs] — *обробляти*
ruminant [ˈru:mɪnənt] — *жуюча тварина*
creamery [ˈkri:mərɪ] — *маслоробня; молочний магазин*
to devise [dɪˈvaɪz] — *придумувати, винаходити*
breeding [ˈbri:dɪŋ] — *розведення*
cattle [ˈkæll] — *велика рогата худоба*
nutritional [nju:ˈtrɪʃnəl] — *харчовий*

Text 10. Butter

Butter is a dairy product obtained by churning the fat from milk until it reaches a solidified form. In most areas the milk of cows is the basis, but elsewhere that of goats, sheep, and mares has been used. Butter was known by 2000 B.C., although in ancient times it was used less as a food than as an ointment, a medicine, or an illuminating oil. At first it was rudely churned in skin pouches thrown back and forth or swung over the back of trotting horses. As butter became a staple food, various sorts of hand churns were devised, including rotating, swinging; and rocking containers operated by plungers. Butter-making on the farm consists of allowing the milk to cool in pans, letting the cream rise to the top, skimming the cream off, and letting it ripen by natural fermentation; it is then churned. Exclusively farm-made until about 1850, butter has become increasingly a factory product. The centrifugal cream separator, introduced into the United States about 1880, and a method devised in 1890 by Stephen Moulton Babcock to determine the butterfat content of milk and cream gave impetus to large-scale production. The application of principles of chemistry and bacteriology facilitates the making of butter of uniform quality. The percentage of fat extraction and the time required for churning depend on the composition of the butterfat; the temperature, acidity, richness, and viscosity of the cream; the speed and motion of the churn; and the size of the fat globules. Commercial butter usually contains from 80% to 85% milk fat, from 12% to 16% water, and about 2% salt. Sweet, or unsalted, butter is favored in Europe, but other markets prefer at least 2% salt. Renovated or process butter is made from rancid or inferior butter, melted and refined, then rechurned. Whey butter, made from cream separated from whey, is usually oily and of inferior quality. The natural color of butter, derived from the carotene of green plant fodder,

ranges from pale yellow to deep gold. Australia, France, West Germany, New Zealand, and the United States are the leading producers; Denmark, New Zealand, and Australia, the chief exporters; and Great Britain, a heavy importer.

The major production centers in the United States are in the North Middle West, especially Minnesota, Iowa, and Wisconsin. Clarified butter, butterfat with the milk solids removed, is useful in cooking and has good keeping qualities. It is made in quantity in Egypt and in India, where it is known as ghee. The high dietary value of butter is due to its large proportion of easily digested fat and to its vitamin A and vitamin D content.

Notes

to obtain [əbˈteɪn] — *одержувати*
to churn [tʃə:n] — *збивати масло*
solidified [səˈlɪdɪfaɪd] — *затверділий, твердий*
pouch [ˈpautʃ] — *торбинка, мішечок*
to swing [swɪŋ] — *коливати(ся)*
to trot — *бігти риссю*
to plunge [ˈplʌndʒ] — *пірнати, занурюватися*
fermentation [ˌfə:menˈteɪʃn] — *бродіння*
centrifugal [senˈtrɪfjugl] — *відцентровий*
impetus [ˈɪmpɪtəs] — *імпульс, повштовх*
globule [ˈglɔbju:l] — *крапля, кулька, пілюля*
viscosity [vɪsˈkɔsɪtɪ] — *в'язкість*
to renovate [ˈrenouveɪt] — *обновляти*
rancid [ˈrænsɪd] — *згірклий*
whey [ˈweɪ] — *сироватка*
fodder [ˈfɔdə] — *фураж, корм*
dietary [ˈdaɪətərɪ] — *дієтичний*
to digest [dɪˈdʒest] — *засвоювати, перетравлювати (їжу)*

Text 11. Margarine

Margarine is a manufactured substitute for butter. It consists of a blend of vegetable oils or meat fats (or a combination of both) mixed with milk and salt. It was developed in the late 1860s by the French chemist Hippolyte Mège-Mouries in a contest sponsored by Napoleon III for a butter substitute. Beef fat, known as oleo oil, was chiefly used at first, but later was supplemented by pork and other animal fats and by vegetable oils such as coconut oil, olive oil, and cotton-

seed oil. At present, most margarines contain only vegetable oils; the margarine produced in the United States is usually made from corn, cottonseed, or soybean oil. The oils, refined, deodorized, and hydrogenated to the desired consistency, are churned or homogenized, usually with cultured skim milk, then chilled and reworked to incorporate salt and remove excess water. Margarine is similar in composition to butter, yields practically the same number of calories, and is easily digestible. It is commonly fortified with vitamin A and vitamin D. In the 1960s a new type of margarine was developed made of polyunsaturated fats. Margarine is sometimes called oleomargarine.

Notes

margarine [ˌmɑːdʒəˈriːn] — *маргарин*
blend — *суміш*
to supplement [ˈsʌplɪment] — *доповнювати*
pork [pɔːk] — *свинина*
coconut [ˈkoukənʌt] — *кокосовий горіх, кокос*
olive [ˈɔlɪv] — *оливка*
soy [ˈsɔɪ] — *соя*
consistency [kənˈsɪstənsɪ] — *консистенція*
calorie [ˈkælərɪ] — *калорія*
digestible [dɪˈdʒestɪbl] — *легкотравний*
to fortify [ˈfɔːtɪfaɪ] — *укріплять*

Text 12. Meat

Meat is a term for the flesh of animals used for food, especially that of cattle, sheep, lambs, and swine, as distinct from game, poultry, and fish; sometimes it is inclusive of all animal flesh. The chief constituents of meat are water, protein, and fat. Phosphorus, iron, and vitamins are also contained in meat, especially in some of the edible organs (e.g., liver). Although meat is digested more slowly than starches or sugars, it has a high food value, with more than 95% of the protein and fat being digested; the fattier meats (e.g., pork) take somewhat longer to digest than the leaner ones. The edible parts of a carcass include lean flesh, fat flesh, and edible glands or organs, such as the heart, liver, kidneys, tongue, tripe, brains, and sweetbread. The comparative toughness of meat depends on the character of the muscle walls and connective tissue, the part of the animal from which the meat is taken, and the age and condition of the animal. Ripening meat, i.e., hanging it for a time at a temperature just above freezing (or, in

a more recently developed technique, at a high temperature) permits enzyme action and the formation of lactic acid, which tenderizes it. Good meat may be recognized by a uniform color; a firm, elastic texture; being barely moist to the touch; and having a scarcely perceptible, clean odor. The choicer cuts should be of fine texture and well marbled with fat. Cooking meat not only softens tissues, kills parasites and microorganisms, and coagulates blood and albumen, but makes the meat more palatable by developing its flavors or introducing new ones by means of seasonings and sauces. Meat, where available, has been a staple food since prehistoric times. The meat supply, obtained at first by using the raw flesh of animals found dead, was augmented by trapping; then, as humans developed their tools and a community life, by hunting; and finally, by the domestication of animals. Meat has been subject to prohibitions, as well as to butchering regulations on religious and hygienic grounds. Meat consumption has been commonly based on the supply, lamb and mutton being preferred in the Middle East, veal in Italy, and pork and beef in most of Europe and America. The leading producers of meat for export are Argentina, Australia, and New Zealand.

Notes

flesh — *м'ясо*
lamb [læm] — *ягня*
poultry [ˈpoultrɪ] — *свійська птиця*
inclusive [ɪnˈkluːsɪv] — *що містить у собі*
edible [ˈedɪbl] — *їстівний*
carcass [ˈkɑːkəs] — *туша*
lean [liːn] — *пісний*
gland [glænd] — *залоза*
texture [ˈtekstʃə] — *тканина*
to coagulate [kouˈægjuleɪt] — *зсідатися, згущати(ся)*
albumen [ˈælbjumɪn] — *білок*
palatable [ˈpælətəbl] — *смачний, приємний*
seasoning [ˈsiːzənɪŋ] — *приправа*
sauce [sɔːs] — *підлива, соус*
to augment [ɔːgˈment] — *збільшувати*
to trap — *ловити пастками (капканами)*
domestication [dɔˌmestɪˈkeɪʃn] — *приручення*
prohibition [ˌproʊɪˈbɪʃn] — *заборона*
to butcher [ˈbʌtʃə] — *убивати худобу*
hygienic [haɪˈdʒiːnɪk] — *гігієнічний*
ground — *основа, підстава, мотив*

Text 13. Sausage

Sausage is food consisting of finely chopped meat mixed with seasonings and, often, other ingredients, all encased in a thin membrane. Although sausages were made by the ancient Greeks and Romans, they were usually plain and unspiced; in the Middle Ages people began to use the various spices and meats that led to the modern sausage. Many of the sausages that became famous were named for the localities where they were first made: the frankfurter in Frankfurt, Germany; the bologna in Bologna, Italy; the genoa salami in Genoa, Italy. Black pudding, an ancient dish in England and Scotland, was made of oatmeal, suet, and hog's blood. White pudding was suet with toasted oatmeal. Sausages are of two types, dry and wet, according to whether the casing is filled with fresh (wet) or cooked (dry) meat. Pork sausage is an example of the wet. Dry sausages are made from fresh meats and curing substances, and then smoked (e.g., peperoni). Salami, most common in Italy and Germany, contains beef and pork and is highly seasoned. The large bologna sausage is of veal and pork and is smoked. Frankfurters and wienerwursts are small, smoked varieties containing lean pork and beef. Sausage is usually packed in casings made either of the cleaned and salted intestines of the slaughtered animals or of synthetic cellulose.

Notes

sausage ['sɔsɪdʒ] — *ковбаса, сосиска*
to encase [ɪn'keɪs] — *упаковувати*
membrane ['membreɪn] — *плівка, оболонка*
plain ['pleɪn] — *простий*
oatmeal ['outmi:l] — *вівсянка*
hog — *свиня, кабан*
to slaughter ['slɔ:tə] — *убивати, різати*
cellulose ['selju:lous] — *клітковина, целюлоза*

Text 14. Fats and Oils

Fats and oils is a group of organic substances that form an important part of the diet and also are useful in many industries. The fats are usually solid, the oils generally liquid at ordinary room temperatures. Some tropical products, liquids in their sites of origin, become solids in cooler climates; in commerce these often retain the name originally given, e.g., palm oil and coconut oil. Fats and oils are derived from both plant and animal sources. Among the vegetable

oils of greatest commercial importance are cottonseed, linseed, olive, palm, corn, peanut, soybean, and castor oils. The method of obtaining the oils is similar for all: the fruits or seeds after being cleaned are crushed and pressed cold to obtain the highest grade of oil and then pressed warm, yielding a grade suitable for industrial use. Sometimes solvents are used to remove the remaining oil from the crushed mass. Edible oils are those used in foods, and for these the highest grade is utilized; these must be pale in color, free from disagreeable odor and taste, and wholesome. The lower grades are suitable for making soap and for other industrial purposes. The chemical property that makes fats solid and oils liquid is the amount of saturation in the ester. Animal fats are esters of saturated fatty acids; vegetable oils are esters of unsaturated fatty acids. Conversion of liquid vegetable oils into solid fats is an important chemical industry. This process, sometimes called hardening, involves hydrogenation of the unsaturated fatty-acid portion of the oil molecule by heating the oil with hydrogen in the presence of a metal catalyst; by controlling the extent of hydrogenation, various products can be obtained. For example, controlled hydrogenation of cottonseed oil produces a solid vegetable cooking fat. Most fats become rancid upon standing; since a major factor leading to rancidity is air oxidation of double bonds, saturated fats are much more resistant to rancidity than unsaturated fats. Animal fats used in foods include butter, lard, chicken fat, and suet. Cod-liver oil and some other fish oils are used therapeutically as sources of vitamins A and D. Nutritionally fats and oils are valued as a source of energy. Because they contain less oxygen than other nutrients they oxidize more readily and release more energy. Fats are digested in the human body chiefly by the enzyme lipase (in the pancreatic juice), aided by the bile. There are several theories to explain the method of absorption of fats; favored by many is the view that they are absorbed by the epithelial cells of the lining of the small intestine in the form of the fatty acids and glycerol into which they are split by digestion and that a recombination to reform the fat occurs within the cells. Most of the fat then enters the lymphatic system through the villi in the lining of the small intestine, although some is probably absorbed directly by the blood vessels of the villi. Medical research indicates the possibility that saturated fats in the diet contribute to the incidence of arteriosclerosis; such fats may raise the blood's level of cholesterol, which is deposited in the arteries.

Notes

fat [fæt] — *жир, сало*
oil ['ɔɪl] — *олія*
to retain [rɪ'teɪn] — *зберігати*
linseed ['lɪnsi:d] — *льняне насіння*

grade — *ступінь, сорт, якість*
solvent ['sɔlvənt] — *розчинник*
wholesome ['houlsəm] — *корисний*
saturation [ˌsætʃə'reɪʃn] — *насиченість*
acid ['æsɪd] — *кислота*
rancidity [ræn'sɪdɪtɪ] — *згірклість*
oxidation [ˌɔksɪ'deɪʃn] — *окислення*
lard [lɑ:d] — *смалець*
bile [baɪl] — *жовч*
to deposit [dɪ'pɔzɪt] — *відкладати(ся)*
to contribute [kən'trɪbju:t] — *сприяти*

Text 15. Soup

Soup is a liquid food, in which different kinds of solid food have been cooked, e.g., meat, fish, fowl, vegetables, cereals, or fruit. Many soups are peculiar to certain localities, e.g., the pot-au-feu of France, the borsch of Ukraine, the mutton broth of Scotland, the minestrone of Italy, and the chowders of various seacoast places. Broth is a thin soup of meat or shellfish liquor, sometimes with cereals added, as in barley broth. Clear soups, made from a rich meat stock, include consommé (beef, veal, or fowl) and bouillon (beef or chicken). A clear soup with finely shredded vegetables added is a julienne soup. Thick soups include vegetable soups made with stock and vegetables (as in pot-au-feu) or with milk and flour (cream soups) or by cooking fish and vegetables in water as for a chowder. A puree differs from a cream soup in that it is thickened with pulp, usually of a vegetable; sometimes, particularly when made with fish, it is called a bisque. Gumbo is either vegetable or meat soup thickened with okra. Stock, the basis of a great many soups, is made by placing lean meat, bones, fowl, fish, or vegetables in cold water, simmering in a covered pot, skimming, straining, and removing the fat. Bones supply marrow and gelatin. The bones of old animals are much richer in marrow and gelatin than those of young ones. Stock is either white or brown; for white, fowl or veal is used; for brown, beef and beef bones or beef combined with veal are used. Jellied soups, served as appetizers in hot weather, may be made from stock or from strained vegetable juices with the addition of gelatin. Gazpacho, the cold soup of Spain, is made of cucumbers, tomatoes, onions, peppers, and seasonings in a base of tomato juice. Soups vary widely as to dietary value. The clear, delicately seasoned ones are important as appetizers and appetite stimulants, while the more substantial ones, like chowders, form, with the addition of bread, a one-dish meal.

Notes

mutton ['mʌtn] — *баранина*
broth [brɔθ] — *бульйон, юшка*
shellfish — *молюск*
liquor ['lɪkə] — *відвар (м'ясний)*
stock — *стовбур*
shredded ['ʃredɪd] — *нарізаний*
pulp — *м'якуш*
to simmer ['sɪmə] — *кипіти на малому вогні*
marrow ['mærou] — *кістковий мозок*

Text 16. Gelatin or Animal Jelly

Gelatin or animal jelly is a foodstuff obtained from connective tissue (found in hoofs, bones, tendons, ligaments, and cartilage) of vertebrate animals by the action of boiling water or dilute acid. It is largely composed of denatured collagen, a protein particularly rich in the amino acids proline and hydroxyproline. The process of manufacture is a complex one that involves removing foreign substances, boiling the material (usually in distilled water in aluminum vessels to prevent contamination), and purifying it of all chemicals used in freeing the gelatin from the connective tissues. The final product in its purest form is brittle, transparent, colorless, tasteless, and odorless and has the distinguishing property of dissolving in hot water and congealing when cold. In contact with cold water it takes up from 5 to 10 times its own weight and swells to an elastic, transparent mass. Gelatin, being readily digested and absorbed, is a good food for children and invalids. It is important in fine cookery as a vehicle for other materials in the form of jellied soups, molded meats and salads, and frozen desserts. Preparations of it are used in the home manufacture of jam, jellies, and preserves to ensure jellification of fruit juices. It is used in the drying and preserving of fruits and meats, in the glazing of coffee, and in the preparation of powdered milk and other powdered foods. Bakeries use it in making meringues, eclairs, and other delicacies. In confectionery making it is used as the basis of taffy, nougat, marshmallows, and fondant. Ice cream manufacture employs it to maintain a permanent emulsion of other ingredients and thus to give body to the finished product. In scientific processes gelatin is widely employed,

being used in electrotyping, photography, waterproofing, and dyeing, and in coating microscopic slides. It is used as a culture medium for bacteriological research and also to make coatings for pills and capsules for court plaster, and for some surgical dressings. It affords a base for ointments and pastes, such as toothpaste; it is an emulsifying agent useful in making liquid combinations and various sprays. In its less pure forms gelatin is known as glue and size. Vegetable gelatin, or agar, is derived from East Indian seaweeds.

Notes

gelatine [ˌdʒelə'ti:n] — *желатин*
jelly ['dʒelɪ] — *желе*
hoof [hu:f] — *копито*
tendon ['tendən] — *сухожілля*
ligament ['lɪgəmənt] — *зв'язка*
cartilage ['kɑ:tɪlɪdʒ] — *хрящ*
vertebrate ['və:tɪbrɪt] — *позвоночна тварина*
dilute [daɪ'lju:t] — *розбавлений, розведений*
to denature [di:'neɪtʃə] — *міняти природні властивості*
contamination [kənˌtæmɪ'neɪʃn] — *забруднення, зараження*
brittle ['brɪtl] — *крихкий, ломкий*
to congeal [kən'dʒi:l] — *замерзати*
delicacy ['delɪkəsɪ] — *ласощі*
toffee ['tɔfɪ] — *цукерки*
emulsion [ɪ'mʌlʃn] — *емульсія*
glue [glu:] — *клей*

Text 17. Sauce

Sauce is a seasoning or flavoring composition, usually in liquid or semiliquid form, used as an appetizing accompaniment for meat, fish, vegetables, and desserts. Sauces, an important feature of quality cookery, especially in France, have often been named for the chefs who created them. Sauces may be classed as hot and cold; and divided again, the hot as white and brown, the cold as the mayonnaise type and the type used for coating cold foods and often containing gelatin. Hot sauces, made with a base of flour, fat, and milk or stock, may be varied by seasonings and added ingredients. Stewed fruits, such as apple and cranberry, are sometimes classified as sauces. Commercial sauces, which are finely blended extracts of various fruits and vegetables with vinegar and condiments, include Worcestershire

sauce, Leicester sauce, chili sauce, creole sauce, soy sauce, Tabasco, and catsup. Sauces for puddings and desserts include syrup, custard, fruit, and creamed sauces (hard sauce and wine and brandy sauce).

Notes

sauce [sɔ:s] — *підлива, соус*
to flavor ['fleɪvə] — *надавати смаку*
cranberry ['krænbərɪ] — *журавлина, клюква*
to blend — *змішувати*
vinegar ['vɪnɪgə] — *о́цет*
condiment ['kɔndɪmənt] — *приправа*

Text 18. Vinegar

Vinegar is a sour liquid consisting mainly of acetic acid and water, produced by the action of bacteria on dilute solutions of ethyl alcohol derived from previous yeast fermentation. The coloring and flavoring are characteristic of the alcoholic liquor (as cider, beer, wine, fermented fruit juices, solutions of barley malt, hydrolyzed cereals, starches, or sugars) from which the vinegar is made. Vinegar is used as a salad dressing, a preservative, a household remedy to allay irritations, a mild disinfectant, and, in cooking, as a fiber softener. Vinegar has been known from antiquity as a natural by-product of wine; the name is derived from the French *vin aigre* (sour wine). The manufacture as a separate industry began in France in the 17th century. The wasteful slow, or natural, process, a spontaneous fermentation in casks half full of beechwood shavings exposed to the atmosphere by bung holes, was superseded in the early 19th century by the quick, or generator, method. The generator used in present-day commercial manufacture is usually a tall, truncated cone or vertical wood tank with a false bottom perforated to admit air that is generally forced through by a blower. The alcoholic solution is allowed to drip through a filling of hard-wood shavings or other material presenting a large surface area. Vinegar made by this method must be aged to remove a natural harshness. It is generally clarified, then pasteurized. Some vinegars are subjected to distillation which removes most of the flavorings other than acetic acid. In another process, the solution is aerated directly by a spinning rotor. The wood shavings are not needed in this case, and the process runs continuously. Acetic fermentation may be impeded by an excessive growth of mother of vinegar, a slimy mass of bacteria, or of the parasitic vinegar eel, a minute, threadlike worm.

Notes

acetic [ə'si:tɪk] — *оцтовий*
acid ['æsɪd] — *кислота*
alcohol ['ælkəhɔl] — *спирт*
yeast ['ji:st] — *дріжджі*
fermentation [ˌfə:men'teɪʃn] — *бродіння*
liquor ['lɪkə] — *напій*
solution [sə'lu:ʃn] — *розчин*
wasteful — *марнотратний*
spontaneous [spɔn'teɪnjəs] — *спонтанний*
cask [kɑ:sk] — *бочонок*
to expose [ɪks'pouz] — *викривати*
bung [bʌŋ] — *втулка*
to supersede [ˌsju:pə'si:d] — *замінятн*
cone ['koun] — *конус*
harshness ['hɑ:ʃnɪs] — *грубість*
to clarify ['klærɪfaɪ] — *очищати*
to aerate ['eɪəreɪt] — *провітрювати*
to impede [ɪm'pi:d] — *перешкоджати, затримувати*

Text 19. Pickle

Pickle is a general term for fruits or vegetables preserved in vinegar or brine, usually with spices or sugar or both. Vegetables commonly pickled include the beet, cabbage, cauliflower, cucumber, olive, onion, pepper, and tomato. Mixed pickles include piccalilli, chowchow, mustard pickles, and chutney. Dill pickles are cucumbers matured in a brine of dill leaves and seed heads. Sweet pickles are made from various fruits or vegetables e.g., tomatoes, cucumbers, peaches, or plums with sugar added. Pickles have limited nutritional value and are often used as appetizers. Before the invention of refrigeration they served as a sort of winter substitute for salads. Cucumbers, the most commonly pickled of all vegetables, are placed underripe in 10% brine, allowed to undergo a lactic acid fermentation, soaked in hot water to remove excess salt, and then covered with vinegar and other ingredients. In a wider sense, a pickle is an acid or saline liquid, such as brine or saltpeter for meat, limewater or water glass for eggs, brandy for fruit, or alcohol for laboratory specimens.

Notes

pickle [pɪkl] — *рола; соління; пікулі*
to brine [braɪn] — *солити*

brine — *рола, солона вода*
cauliflower ['kɔlɪˌflauə] — *цвітна капуста*
dill — *окріп*
lime ['laɪm] — *липа; вапно*
specimen ['spesɪmɪn] — *зразок*

Text 20. Fisheries

From earliest times and in practically all countries, fisheries have been of industrial and commercial importance. In the large North Atlantic fishing grounds off Newfoundland and Labrador, European and American fishing fleets have been taking cod, herring, haddock, and mackerel for centuries. Today the largest and most valuable U.S. catch (mainly shrimp) is made in the Gulf of Mexico. Other valuable U.S. catches are tuna, salmon, crab, oyster, and lobster. Peru is the world's leading fishing nation, followed by Japan, and China. The United States and Norway vie for fifth place. In 1971 more than 76.5 million tons of fish were taken by all fishing nations. The commercial methods chiefly in use today — each with a great variety of modifications — employ encircling nets (purse seine, haul seine, trawl seine), entangling nets (gill and trammel), line, and trap (for lobster and crab). Trawlers and purse boats take most commercial catches. Since World War II, Japan and the USA have been operating factory ships that freeze or can fish shortly after they are caught. The drying, canning, salting, and preserving of fish comprise a vast industry with, in addition, the manufacture of numerous by-products, including glue, fertilizer, and in the Orient, fish sauces. In the United States, since all waters within a state are subject to state jurisdiction, domestic fisheries are governed by state regulations, except when national control results from the treaty-making power and except for the regulation of navigation, customs, and interstate commerce, which are granted to the Federal government by the Constitution. Agreements between states concerning fishing in boundary waters (such as that between Washington and Oregon concerning the Columbia River salmon fisheries) require the ratification of Congress. State fishery legislation is generally both restrictive and protective. Fish may be protected by imposing closed seasons during the spawning season or for the period necessary for the increase of depleted species; certain waters may be entirely closed to commercial fishing; and the taking of fish below a certain size may be forbidden. Undesirable types of fishing gear are prohibited and the use of other

apparatus restricted. State statutes forbidding the pollution or the obstruction of nonnavigable streams are general. National governments generally restrict fishing rights within territorial waters to citizens and may establish jurisdiction over portions of the open sea, often for the purpose of protecting shore fisheries. While a national government may regulate the high-seas fisheries of its own citizens, the right to take products from the high seas is a subject for international agreements. Fisheries have occupied an important place in the economic structure of many countries throughout history. The Black Sea fisheries formed an important source of Phoenician and Greek income; Spanish and Sicilian waters yielded fish for Rome; the economy of the Hanseatic League was partly based on the North Sea herring fisheries; cod fishing was a chief industry of New England; and fisheries in the Pacific are vital to Japan. For that reason fishing rights have long been the basis of controversy. In the modern age such disputes have generally been settled by arbitration or by treaties. Fishing rights, which had been enjoyed by the American colonists on the entire Atlantic coast, were confirmed in the Treaty of Paris (1783), but the right to dry fish on the Newfoundland coast and on the settled parts of the Labrador and Nova Scotian coasts (except by agreement with the inhabitants) was expressly denied. That treaty was abrogated by the British upon the outbreak of the War of 1812, and the Treaty of Ghent (1814) contained no provisions relating to the controversial issue of fishing rights. Friction developed, and, after prolonged parleying, another treaty further restricting American rights was negotiated (1818). This convention was replaced by the reciprocity treaty of 1854, which abolished all restrictions except for shellfish. The United States abrogated the treaty in 1866, but a new treaty (1871, with a protocol in 1873) revived the provisions of the agreement of 1854 (to latitude 39°N). Since the Canadians declared their waters more valuable than those of the United States, the question was arbitrated, and Canada received an award of $5,500,000 (1877). When the United States denounced the treaty (1885), American vessels were again seized and strained relations resulted. In 1910, however, the North Atlantic Coast Fisheries Arbitration at The Hague ended the prolonged controversy. Canada and the United States in 1923 and 1930 signed agreements regulating the halibut fisheries of the North Pacific. In 1882, Great Britain, Germany, France, Denmark, and Belgium signed the North Sea Fisheries Convention, which ended lawlessness in that area by granting a mutual right of visit, search, and arrest to the public vessels of the treaty powers. A similar treaty, regulating the fishing banks off

Iceland and the Faeroe Islands, was signed by Great Britain and Denmark in 1901, and three years later Anglo-French rights in the North Atlantic were set forth in a convention. The fisheries of the Pacific have also been the subject of many international agreements, such as the Japanese right to fish in specified sections of Siberian waters, first granted by the Treaty of Portsmouth in 1905 and continued by later agreements. One of the most celebrated contentions about territorial rights in waters concerned not fishing proper but the hunting of fur seals. New international problems raised in recent years involve territorial limits and marine pollution. Current international practice recognizes a 12-mi exclusive fisheries zone, but some nations — among them Peru, Ecuador, Argentina, and Brazil — claim territorial jurisdiction up to 200 mi. To stabilize international rules governing national rights in the oceans, the United Nations began an ongoing Conference on the Law of the Sea in the summer of 1974. A prime concern of the conference is pollution. The oceans have long been used as a dumping ground, but in recent years levels of pollutants in the open seas as well as in coastal areas have risen sharply. Nuclear wastes, heavy metals, dredge spoils, pesticides and other persistent petrochemicals, plastics, accidentally spilled oil, deliberately discharged ship bilge, and sewage — all threaten marine ecology and resources and thus global food supplies.

Notes

cod — *тріска*
herring ['herɪŋ] — *оселедець*
haddock ['hædək] — *пікша (вид тріски)*
mackerel ['mækrəl] — *макрель, скумбрія*
shrimp [ʃrɪmp] — *креветка*
salmon ['sæmən] — *лосось*
crab — *краб*
oyster ['ɔɪstə] — *устриця*
lobster ['lɔbstə] — *омар*
to vie [vaɪ] — *суперничати*
to encirle [ɪn'sə:kl] — *оточувати*
to haul [hɔ:l] — *тягти, перевозити*
to trawl [trɔ:l] — *тягти*
to entangle [ɪn'tæŋgl] — *спіймати, заплутувати*
trammel ['træml] — *невід; трал*
trap — *пастка*
catch [kætʃ] — *улов*
to spawn [spɔ:n] — *розмножуватися*

to deplete [dɪ'pli:t] — *вичерпувати запаси*
gear ['gɪə] — *прилад*
obstruction [əb'strʌkʃn] — *перешкода, обструкція*
to yield [ji:ld] — *виробляти, давати*
vital ['vaɪtl] — *життєвий, конче необхідний*
controversy ['kɔntrəvə:sɪ] — *дискусія, суперечка*
arbitration [ˌɑ:bɪ'treɪʃn] — *третійське рішення*
treaty ['tri:tɪ] — *договір; угода*
to abrogate ['æbrougeɪt] — *скасовувати*
to parley ['pɑ:lɪ] — *вести переговори*
reciprocity [ˌresɪ'prɔsɪtɪ] — *взаємодія*
to abolish [ə'bɔlɪʃ] — *скасовувати*
to denounce [dɪ'nauns] — *викривати, засуджувати*
convention [kən'venʃn] — *договір*
seal [si:l] — *морський котик; тюлень*
prime ['praɪm] — *головний*
concern [kən'sə:n] — *турбота*
to dump [dʌmp] — *вивантажувати*
waste — *відходи*
dredge [dredʒ] — *землечерпалка*
persistent — *стійкий, тривалий*
to spill (spilled, spilt) — *проливати, розливати*
oil — *нафта*
deliberately [dɪ'lɪbərɪtlɪ] — *навмисно*
to discharge [dɪs'tʃɑ:dʒ] — *виливати*
bilge [bɪldʒ] — *трюмна вода*
sewage ['sju:ɪdʒ] — *стічні води*
marine [mə'ri:n] — *морський*

Text 21. Fish Curing

Methods of curing fish by drying, salting, smoking, and pickling; or by combinations of these processes have been employed since ancient times. On sailing vessels, fish were usually salted down immediately to prevent spoilage; the swifter boats of today commonly bring in unsalted fish. Modern freezing and canning methods have largely supplanted older methods of preservation. Fish to be cured are usually first cleaned, scaled, and eviscerated. Fish are salted by packing them between layers of salt or by immersion in brine. The fish most extensively salted are cod, herring, mackerel, and haddock. Smoking preserves fish by drying, by deposition of creosote ingredients, and,

when the fish are near the source of heat, by heat penetration. Herring and haddock (finnan haddie) are commonly smoked. Kippers are split herring, and bloaters are whole herring, salted and smoked. Sardines, pilchards, and anchovies are small fish of the herring family, often salted and smoked and then preserved in oil. Fish are dried under controlled conditions of temperature, humidity, and air velocity. Since the dried product is relatively unappetizing and rehydration slow, other preservation methods are more common.

Notes

to cure [kjuə] — *виліковувати*
spoilage ['spɔɪlɪdʒ] — *порча*
to supplant [sə'plɑ:nt] — *виживати*
to scale ['skeɪl] — *зважувати*
immersion [ɪ'mə:ʃn] — *занурювання*
brine ['braɪn] — *розсіл*
creosote ['krɪəsout] — *креозот*
kipper — *копчена риба*
bloater ['bloutə] — *копчений оселедець*
pilchard ['pɪltʃəd] — *сардинка*
anchovy [æn'tʃouvɪ] — *анчоус*
velocity [vɪ'lɔsɪtɪ] — *швидкість*

Text 22. Peanut

Peanut is a name for a low, annual leguminous plant (*Arachis hypogaea*) of the family Leguminosae and for its edible seeds. Native to South America and cultivated there by pre-Columbian Indians, the peanut was brought to North America in the slave-trade days by way of Africa, where it is said to have been introduced by early explorers. In the United States it has been extensively cultivated only since the late 19th century. It is now grown in most tropical, subtropical, and temperate regions, especially in India and China (the major world producers), West Africa, and the South East United States. The seeds — peanuts — are eaten fresh or roasted and are used in cookery and confectionery. They are ground for peanut butter, an important article of commerce, and also yield an oil used for margarine, cooking oil, soap manufacture, and industrial purposes. The herbage is used for hay, the residue from oil extraction (called peanut-oil cakes) for stock feed, and the whole plant, left in the ground, as pasturage for swine. Peanut crops are usually harvested by hand except in the United States. Europe is the chief importer and processor, especially

for oil manufacture. In the United States the amount of the crop converted to oil depends on the demand for whole peanuts; it is usually only 15% to 20%. Because of its numerous uses (George Washington Carver developed several hundred), high protein content, and adaptability to varying demand, the peanut is an advantageous agricultural crop. There are two types of peanut plant — bunch nuts and vine, or trailing, nuts — named for the way the plants grow. The peanut plant is unusual for its habit of geocarpy: when the pod starts to form, it is pushed into the ground by the elongation of its stalk and matures underground. Other names for the peanut are goober, pinder, earthnut, groundnut, and ground pea.

Notes

peanut ['pi:nʌt] — *арахіс, зелений горіх*
leguminous [le'gju:mɪnəs] — *бобовий, стручковий*
temperate ['tempərɪt] — *помірний*
herbage ['hə:bɪdʒ] — *трави*
pasturage ['pɑ:stjurɪdʒ] — *пасовище; корм*
processor [prou'sesə] — *процесор*
advantageous [ˌædvən'teɪdʒəs] — *вигідний, сприятливий*
vine — *виноградна лоза*
pod — *стручок*
to elongate ['i:lɔŋgeɪt] — *розтягати(ся)*

Text 23. Coconut

Coconut is a fruit of the coco palm, a tree widely distributed through tropical regions. The seed is peculiarly adapted to dispersal by water since the large pod holding the nut is buoyant and impervious to moisture. The trees therefore establish themselves naturally on small islands and low shores bordering the tropic seas. The tree grows to a height of from 60 to 100 ft. (18—30 m), with a smooth cylindrical stem marked by the ringlike scars of former leaves. It bears at the top a crown of frondlike leaves and yellow or white blossoms. The number of nuts varies; a well-cared-for tree may yield 75 to 200 or more annually. The mature fruit as it comes from the tree is encased in a thick, brown fibrous husk. The nut itself has a hard woody shell, with three round scars at one end; the embryo lies against the largest scar and emerges through it as a developing plant. Through this easily punctured spot the milk of the young coconut may be drained. Its constantly growing commercial value has led to extensive cultivation of the coconut, especially in the Malay Archipelago, Sri Lanka,

and India. A few are found in the southern extremity of Florida. The coco palm is one of the most useful trees in existence, every part of it having some value. The fruit, either ripe or unripe, raw or cooked, is a staple food in the tropics; the terminal bud, called palm cabbage, is considered a delicacy, and the inner part of young stems is also eaten. The milk of the young nut is a nutritious drink. A sweet liquid obtained from the flower buds ferments readily and is used as a beverage, both when fresh and when distilled to make arrack; it may be boiled down to make various palm sugars, e.g., jaggery. The leaves are used for making fans, baskets, and thatch. The coir (coarse fibers obtained from the husk) is made into cordage, mats, and stuffing; it becomes more buoyant and elastic than hemp in salt water. The hard shell and the husk are used for fuel. The fibrous center of the old trunk is also used for ropes, and the timber, known as porcupine wood, is hard and fine-grained and takes a high polish. From the nutshells are made containers of various kinds — cups, ladles, and bowls — often highly polished and ornamentally carved. The root is chewed as a narcotic. Commercially the greatest value of the coconut lies in the oil, which is extracted from the dried kernels of the fruit. The nuts when ripe are apt to spoil or become rancid. Therefore when they are gathered they are broken open and the flesh is dried and exported under the name of copra. The oil content of copra ranges from 50% to 70% depending upon the method of drying. The coconut and the olive are the earliest recorded sources of vegetable oil. Coconut oil, the major type of palm oil, has been extracted by mortar and pestle in the Orient since antiquity. Primitive methods of drying and expressing the copra are giving way to modern machinery; such as rotary driers and hydraulic presses. The residue, known as coco cake, makes excellent cattle food, as it usually contains a remnant of from 6% to 10% of oil. Large quantities of shredded or desiccated coconut made from copra and many whole coconuts are exported for use chiefly in the making of cakes, desserts, and confectionery.

Notes

coconut ['koukənʌt] — *кокосовий горіх*
palm [pɑ:lm] — *пальма*
dispersal [dɪs'pə:sl] — *поширення*
pod — *кокон; лушпиння*
buoyant ['bɔɪənt] — *життєрадісний*
impervious [ɪm'pə:vjəs] — *непроникний*
moisture ['mɔɪstʃə] — *вогкість, сирість*
stem — *стовбур*
scar [skɑ:] — *рубець*

crown ['kraun] — *крона*
mature [mə'tjuə] — *зрілий*
to encase [ɪn'keɪs] — *упаковувати*
fibrous ['faɪbrəs] — *волокнистий*
husk [hʌsk] — *шкаралупа, шкірка*
embryo ['embrɪou] — *ембріон, зародок*
to puncture ['pʌŋktʃə] — *проколювати, пробивати*
spot — *пляма*
to drain [dreɪn] — *відводити (воду)*
extremity [ɪks'tremɪtɪ] — *крайність, безвихідь*
staple ['steɪpl] — *основний*
terminal ['tə:mɪnl] — *кінцевий*
bud — *брунька*
nutritious [nju:'trɪʃəs] — *поживний*
hemp — *коноплі*
porcupine ['pɔ:kjupaɪn] — *дикобраз*
ladle ['leɪdl] — *ківш, черпак*
kernel ['kə:nl] — *зерно, ядро*
apt [æpt] — *відповідний, доречний*
rancid ['rænsɪd] — *згірклий*
mortar [mɔ:tə] — *ступка*
pestle ['pesl] — *товкач*
to shred — *дерти, шматувати*

Text 24. Confectionery

Confectionery is delicacies or sweetmeats that have sugar as a principal ingredient, combined with coloring matter and flavoring and often with fruit or nuts. In the United States it is usually called candy, in Great Britain, sweets or boiled sweets. Sweetmeats, long known in the Orient and to the Egyptians, were at first preserved or candied fruits, probably made with honey. One of the earliest functions of candy was to disguise unpleasant medicine, and prior to the 14th century confections were sold chiefly by physicians. Medieval physicians often used for this purpose sugarplate, a sweetmeat made of gum dragon, white sugar, and rosewater, beaten into a paste. One of the earliest confections still surviving is marzipan, known throughout Europe; it is made of almonds or other nuts, pounded to a paste and blended with sugar and white of egg. In the Middle Ages it was sometimes molded into fancy shapes and stamped with epigrams. Sugarplums, made of boiled sugar, were known in England in the

17th century, but it was not until the 19th century that candymaking became extensive. The display of British boiled sweets at the national exhibition of 1851 stimulated manufacture in other countries, especially in France. In the United Slates in the middle of the 19th century about 380 small factories were making lozenges, jujube paste, and stick candy, but most fine candy was imported. With the development of modern machinery and the increasing abundance of sugar, confectionery making became an important industry. In the early 1970s annual candy sales in the United States had reached around $2 billion. Candy is roughly divided into two classes, hard and soft; the distinction is based on the fact that sugar when boiled passes through definite stages during the process of crystallization. Fondant, or sugar cooked to the soft stage, is the basis of most fancy candies; such as chocolate creams.

Notes

confectionery [kən'fekʃnərɪ] — *кондитерські вироби*
delicacy ['delɪkəsɪ] — *ласощі*
sweetmeats — *цукерки, ласощі*
honey ['hʌnɪ] — *мед*
to disguise [dɪs'gaɪz] — *маскувати*
confection [kən'fekʃn] — *ласощі, солодощі*
to blend — *змішувати*
to mold ['mould] — *перетворювати*
display [dɪs'pleɪ] — *показ*
abundance [ə'bʌndəns] — *велика кількість*
chocolate ['tʃɔkəlɪt] — *шоколад*

Text 25. Raisin

Raisin is a dried fruit of certain varieties of grapevines bearing grapes with a high content of sugar and solid flesh. Although the fruit is sometimes artificially dehydrated, it is usually sun-dried. The culture of grapes for the production of raisins is limited to regions with a long, hot growing season because the grape must remain on the vine until fully mature in order to attain a high percentage of sugar and because enough time must elapse between harvesting and fall rains to permit sun-drying. Raisins are produced from grapes of the European type (*Vitis vinifera*). Most seedless raisins, especially in California, are produced from the Sultanina, or Thompson, variety of seedless grape, known in international trade as the Sultana. A different variety, produced in California, is known there as the Sultana.

The Muscat, a very ancient variety, is noted for its flavor and meatiness, but it has seeds and is somewhat sticky; it is commonly marketed in clusters for table use. Raisins of sharp flavor and firm texture are often called currants (although unrelated to the true currant) and are preferred for certain bakery products. The best known of these is the Black Corinth, or Zante, currant of Greece; the variety is grown also in California. Grapes have been dried for out-of-sea-son consumption from ancient times and were early important in Mediterranean trade. Spain, Asia Minor, and Greece were long the centers of cultivation, but in the 20th century Australia also became an important producer and California became the leading producer, over one third of its annual grape crop now being used to make raisins. Raisin production was introduced in California by Spanish missionaries in the late 18th century and began to assume importance after 1875; although grapes are cultivated over a large area, the region around Fresno is outstanding in the production of grapes for raisins. Clusters of fully ripened grapes are usually picked by hand, placed in trays between the rows of vines to dry in the sun for several days, then shipped to packing houses, where they are cleaned and stemmed by machine. Today most seed grapes are seeded, and many grapes are bleached and dipped in oil to improve their appearance. About $3^1/_2$ lb (1.6 kg) of grapes yield 1 lb (.45 kg) of raisins. Raisins are valuable nutritionally because of their sugar, mineral (especially iron), and vitamin (B and A) content.

Notes

raisin ['reɪzn] — *ізюм*
to dehydrate [ˌdi:'haɪdreɪt] — *обезводнювати*
to elapse [ɪ'læps] — *минати*
sticky ['stɪkɪ] — *липкий*
cluster ['klʌstə] — *гроно*
currant ['kʌrənt] — *смородина*
texture ['tekstʃə] — *структура*
to ship — *вантажити*
to seed [si:d] — *сіяти*

Text 26. Wine

Wine is a alcoholic beverage made by the fermentation of the juice of the grape. Wines are distinguished by color, flavor, bouquet or aroma, and alcoholic content. Wine is also divided into three main types: still or natural, fortified, and sparkling. Wines are red, white, or rosé (depending on the grape used and the amount of time the

skins have been left to ferment in the juice). For red wines the entire crushed grape is utilized; for white wines, the juice only. In rosé wines, the skins are removed after fermentation has begun thus producing a light pink color. Wines are also classified as dry or sweet, according to whether the grape sugar is allowed to ferment completely into alcohol (dry), or whether some residual sugar has been left (sweet). In a natural wine all the alcohol present has been produced by fermentation. Fortified wines, such as sherry, port, Madeira, and Malaga, are wines to which brandy or other spirits have been added. These wines contain a higher alcohol content (from 16% to 35%) than the still wines (from 7% to 15%). Sparkling wines, of which champagne is the finest example, are produced by the process of secondary fermentation in the bottle. In natural-wine making the grapes are gathered when fully ripe (sometimes, as for sauterne, when overripe). Mechanical extraction of the juice, called must, has almost entirely replaced treading. For red wines the must is fermented with the skins and pips, from which the newly formed alcohol extracts coloring matter and tannin. Fermentation starts when wine yeasts existing on the skins of ripe grapes, come in contact with the must. It may take from a few days to several weeks, according to the temperature and the amount of yeast present or introduced. When the new wine has become still and fairly clear, it is run off into large casks, where it undergoes a complicated series of chemical processes including oxidation, precipitation of proteids, and formation of esters that create a characteristic bouquet. The wine is periodically fined (clarified), then racked into smaller casks. After some months, or for certain wines several years, the wine is ripe for bottling. The very rare, superfine natural wines made in good vintage years from perfect grapes of the better varieties and possessing the unaccountable quality that vintners call breed are produced in commercial quantities in limited areas of the Bordeaux and Burgundy regions in France, of the Rhine valley in Germany, and around Tokaj, Hungary. The fine *sherry* of Spain and port of Portugal are superior fortified wines. Champagne is the only superfine sparkling wine. So ancient that its origin is unknown, wine is mentioned in early Egyptian inscriptions and in the literature of many lands. The term *wine* is also applied to alcoholic beverages made from plants other than the grape, e.g., elderberry wine, dandelion wine.

French wine. France is the greatest wine-producing area in the world, both in quantity and quality, and has developed superfine natural still wines and the finest sparkling wine — champagne. The department of Bordeaux furnishes red wine known as claret and white wine, both dry except for sauterne. The best-known Bordeaux wines are Médoc (red),

classified and known by the vineyard names, as Château Lafite, Château Margaux, Château Latour; graves (red or white); sauterne (white), sweet, made from overripe grapes and including the noted Château d'Yquem; and St. Emilion-Pomerol. Burgundy wines, red and white, have more body than the Bordeaux. Connoisseurs prize the Burgundies of the Côte d'Or, especially the white Montrachet, and red Clos Vougeot and Romanée. The Chablis area produces fine, white Burgundy. Good wines are made in the Loire valley (Vouvray), the Rhône valley (Hermitage:), Alsace, and the Jura mountains. A great quantity of ordinary wine is produced in South France, much of it made into vermouth, distilled into brandy, or used for blending.

Notes

bouquet ['bukeɪ] — *букет*
to utilize ['ju:tɪlaɪz] — *використовувати*
extraction [ɪks'trækʃn] — *витягування*
to tread [tred] — *давити*
pip — *кісточка*
yeast [ji:st] — *дріжджі*
must — *пліснява*
oxidation [ˌɔksɪ'deɪʃn] — *окислення*
precipitation [prɪˌsɪpɪ'teɪʃn] — *осад*
claret ['klærət] — *кларет (сорт вина)*
dandelion ['dændɪlaɪən] — *кульбаба*
superfine ['sju:pə'faɪn] — *вищого гатунку*
except [ɪk'sept] — *крім*

Text 27. Whiskey

Whiskey is a spirituous liquor distilled from a fermented mash of grains, usually rye, barley, oats, wheat, or corn. Inferior whiskeys are made from potatoes, beets, and other roots. The standard whiskeys of the world are Scotch (commonly spelled *whisky*), Irish, American, and Canadian. The Scotch Highland whiskey (made in pot stills) and that of the Lowlands (patent stills) differ in the percentage of barley used, quality of the water, quantity of peat employed in curing the malt, manner of distilling, and kind of casks in which they are matured. Practically all Scotch whiskeys are blends. Irish whiskey resembles Scotch, but no peat is used in the curing, and instead of the dry, somewhat smoky flavor of Scotch, it has a full, sweet taste. American whiskeys are divided into two main varieties, rye

and bourbon, a corn whiskey that derives its name from Bourbon co., Ky. They have a higher flavor and a much deeper color than Scotch or Irish and require from two to three years longer to mature. Newly made whiskey is colorless, the rich brown of the matured liquor being acquired from the cask in which it is stored. Canadian whiskey has a characteristic lightness of body and must, according to law, be produced from cereal grain only. Whiskey was made in England in the 11th century chiefly in monasteries, but in the 16th century distilling was carried on commercially. No whiskey can be released from bond in Great Britain until it has matured in wood at least three years, and in practice most whiskey is stored seven or eight years before marketing. In the United States bonded whiskey must stay a minimum of four years in bond before it can be labelled as bonded rye or bourbon. The illicit manufacture of whiskey to avoid payment of excise taxes has been common. In the United States this is known as moonshining.

Notes

spirituous ['spɪrɪtjuəs] — *спиртний*
liquor ['lɪkə] — *напій*
rye ['raɪ] — *жито*
oats [outs] — *овес*
inferior [ɪn'fɪərɪə] — *гірший*
peat [pi:t] — *торф*
malt [mɔ:lt] — *со́лод*
cereals ['sɪərɪəlz] — *хлібні злаки*
bond — *договір*
illicit [ɪ'lɪsɪt] — *незаконний*
moonshining — *нісенітниця; фантазія*

Text 28. Champagne

Champagne is sparkling white wine made from grapes grown in the old French province of Champagne. The best champagne is from that part of the Marne valley whose apex is Rheims, the center of the industry. Champagne was reputedly developed by a monk, Dom Pérignon, in the 17th century. It is a mixture of black Pinot Noir and white Chardonnay grapes and is named for the vintners and shippers responsible for each blend. The small, slightly acid grapes are laboriously cultivated. After the first fermentation the wine is blended; it undergoes a secondary fermentation, then is drawn off into bottles reinforced to withstand high internal pressure, and is sweetened to

induce further fermentation. The carbonic acid retained in the bottle after the final fermentation renders champagne sparkling. The wine is matured in the labyrinthine tunnels of the old chalk quarries of Rheims. The sediment formed is collected on the cork by tilting the bottle neck downward and frequently rotating it by hand. After fermentation comes the *dégorgement* process, whereby the neck of the bottle is frozen and the cork is removed; the lump of frozen sediment shoots out, propelled by the pressure in the bottle. The space left is filled with the proper dosage of cane sugar dissolved in wine and usually fortified with cognac. *Brut* champagne is theoretically not sweetened; extra dry champagne, very lightly. An American sparkling wine called champagne is made in New York and California.

Notes

champagne [ʃæm'peɪn] — *шампанське*
sparkling ['spɑ:klɪŋ] — *шипучий, іскристий*
apex ['eɪpeks] — *верхівка*
blend — *суміш*
laboriously [lə'bɔ:rɪəslɪ] — *важко; старанно*
fermentation [ˌfə:men'teɪʃn] — *бродіння*
to reinforce [ˌri:ɪn'fɔ:s] — *підсилювати, підкріплювати*
to induce [ɪn'dju:s] — *спонукати*
labyrinth ['læbərɪnθ] — *лабіринт*
quarry ['kwɔrɪ] — *кар'єр*
sediment ['sedɪmənt] — *осад, гуща*
to tilt — *нахиляти*
cognac ['kounjæk] — *коньяк*

Text 29. Brandy

Brandy is a strong alcoholic spirit distilled from wine or from marc, the residue of the wine press. The most noted brandy is cognac, made from white grapes in the Charente district of France. The label *Cognac, fine champagne* denotes the finest type of cognac, which comes from a small area around Cognac. Brandy is manufactured commercially in other districts of France, notably Armagnac and in Spain, Portugal, Australia, Italy, South Africa, and the United States. Most fine brandies are distilled in pot stills constructed to retain the volatile ingredients. The product is blended and flavored, then stored in casks (preferably oak), where it mellows and takes on a yellow

color; it acquires a deeper tint from long storage or the addition of caramel syrup. Brandy marketed in the United States must be matured in cask for at least four years. Brandy made from marc is very potent and is inferior to wine brandy. Liquor distilled from fermented beets, grains, or sugar-cane is sometimes called brandy. The term, qualified by the name of a fruit, is applied to spirits distilled from the fermented juice of fruits other than the grape, e.g., peach brandy, cherry brandy, and plum brandy (slivovitz), which is extensively manufactured in the Balkans.

Notes

spirit ['spɪrɪt] — *спирт*
to distil [dɪs'tɪl] — *очищати*
residue ['rezɪdju:] — *залишок, осад*
still — *винокурний завод*
volatile ['vɔlətaɪl] — *непостійний, мінливий*
mellow ['melou] — *стиглий, соковитий*
caramel ['kærəmel] — *карамель*
syrup ['sɪrəp] — *сироп*
to market ['mɑ:kɪt] — *купувати або продавати*
potent ['poutənt] — *сильний, сильнодіючий*
inferior [ɪn'fɪərɪə] — *гірша якість*
beet — *буряк*

Text 30. Food Poisoning

Food poisoning is an acute illness following the eating of foods contaminated by bacteria, bacterial toxins, or harmful chemical substances. The symptoms, in varying degree and combination, include abdominal pain, vomiting, diarrhea, headache, and prostration. It was once customary to classify all such illnesses as "ptomaine poisoning," but it was later discovered that ptomaines, the products of decayed protein, do not cause disease. In general, the bacteria that cause food poisoning do not affect the appearance, aroma, or flavor of food. In gastrointestinal disturbances due to bacteria the most frequent cause is an organism of the *Salmonella* group. The symptoms of bacterial food poisoning, which appear about 12 hr after ingestion of the contaminated food and last one or two days, are usually headache, chills, fever, muscle aches, prostration, nausea, vomiting, abdominal cramps, and diarrhea. In severe cases there may be dehydration, acid-base imbalance, and shock. Bacterial food poisoning is rarely fatal. Treatment includes rest, sedation, and replacement of fluid loss if necessary. The

most common type of food poisoning is caused not by bacteria perse but by their toxins (staphylococcus toxins). Custards, mayonnaise, cream-filled pastry, milk, processed meat, and fish are the foods most often contaminated. Carriers and food handlers with staphylococcic skin infections are mainly responsible for the spread of staphylococcus toxin poisoning. The onset of symptoms from such poisoning (similar to those of *Salmonella* infection) occurs abruptly 2 to 4 hr after ingestion of the polluted food. The illness rarely lasts more than 6 hr, and fatalities are rare. Treatment is the same as for *Salmonella* infection. The most serious type of food poisoning caused by bacterial toxins is due to improper preservation or canning of food. Nonbacterial food poisoning may occur after eating foods that contain a naturally occurring or acquired deleterious substance. Ingestion of poisonous mushrooms or toadstools (muscarine poisoning) may be followed in a matter of several minutes to 2 hr by severe thirst, abdominal cramps, diarrhea, vomiting, sweating, dizziness, confusion, collapse, coma, and, occasionally, convulsions. Poisoning may occur also after the ingestion of immature or sprouting potatoes because of the presence of solanine, an alkaloid. Mussels and clams that have fed on a poisonous plankton are a cause of food poisoning, since the poisonous substance is not destroyed by cooking. Ergot poisoning, caused by ingestion of rye grain infected with that fungus, causes damage to the blood vessels and gangrene, as well as gastrointestinal and neurologic symptoms. It is also possible to take into the body gross poisons such as arsenic and lead with foods that have been accidentally contaminated or sprayed with preservatives and not properly cleansed before ingestion. Food from containers lined with cadmium has been known to cause poisoning.

Notes

harmful — *шкідливий*
abdominal [æb'dɔmɪnl] — *черевний*
vomiting ['vɔmɪtɪŋ] — *блювота*
diarrhea [ˌdaɪə'rɪə] — *пронос*
gastrointestinal — *шлунковокишковий*
prostration [prɔs'treɪʃn] — *знемога*
nausea ['nɔ:sjə] — *нудота*
cramp [kræmp] — *спазм; судома*
dehydration [ˌdi:haɪ'dreɪʃn] — *обезводнення*
sedation [sɪ'deɪʃn] — *заспокійливе*
custard ['kʌstəd] — *крем*
processed ['prousəst] — *оброблене*
abruptly [ə'brʌptlɪ] — *раптом*

canning ['kænɪŋ] — *консервування*
deleterious [ˌdelɪ'tɪərɪəs] — *шкідливий*
toadstool ['toudstu:l] — *поганка*
sweat [swet] — *піт*
dizziness ['dɪzɪnɪs] — *запаморочення*
confusion [kən'fju:ʒn] — *плутанина, збентеження*
collapse [kə'læps] — *знесилення, занепад сил*
to ingest [ɪn'dʒest] — *ковтати*
to sprout ['spraut] — *пускати пáгони*
mussel [mʌsl] — *раковина*
fungus ['fʌŋgəs] — *грибок (біол.)*
arsenic ['ɑ:snɪk] — *миш'як*
to cleanse ['klenz] — *очищати, чистити*
cadmium ['kædmɪəm] — *кадмій*

Text 31. Food Preservation

Because most foods remain edible for only a brief period of time, people since the earliest ages have experimented with methods for successful food preservation. Among the products of early food conservation were cheese and butter, raisins, pemmican, sausage, bacon, and grain. As scientific investigations regarding the causes of food spoilage were undertaken, they pointed the way to a wider application of methods already in use and to the discovery of new ones. Before 1860, changes in food were explained on the theory of spontaneous generation. Pasteur demonstrated that ferments, molds, and some forms of putrefaction were caused by the presence of microorganisms widely distributed in the environment. Since these microorganisms are the main cause of food spoilage, food preservation depends on rendering conditions unfavorable for their growth. Processes of preservation may be generally classified as drying, heating, refrigeration, and the use of chemicals or other particular agencies. The most ancient method is drying, and it was employed early for fruits, grains, vegetables, fish, and meat. It was sometimes combined with parching, as in the oatmeal of Scotland or the corn of the American Indian. Modern applications of this ancient device are seen in dried or dehydrated fruits and vegetables, milk, meat, and eggs. A more recent variation, known as freeze-drying, is now being used on such foods as coffee, meat, orange juice, and soup. The early method of drying was by direct exposure to the sun's rays; in modern industry the process is hastened by complex apparatus and by chemical agencies. The use of sugar was early com-

bined with drying. Smoking, a method used mainly for fish and meat, combines the drying action with chemicals produced from the smoke, which form a protective coating. The process of heating was used centuries before its action was understood. One of the most important modern applications of the heat principle is the pasteurization of milk. Food may be preserved in its original state for a great length of time by refrigeration. In modern food preservation, preservatives function in two ways. One is by delaying the spoilage of the food, while the other is by ensuring that the food retains, as nearly as possible, its original quality. The first method includes the use of sugar, vinegar for pickling meats and vegetables, salt (one of the oldest preservatives), and alcohol. Good wine will keep almost indefinitely, and fruit placed in a 15% to 20% alcohol solution (brandying) is well preserved. The second method includes the use of ascorbic acid: (which prevents color deterioration in canned fruits), benzoic acid, sulfur dioxide, and a variety of neutralizers, firming agents, and bleaching agents. The excessive or unacknowledged use of these chemical agencies has been legislated against by most governments. The exclusion of air, nowadays accomplished by hermetic sealing, is an old device, formerly practiced by pouring hot oil over potted meat or fish, by coating or mixing food with melted fat, as in pemmican, or by burying vegetables in the earth or in sand. The use of melted paraffin achieves the same result. Eggs may be preserved by preventing air from penetrating their porous shells, usually by coating them with an impervious substance. Atomic radiation has also been used successfully to destroy many of the microorganisms that might cause spoilage in food.

Notes

mold ['mould] — *цвіль; пліснява*
putrefaction [ˌpju:trɪ'fækʃn] — *гниття*
to parch ['pɑ:tʃ] — *сушити*
to hasten ['heɪsn] — *поспішати*
to bleach [bli:tʃ] — *відбілювати*
excessive [ɪk'sesɪv] — *надмірний*
acid ['æsɪd] — *кислота*
deterioration [dɪˌtɪərɪə'reɪʃn] — *погіршення, псування*
sulphur ['sʌlfə] — *сірка*
hermetic [hə:'metɪk] — *герметичний*
to pour [pɔ:] — *лити(ся)*
paraffin ['pærəfɪn] — *парафін*
porous ['pɔ:rəs] — *пористий*
impervious [ɪm'pə:vjəs] — *непроникний, глухий*

4. Section. Light Industry

Text 1. Flax

Flax is a common name for members of the Linaceae, a family of annual herbs, especially members of the genus *Linum*, and for the fiber obtained from such plants. The flax of commerce has been cultivated since prehistoric times. It was the major source of cloth fiber until the growth of the cotton industry (about 1800) and the competitive use of other fibers, such as jute. Flax has been transplanted from its native locales in Eurasia to all temperate zones of the world that provide a suitable habitat (a cool, damp climate) for its cultivation as a fiber plant; it is also grown in many tropical countries for its oil-bearing seeds. Flax plants grow to 4 ft (120 cm) in height and bear blue or white flowers that mature into bolls containing 10 seeds each. When grown for fiber, flax is sown densely to prevent branching and is gathered before maturity; for seed, it is sown sparsely and allowed to branch and fruit. To obtain the fiber, the stems, stripped of leaves, may be tied in bunches and immersed in warm water for a few days or in cool water for one or two weeks, or they may be spread out on grass and exposed to the dew and sun for several weeks. This process, called retting, permits bacteria to break down the woody tissues by fermentation and to dissolve by enzyme action the substances binding the fiber cells. After retting, the stems are washed and allowed to dry and then are scutched (beaten) to separate the fibers from other material and to crush the pith. A combing process (called hackling) removes any remaining nonfibrous matter. The fiber cells range in length from $^1/_2$ to 2 in. (1.3—5.1 cm); the cell bundles (fibers) range from 12 to 36 in. (30—90 cm). Short, broken fibers are called tow and are used to make

coarse fabrics and cordage; the long fibers are used for strong threads and fine linens. Flax fiber is also used for such products as insulating material and writing and cigarette paper. The seeds are crushed to make linseed oil, and the remaining linseed cake is used for fodder; dried flaxseed is used in various medicinal preparations.

Notes

flax [flæks] — *льон*
herb [hə:b] — *рослина*
jute [dʒu:t] — *джутовий; джут*
locale [lou'kɑ:l] — *місце*
habitat ['hæbɪtæt] — *помешкання*
sparsely ['spɑ:slɪ] — *негусто*
to strip — *обдирати*
to immerse [ɪ'mə:s] — *занурювати*
to expose [ɪks'pouz] — *експонувати*
dew ['dju:] — *роса*
pith [pɪθ] — *серцевина*
to hackle ['hækl] — *чесати (льон)*
tow ['tou] — *буксирний канат*
linen ['lɪnɪn] — *лляний; полотно*
fodder ['fɔdə] — *фураж, корм*

Text 2. Textiles

Textiles are all fabrics made by weaving, felting, knitting, braiding, or netting, from the various textile fibers. Yarn, fabrics, and tools for spinning and weaving have been found among the earliest relics of human habitations. Linen fabrics dating from 5000 B.C. have been found in Egypt. Woolen textiles from the early Bronze Age in Scandinavia and Switzerland have been discovered. Cotton has been spun and woven in India since 3000 B.C., and silk has been woven in China since at least 1000 B.C. About the 4th century, A.D., Constantinople began to weave the raw silk imported from China. A century later silk culture spread to the Western countries, and textile making developed rapidly. By the 14th century splendid fabrics were being woven on the hand looms of the Mediterranean countries in practically all the basic structures known to modern craftsmen, and there has been no change in fundamental processes since that time, although methods and equipment have been radically altered. Textiles are classified according to their component fibers into silk, wool, linen, cotton, such synthetic fibers as rayon, nylon, and polyesters, and some

inorganic fibers, as cloth of gold, glass fiber, and asbestos cloth. They are also classified as to their structure or weave, according to the manner in which warp and weft cross each other in the loom. Value or quality in textiles depends on several factors, such as the quality of the raw material used and the character of the yarn spun from the fibers, whether clean, smooth, fine, or coarse and whether hard, soft, or medium twisted. Density of weave and finishing processes are also important elements in determining the quality of fabrics. Tapestry, sometimes classed as embroidery, is a modified form of plain cloth weaving. The weaving of carpet and rugs is a special branch of the textile industry; other specially prepared fabrics not woven are felt and bark (or tapa) cloth, which are beaten or matted together, and a few in which a single thread is looped or plaited, as in crotchet and netting work and various laces. Most textiles are now produced in factories, with highly specialized power looms, but many of the finest velvets, brocades, and table linens are still made by hand. Textile printing, the various processes by which fabrics are printed in colored design, is an ancient art. Although the time and place of origin are uncertain, examples of Greek fabrics from the 4th century B.C. have been found. India exported block prints to the Mediterranean region in the 5th century B.C., and Indian chintz was imported into Europe during the Renaissance and widely imitated. France became a leading center and was noted especially for the toile de Jouy manufactured at Jouy from 1760 to 1811. Early forms of textile printing are stencil work, highly developed by Japanese artists, and block printing. In the latter method a block of wood, copper, or other material bearing a design in intaglio with the dye paste applied to the surface is pressed on the fabric and struck with a mallet. A separate block is used for each color, and pitch pins at the corners guide the placing of the blocks to assure accurate repeating of the pattern. In cylinder or roller printing, developed about 1785, the fabric is carried on a rotating central cylinder and pressed by a series of rollers each bearing one color. The design is engraved on the copper rollers by hand or machine pressure or etched by pantograph or photoengraving methods; the color paste is applied to the rollers through feed rollers rotating in a color box, the color being scraped off the smooth portion of the rollers with knives. More recent printing processes include screen printing, a hand method especially suitable for large patterns with soft outlines, in which screens, one for each color, are placed on the fabric and the color paste pressed through by a wooden squeegee; spray printing, in which a spray gun forces the color through a screen; and electrocoating, used to apply a patterned pile. Color may be applied by the various processes directly; by the discharge method, which uses chemicals to

destroy a portion of a previously dyed ground; or by the resist, or reserve, method, which prevents the development of a subsequently applied color to a portion of the fabric treated with a chemical or with a mechanical resist.

Notes

textile ['tekstaɪl] — *тканина*
fabric ['fæbrɪk] — *тканина*
to weave [wi:v] — *ткати*
woolen ['wulɪn] — *вовняний*
to spin — *прясти, крутитися*
to loom [lu:m] — *невиразно вимальовуватися*
to alter ['ɔ:ltə] — *змінювати*
to warp [wɔ:p] — *перекручувати*
weft — *тканина*
yarn [jɑ:n] — *пряжа, нитки*
tapestry ['tæpɪstrɪ] — *гобелен, декоративна тканина*
to plait ['plæɪt] — *плести*
crotchet ['krɔtʃɪt] — *гачок; фантазія*
lace ['leɪs] — *мереживо*
brocade [brɔ'keɪd] — *парча*
to print — *набивати (ситець)*
chintz [tʃɪnts] — *ситець*

Text 3. Linen

Linen is a fabric or yarn made from the fiber of flax probably the first vegetable fiber known to man. Linens more than 3,500 years old have been recovered from Egyptian tombs. Phoenician traders marketed linen in Mediterranean ports. Worn by Egyptian, Greek, and Jewish priests as a symbol of purity, it also typified luxury as in the phrase "purple and fine linen." Flax was cultivated by the Romans and introduced by them into north Europe. The production of linen was encouraged by Charlemagne, and linen became the principal European textile of the Middle Ages. Flanders has been renowned from the 11th century for its creamy flax and fine thread. French Huguenots excelled in working flax and carried the art abroad, notably to Ireland, where Louis Crommelin established (about 1699) a manufactory at Lisburn, near Belfast. Ireland is still the largest producer of fine linen, with Belgium and Japan producing somewhat lesser amounts. The first flaxspinning mill was opened in England in 1787, but only in 1812 was linen successfully woven with power looms. The industry

suffered in relation to cotton because many textile inventions were not applicable to linen, the inelasticity of the fiber causing it to break readily under tension. Although linen exceeds cotton in coolness, luster, strength, and length of fiber, the expense of production limits its use. After the flax fiber is removed from the stems, it is delivered to the mills, where it is hackled to separate and straighten the fibers, overlapped on a spreadboard to form a continuous ribbon, drawn out through rollers, then wound from the roving frame on bobbins in a loosely twisted thread. For fine goods the thread is usually spun wet. Linen may be bleached in the yarn or in the piece. It is woven into fabrics ranging from heavy canvas to sheer handkerchief linen.

Notes

linen ['lɪnɪn] — *лляний*
tomb [tu:m] — *могила*
applicable ['æplɪkəbl] — *придатний*
to excel [ɪk'sel] — *перевершувати*
to overlap [ˌouvə'læp] — *частково співпадати*
bobbin ['bɔbɪn] — *шпулька, котушка*
to bleach ['bli:tʃ] — *білити, відбілювати*
sheer ['ʃɪə] — *прозорий, легкий*

Text 4. Velvet

Velvet is a fabric having a soft, thick, short pile, usually of silk, and a plain twill or satin weave ground. The pile surface is formed by weaving an extra set of warp threads that are looped over wires as in Wilton carpet, the rods being withdrawn after the weft thread is placed, leaving a row of loops or tufts across the breadth. The loops may remain uncut, forming terry velvet, or be cut, automatically in machine weaving or by a special tool in handlooming. The fabric may also be woven double, face to face, then cut apart. Velvet is supposedly one of the silk weaves developed on the ancient shuttle looms of China. The most beautiful weaves, such as brocades, are still done by hand. India has produced velvet from remote times, often richly embroidered, for the furniture and trappings of royalty. Many fine velvets were made in Turkey, and Persia was famous for its beautiful designs and colors. Magnificent velvets were used in Europe in 12th— and 13th-century religious and court ceremonials. Lucca and Genoa apparently were the first cities to make fine velvets and excelled, through the 16th and 17th century. Genoese velvet was notable for designs formed by contrasts of cut and uncut pile. Venetian and

Florentine fabrics were sumptuous brocades, floral designs on contrasting grounds or on cloth of gold. Utrecht made a rich, heavy velvet used for wall and furniture coverings. Modern velvets are of many types and grades. Lyons velvet has a stiff ground and erect pile. Transparent velvet has a sheer foundation. Panne velvet is a long-napped weave, pressed. Plush and velveteen resemble velvet and are sometimes used as substitutes; the weft loops, rather than the warp loops, form the pile on these substitutes.

Notes

velvet ['velvɪt] — *оксамит, бархат*
pile ['paɪl] — *ворса*
twill — *саржа*
thread [θred] — *нитка*
tuft ['tʌft] — *пучок; жмуток*
to embroider [ɪm'brɔɪdə] — *вишивати*
sumptuous ['sʌmtjuəs] — *розкішний, пишний*
panne [pæn] **velvet** — *пан-бархат*
napped [næpt] — *ворсистий*
plush ['plʌʃ] — *плюш; плис*

Text 5. Leather

Leather is a skin or hide of animals, cured by tanning to prevent decay and to impart flexibility and toughness. Prehistoric and primitive peoples preserved pelts with grease and smoke and used them chiefly for shoes, garments, coverings, tents, and containers. Today pelts are prepared for tanning by dehairing, usually with lime, followed by fleshing and cleaning. After tanning, leather is generally treated with fats to assure pliability. The practice of shaving leather to the required thickness was abandoned early in the 18th century, after the invention of a machine that split the tanned leather into a flesh layer and a grain (hair-side) layer; skivers are thin, soft grains used for linings and for covering firm surfaces. Characteristic grains may be brought out by rubbing, as in Morocco leather (goatskin), or may be imitated by embossing. Finishes include glazing, a high glaze being achieved by rolling with glass cylinders; coloring with stains or dyes; enameling or lacquering as for patent leather; and sueding, buffing with emery or carborundum wheels to raise a nap, usually on the flesh side. Russia leather, originally vegetable-tanned calfskin dressed with birch oil that imparted a characteristic odor and often dyed red with brazilwood, is a term now covering a number of variants. Rawhide is similar to parchment

and is untanned. Cordovan, or Spanish, leather, a soft, colored leather made at Cordoba during the Middle Ages and often richly modelled and gilded, is imitated for wall coverings, panels and screens. Leather is much used in bookbinding. Artificial leather, made since about 1850, was originally a strong fabric coated with a rubber composition or with a synthetic substance such as pyroxylin. Since World War II, materials made from vinyl polymers have far outstripped the earlier artificial leathers in commercial importance.

Notes

leather ['leðə] — *шкіра*
tan [tæn] — *загар*
decay [dɪ'keɪ] — *розпад*
to impart [ɪm'pɑ:t] — *наділяти*
garment ['gɑ:mənt] — *предмет одягу*
pliability [ˌplaɪə'bɪlɪtɪ] — *гнучкість*
enamel [ɪ'næml] — *емаль*
buff [bʌf] — *буйволова шкіра*
emery ['eməɪ] — *наждак*
parchment ['pɑ:tʃmənt] — *пергамент*

Text 6. Cotton

Cotton is the most important of the vegetable fibers. Cotton has been spun, woven, and dyed since prehistoric times. It formed the staple clothing of India, Egypt, and China. Hundreds of years before the Christian era cotton textiles were woven in India with matchless skill, and their use spread to the Mediterranean countries. In the 1st century Arab traders brought fine muslin and calico to Italy and Spain. The Moors introduced the cultivation of cotton into Spain in the 9th century. Fustians and dimities were woven there and in the 14th century in Venice and Milan, at first with a linen warp. Little cotton cloth was imported to England before the 15th century although small amounts were obtained chiefly for candlewicks. By the 17th century the East India Company was bringing rare fabrics from India. Before the arrival of the white man in the New World, cotton was skillfully spun and woven into fine garments and dyed tapestries. Cotton fabrics found in Peruvian tombs are said to belong to a pre-Inca culture. In colors and texture, the ancient Peruvian and Mexican textiles resemble those found in Egyptian tombs. Cotton cultivation began in America in the Jamestown colony (1607). Since the early days of the republic, the United States has been the world's

leading producer of cotton. The invention (1793) of the cotton gin, a machine for separating seeds from fiber, and the mechanization of textile production marked the Industrial Revolution and suddenly brought cotton into world prominence to supersede flax and wool textiles. The manufacture of cotton goods is a great industry, second only to that of Great Britain (where it centers about Lancashire). For some years American manufacture was chiefly in New England; today an increasing number of mills are located in the Southern cotton-producing states, the so-called Cotton Belt. Cotton has played a significant historical role in world industry. The reliance of British mills on imported cotton fiber influenced that country's accession to the Monroe Doctrine, and its need for the large African and Indian markets for cotton goods dictated much of its seadomination policy as an imperial nation. In the United States, cotton brought about the one-crop economy of the Deep South and was a principal economic cause of the Civil War. The passing of slavery, always an adjunct of the cotton plantations, and the exhaustion of the soil pushed the Cotton Belt to the West. Large cotton-producing countries such as Brazil, Egypt, and India (the second largest world producer) have used cotton exports to offset an unfavorable balance of trade. China and the USSR rank after the United States and India in total annual production. All cotton-producing nations have depended on an abundance of cheap labor; although mechanical cultivating and picking devices have long been known, they have been perfected for widespread use (especially in the United States) only since World War II. The cotton plant belongs to the genus *Gossypium* of the family Malvaceae. It is generally a shrubby plant having broad three-lobed leaves and seeds in capsules, or bolls; each seed is surrounded with downy fiber, white or creamy in color and easily spun. The fibers flatten and twist naturally as they dry. Cotton is of tropical origin but is most successfully cultivated in temperate climates with well-distributed rainfall. In the United States nearly all the commercial cotton crop comes from varieties of upland cotton (G. *hirsutum*), but small quantities are obtained from sea-island and American-Egyptian cotton. Cotton is planted annually by seed in furrows; the plants are thinned and weeded during the spring growing season. Diseases and insect pests are numerous; of these the most destructive is the boll weevil, which causes enormous losses. Sea-island cotton, valued for its silky fibers, was the leading type before the advent of this insect, to which it is particularly susceptible. When mechanical pickers are employed, a chemical defoliant is used to make the leaves drop so that only the cotton bolls are left on the plant for stripping. In the ginhouse the cotton is separated from the seeds by a cotton gin and then baled.

Notes

cotton ['kɔtn] — *бавовна*
fiber ['faɪbə] — *волокно; нитка*
to spin (span, spun) — *прясти*
staple ['steɪpl] — *основний*
matchless ['mætʃlɪs] — *незрівняний*
muslin ['mʌzlɪn] — *міткаль*
calico ['kælɪkou] — *міткаль; ситець*
dimity ['dɪmɪtɪ] — *тканина для порт'єр*
tapestry ['tæpɪstrɪ] — *гобелен*
to supersede [ˌsju:pə'si:d] — *заміняти*
accession [æk'seʃn] — *доступ*
adjunct ['ædʒʌŋkt] — *додаток*
imperial [ɪm'pɪərɪəl] — *імперський*
offset ['ɔ:fset] — *паросток*
abundance [ə'bʌndəns] — *велика кількість*
furrow ['fʌrou] — *зморшка*
weed [wi:d] — *бур'ян*
gin [dʒɪn] — *джин*
to strip — *здирати, обдирати*

Text 7. Wool

Wool is a fiber from the fleece of the domestic sheep. It consists of the cortex, overlapping scales (sharper and more protruding than those of hair) that may expand at their free edges causing fibers to intermesh; elasticum, the inner layer; and a core. When soaked, the elasticum and core contract, shrinking the fiber. Elasticity resulting from the molecular structure of wool and resiliency from its crimp make wool fabrics crease resistant. Fine wool will stretch one third its length. Wool is warm because its fibers are nonconductors of heat and its crimp permits it to enmesh still air. It is highly absorbent and releases moisture slowly. Its tensile strength is one fourth greater than that of cotton. A protein compound of complex chemical composition, it is soluble in hot caustic soda. No known wild sheep are wool bearing. The supposed ancestors of the domestic sheep had long hair and a soft, downy undercoat, which under domestication gradually became wool, while the long hair disappeared. In this development, breeding, feed, climate, and protection were influential, as shown by an atavistic return of neglected sheep to long hair and rudimentary wool. Wool was probably the first fiber to be woven into a textile, as

herding flocks was the first step upward from primitiveness. In the tombs and ruins of Egypt, Nineveh, and Babylon, in the barrows of early Britons, and among the relics of the Peruvians, fragments of woollen fabrics are found. The Romans as early as 200 B.C. began to improve their flocks, which became the progenitors of the famed Spanish merino sheep. The Britons kept sheep and wove wool long before the Roman invasion, but the establishment by the Romans of a factory at Winchester probably improved their methods. William the Conqueror brought into England skilled Flemish weavers. Henry II encouraged wool industries by laws, cloth fairs, and guilds of weavers. Edward III brought weavers, dyers, and fullers from Flanders. England became the great wool-producing country of Europe, and wool was the staple of its industry until cotton began to overshadow it in the 18th century. In the American colonies, sheep raising started in Jamestown. Stringent English laws against exporting wool in the attempt to force upon the colonies the use of English cloth, early drove the settlers to the raising of sheep. George Washington imported sheep and brought spinners and weavers from England. Early in the 19th century imported Merinos greatly improved the existing stock. Spinning and weaving were early established in New England, at first in homes, later in small factories. The first factory in America using water power to weave wool was established (1788) at Hartford, Conn., and was encouraged by tax exemption and a bounty on each yard woven. The United States now produces a substantial amount of the world's wool, chiefly in Texas, Montana, Wyoming, Utah, Oregon, Idaho, New Mexico, Colorado, California, and Ohio. Woollen cloth manufacture is largely centered in New England. Other important wool producers include Australia, Argentina, New Zealand, Russia, the Republic of South Africa, Uruguay, Great Britain, China, and India. For industrial purposes the fiber of the camel, Angora goat, Kashmir goat, llama, alpaca, and vicuna is classed as wool. Sheep are sheared with mechanical clippers. The fleece is classed as: lamb's wool, or first clip; hog wool, clipped from sheep 12 to 14 months old; wether wool, from older animals; taglocks, the ragged, discolored portion; and pulled wool, usually weakened when recovered by sweating or chemical processes from sheep slaughtered for mutton. The wool is sorted as to fineness, crimp, length of fiber, and felting qualities. Dirt, suint (dried perspiration), and lanolin are removed by a soap-alkali scouring; by the expensive naphtha solvent method, which retains the full strength and softness of the fiber; or by freezing and shaking. Wool may be carbonized to remove vegetable matter. It is bleached and dyed as raw stock, yarn, or in the piece;

it is oiled to withstand processing and is often blended. Woollen goods are woven from carded short-staple fibers into soft yarns adapted to fulling and napping.

Notes

fleece [fli:s] — *шерсть*
cortex ['kɔ:teks] — *кора*
core [kɔ:] — *серцевина*
resiliency [rɪ'zɪlɪənsɪ] — *еластичність*
to crimp — *гофрувати (матерію)*
to crease [kri:s] — *робити складки*
to enmesh [ɪn'meʃ] — *обплутувати*
to absorb [əb'sɔ:b] — *поглинати (воду)*
moisture ['mɔɪstʃə] — *волога*
rudimentary [ˌru:dɪ'mentərɪ] — *елементарний*
barrow ['bærou] — *тачка*
exemption [ɪg'zempʃn] — *звільнення*
bounty ['bauntɪ] — *подарунок, щедрість*
to blend (blended, blent) — *змішувати(ся)*
to shear [ʃɪə] (sheared, shorn) — *стригти*
to scour ['skauə] — *чистити*
solvent ['sɔlvənt] — *розчинник*
naphtha ['næfθə] — *нафта*
to withstand (withstood) — *вистояти, противостояти*
to bleach ['bli:tʃ] — *відбілювати*
to process ['prousəs] — *обробляти*

Text 8. Cosmetics

Cosmetics are preparations externally applied to change or enhance the beauty of skin, hair, nails, lips, and eyes. The use of body paint for ornamental and religious purposes has been common among primitive peoples from prehistoric times. Ointments, balms, powders, and hair dyes have also been used from ancient times. Many cosmetics originated in the Orient, but their ingredients and use are first recorded in Egypt; ancient tombs have yielded cosmetic jars (called kohl pots) and applicators (called cosmetic spoons). The Egyptians used kohl to darken their eyes; a crude paint was used on the face, and fingers were often dyed with henna. Greek women used charcoal pencils and rouge sticks of alkanet and coated their faces with powder, which often contained dangerous lead compounds. Beauty aids reached a peak in imperial Rome — especially chalk for the face and a rouge called fucus —

and ladies required the services of slaves adept in their use. Many cosmetics survived the Middle Ages, and Crusaders brought back rare Eastern oils and perfumes. In the Renaissance, cosmetics, usually white-lead powder and vermilion, were used extravagantly. From the 17th century recipes and books on the toilette abounded. Professional cosmetologists began to appear, and luxurious prescriptions often included a bath in wine or milk. At its height by 1760, the use of cosmetics virtually disappeared with the advent of the French Revolution. The year 1900 saw a revival of their use, accompanied by the manufacture of beauty aids on a scientific basis in France. Since then the industry has grown to tremendous proportions with products manufactured for every conceivable use. In the United States, cosmetics intended for interstate commerce are controlled under the Federal Food, Drug, and Cosmetic Act of 1938.

Notes

external [eks'tə:nl] — *зовнішній*
to enhance [ɪn'hɑ:ns] — *збільшувати*
ointment ['ɔɪntmənt] — *мазь*
balm [bɑ:m] — *бальзам*
powder ['paudə] — *порошок; пудра*
dye [daɪ] — *фарба*
jar [dʒɑ:] — *банка, глечик*
crude [kru:d] — *сирий, необроблений*
henna ['henə] — *хна*
charcoal ['tʃɑ:koul] — *деревне вугілля*
lead [led] — *свинець*
recipe ['resɪpɪ] — *рецепт*
virtually ['və:tjuəlɪ] — *фактично*
conceivable [kən'si:vəbl] — *мислимий*

Text 9. Lace

Lace is a patterned openwork fabric made by plaiting, knotting, looping, or twisting. The finest lace is made from linen thread. Handmade laces include needlepoint and bobbin lace, tatting, crochet work, and some fabrics made by netting and darning. Lace was developed prior to the 16th century from the drawn work, cutwork, and lacis (darning on squares of net) of the embroiderers' craft. With drawn work, more and more threads were removed until the ground vanished altogether. A design was executed and its principal line supported the complete pattern. The first of such laces, reticella, originated in Venice and was based on geometric forms. Later, as laceworkers sought relief from the restrictions of symmetrical design, the illogical but beautiful designs of *punto in aria* (literally, a stitch in the air) were first created. The richest, most sumptuous of these needlepoint laces was the Venetian raised point of the 17th century. The vogue for lace began about 1540, and pattern books began to appear. Early reticella designs usually included pointed or scalloped edges. By the time of Charles I lace was used extravagantly for both costume and interior decorating; by 1643 lacemaking had become an established industry. In France patterns became increasingly more detailed and delicate; the light, *flowery point de France* was used for every conceivable decorative purpose. Later the laces of AlenHon, Argentan, and Valencienne exemplified French style and design. The making of bobbin, pillow, or bone lace, which is mentioned as early as 1495, passed from Italy to Flanders, reaching its height of production there in the 18th cent. Laces, often named for their location of origination, are of many types. Valenciennes is a fine, diamond-meshed lace much used for trimmings and ruffles. Mechlin is of similar type, but filmier; torchon is a simple, loose lace, made and used by peasants all over Europe; Honiton, one of the fine English laces, has a net foundation with appliqué of delicate, handmade braid. Brussels is a rich lace of several varieties. Duchesse has exquisite patterns with much raised work. Maltese is coarse and heavy, usually made of silk. Chantilly is a delicate mesh with ornate patterns, originally made of the yellowish undyed silk called blonde, later often dyed black. *Point d'Espagne* is lace of gold or silver thread. A number of laces fall outside a strict classification. Guipure has a heavy pattern formed by a braid with a less valuable core covered with fine silk, gold, or silver thread. Limerick lace is tambour work on net. Renaissance or Battenberg lace is of heavy tape formed into a pattern and filled in with lace stitches. Carrickmacross is cutwork lace. So-called English point *or point d'Angleterre* is Flemish point, at one time smuggled into England and renamed. *Filet* is a combination of knotting and darning, reminiscent of the earliest lace forms attempted. Cutwork, or various combinations of early lace forms with embroidery also formed an important step in lacemaking. The better-known knotted laces are tatting and macramé; macramé evolved from the early Italian *punto a groppo*. Crocheted lace reached its finest development in Ireland. Knitted laces, for which many intricate patterns survive, have been mainly of peasant use. The chief modern centers of lacemaking are France, Belgium, England, Ireland, and Italy. Machine-made lace first appeared about 1760, and by 1813 a bobbinet ma-

chine was perfected. After 1832 cotton thread somewhat replaced linen. In the 20th century many lace patterns have been revived and modified, and called Cluny lace.

Notes

lace ['leɪs] — *мереживо, шнурок*
bobbin ['bɔbɪn] — *шпулька; котушка*
crochet ['krouʃeɪ] — *тамбурна вишивка*
to darn [dɑ:n] — *лагодити, штопати*
to vanish ['vænɪʃ] — *зникати, пропадати*
stitch [stɪtʃ] — *стібок; петля*
sumptuous ['sʌmptjuəs] — *розкішний*
vogue ['voug] — *мода*
scallop ['skɔləp] — *зубець*
trimming — *оздоблення, прикраси*
braid ['breɪd] — *шнурок, тасьма*
exquisite ['ekskwɪzɪt] — *вишуканий*
Maltese ['mɔ:l'ti:z] — *мальтійський*
tambour ['tæmbuə] — *барабан*

Text 10. Soap

Ancient peoples are believed to have employed wood ashes and water for washing and to have relieved the resulting irritation with grease or oil. In the 1 st cent. A.D., Pliny described a **soap** of tallow and wood ashes used by Germanic tribes to brighten their hair. A soap factory and bars of scented soap were excavated at Pompeii. Soap fell into disuse after the fall of Rome but was revived in Italy probably in the 8th century and reached France about 1200; Marseilles became noted as a soapmaking center. Although soap was known in England in the 14th century, the first English patent to a soapmaker was issued in the 17th century. The industry was handicapped in England from 1712 to 1853 by a heavy tax on soap. In the American colonies soap factories appeared at an early date, and many housewives made soap from waste fats and lye (obtained by leaching wood ashes). The manufacture of soap was stimulated by Chevreul's discovery of oleic and stearic acids in the early 19th century and by Leblanc's method (1791) of preparing soda from salt. Chemically, soaps are metallic salts of fatty acids. The manufacture of soap is based on a chemical reaction (saponification) in which an alkali acts upon a fat to form a metal salt (soap) and an alcohol (glycerol). A number of methods may be employed to make soap, but all are based

on the same principle of operation. Fats and oils (often blended) are heated in a large vessel, then enough alkali to react with all the fat is stirred in. Salt is added, and the soap then forms a light curd that floats to the surface. Glycerol, a valuable by-product, can be distilled from the liquid residue. To produce a purer soap, the curds are washed with salt solution, water is later added, and the solution is allowed to settle; the upper of the two layers thus formed is the pure soap, called scented soap. It is thoroughly churned, poured into huge frames, cut with wires, shaped, and stamped. Hard-milled soap is run over chilled rollers and is scraped off as chips which are rolled into ribbons, cut, and shaped. Soap is marketed also as chips, flakes, and beads and in powdered form. Soap powders, as distinguished from powdered soap, contain builders that assist in rough cleaning. Soaps differ according to the lathering properties of the fat or oils and according to the alkali employed. When sodium hydroxide is used as the alkali, hard soaps are formed; potassium hydroxide yields soft soaps. Aluminum, calcium, magnesium, lead, or other metals are used in place of sodium or potassium for soaps used in industry as paint driers, ointments, and lubricating greases and in waterproofing. Fillers are added to many soaps to increase lathering, cleansing, and water-softening properties; the sodium salt of rosin is commonly used in yellow laundry soap to increase lathering. Soap substitutes include saponin-containing plants such as soapwort and shagbark and the modern soapless detergents (usually sulfonated alcohols), which may be used in hard water and even in salt water without forming curds. Soap cleanses by lowering the surface tension of water, by emulsifying grease, and by absorbing dirt into the foam.

Notes

to employ [ɪm'plɔɪ] — *застосовувати*
ash [æʃ] — *попіл, зола*
tallow ['tælou] — *жир, сало*
scented ['sentɪd] — *запашний*
to handicap ['hændɪkæp] — *перешкоджати*
tax [tæks] — *податок*
alkali ['ælkəlaɪ] — *луговий*
curd [kə:d] — *піна*
to churn [tʃə:n] — *змішувати*
flake ['fleɪk] — *пластівець*
lather ['lɑ:ðə] — *мильна піна*
potassium [pə'tæsjəm] — *калій*
to lubricate ['lʌbrɪkeɪt] — *мастити*
rosin ['rɔzɪn] — *каніфоль*

Text 11. Embroidery

Embroidery is ornamental needlework applied to all varieties of fabrics and worked with many sorts of thread — linen, cotton, wool, silk, gold, and even hair. Decorative objects, such as shells, feathers, beads, and jewels, are often sewn to the embroidered piece. The bayeux tapestry is among the most famous examples of embroidery. The art probably antedates that of weaving. Needlework is mentioned in the Vedas and in Exodus in the Bible. In ancient Egypt, gold was used for the decorative stitches, which often covered the entire garment; such work has been found on mummy wrappings. The borders of Greek and Roman garments were often finely embroidered. In the Orient, sumptuous designs of gold and silver thread were produced from remotest times; the intricate embroidery of China became stylized and remained unchanged for centuries. From the richly decorative art of Byzantium (4th century) embroidery was introduced into Europe and thereafter followed the great period (12th-14th century) of church embroidery. The famous opus Anglicanum, or English work (e.g., the Syon cope, Victoria and Albert Mus.), dates from this time. Monasteries and convents were kept busy adorning vestments and altarpieces, and embroidery ateliers were founded. Secular needlework was far simpler, confined to embroidered bands around the edges of hems, sleeves, necks, and mantles in coarse and dull-colored threads. When Crusaders returned with examples of the superb fabrics of the East, interest in embroidery for nonecclesiastical uses was stimulated, and the technique of appliqué was developed. By 1389 pearls and spangles were being set in the embroidery. After the Renaissance, peasant embroidery flourished in Greece, Scandinavia, the Balkans, and many other areas. Embroidery as folk art was far less varied, complex, and imaginative than the masterworks produced by professional church and court embroiderers. The Elizabethan period was famous for its household and costume embroidery. Gold and silver thread was used on velvet, brocade, and silk, and the allover design was often enhanced with pearls and gems. "Spanish blackwork," black silk on white linen with touches of gold, became enormously popular, while the use of drawnwork and cutwork led to the development of fine lace. In the 18th century, French influence refined embroidery techniques; quilting was developed using backstitch embroidery, especially popular in making petticoats and coat-tails. By the 19th century embroidery for male attire had declined except for occasional decorative vests and ties. Modern embroidery is most frequently used on lingerie and linens, but with the introduction of machine-made embroidery, the quality has deteriorated.

Notes

embroidary [ɪm'brɔɪdərɪ] — *вишивання; вишивка*
ornamental [ˌɔ:nə'mentl] — *декоративний*
shell — *шкарлупа*
bead [bi:d] — *намистина; бісер (множ.)*
tapestry ['tæpɪstrɪ] — *гобелен*
to antedate ['æntɪ'deɪt] — *передувати*
intricate ['ɪntrɪkɪt] — *складний*
cope ['koup] — *мантія*
convent ['kɔnvənt] — *манастир (жіночий)*
vestment ['vestmənt] — *церковний одяг*
to confine [kən'faɪn] — *обмежувати*
band — *стрічка, тасьма*
hem — *рубець (на одязі)*
mantle ['mæntl] — *накидка*
to flourish ['flʌrɪʃ] — *процвітати*
gem [dʒem] — *самоцвіт; дорогоцінний камінь*
to quilt [kwɪlt] — *стьобати*
attire [ə'taɪə] — *убрання*
to deteriorate [dɪ'tɪərɪəreɪt] — *погіршувати(ся)*

Text 12. Quilting

Quilting is a form of needlework in which two layers of fabric over an interlining are sewn together, usually in a pattern of back or running (quilting) stitches. This method of securing warmth in covering and clothing has been practiced in north Asia and Europe for centuries. Quilting has been a feature of embroidery in the form of raised work. It was a distinctive type of needlework in pioneer American homes, at first utilitarian, later ornamental. Quilts were usually of the pieced, or patchwork, type until about 1750, when the appliqué, or laid-on, quilt and the monotone quilt decorated by trapunto (padding or cording) became popular. A fad for quilted petticoats for women and coat-tails for men was at its height from 1688 to 1714. The art of quilting is still practiced by Southern mountaineers and in other rural districts and has been revived generally as ornamental needlework. Machine-quilted materials are used for wearing apparel and in interior decoration, particularly for bed and couch covers.

Notes

stitch [stɪtʃ] — *стібок; петля*
pioneer [ˌpaɪə'nɪə] — *перший поселенець*

patchwork — *штопання, латання*
apparel [ə'pærl] — *одяг, убрання*
couch ['kautʃ] — *кушетка*

Text 13. Dye

Dye is any substance, natural or synthetic, used to color various materials, especially textiles, leather, and food. Natural dyes are so called because they are obtained from plants, from animals, and from certain naturally occurring minerals. They have been almost entirely replaced in modern dyeing by synthetic dyes. Most of these are prepared from coal tar, being formed from an aromatic hydrocarbon such as benzene, from which indigo is derived, or anthracene, which yields alizarin. Although some materials, e.g., silk and wool, can be colored simply by being dipped in the dye (the dyes so used are consequently called direct dyes), others, including cotton, commonly require the use of a mordant. Alizarin is a mordant dye and the color it gives depends upon the mordant used. Dyes are classified also as acidic or basic according to the medium required in the dyeing process. A vat dye, e.g., indigo, is so called from the method of its application; it is first treated chemically so that it becomes soluble and is then used for coloring materials bathed in a vat. When the materials become impregnated with the dye, they are removed and dried in air, the indigo reverting to its original, insoluble form. The process by which a dye becomes "attached" to the material it colors is not definitely known. One theory holds that a chemical reaction takes place between the dye and the treated fiber; another proposes that the dye is absorbed by the fiber. Dyeing is an ancient industry. The Chinese, Persians, and Indians used natural dyes many centuries ago, including indigo, probably the oldest dye in use, and Tyrian purple, derived from a species of snail. The Egyptians prepared some brilliant colors. In the 13th and 14th century dyeing assumed importance in Italy; the methods employed were carried to other parts of Europe and, as new dyes became known, the dyeing industry flourished and grew. Cochineal was introduced from Mexico. Finally, in the 19th century the work of W.H.Perkin and Adolf von Baeyer produced the first synthetic dyes.

Notes

dye ['daɪ] — *фарба*
mordant ['mɔ:dənt] — *уїдливий*

acidic [æ'sɪdɪk] — *кислуватий*
vat ['væt] — *бочка, діжка*
cochineal ['kɔtʃɪni:l] — *кошиніль (фарба)*
impregnated [ɪm'pregnɪtɪd] — *насичений*
snail ['sneɪl] — *слимáк*

Text 14. Knitting

Knitting is a construction of a fabric made of interlocking loops of yarn by means of needles. Knitting, allied in origin to weaving and to the netting and knotting of fishnets and snares, was apparently unknown in Europe before the 15th century, when it began to be practiced in Italy and Spain. The Scots claimed its invention and also its introduction into France. Hand-knitting needles are of bone, wood, steel, ivory, or celluloid. Two needles with heads are required for flat or selvage work; three or more, pointed at both ends, for tubular work such as hose; and for larger tubular work, a circular needle. The first knitting machine, invented in England in 1589 by William Lee, was refused a patent by Queen Elizabeth on the grounds that it would curtail the work of hand knitters. Lee's machine, marketed in France, was the forerunner of the warp and circular frames used after 1790; these in turn developed into the two modern types of power machines, the warp and the weft. The springbeard needle of Lee's frame was supplemented in 1847 by Matthew Townsend's latch needle, commonly used for coarse work. In 1864, William Cotton patented a machine by which garments and the heels and toes of hosiery might be shaped. Automatic machines were first introduced in 1889. In weft knitting, which includes hand knitting, the fabric is constructed in horizontal courses with one continuous yarn. The basic stitches are the plain (or jersey), purl, and rib. Either flat-bed or circular machines may be used. The warp, or chainloom, machine, generally flatbed, builds vertical chains, or wales, each having a separate yarn. The wales are tied together by zigzagging the yarns from needle to needle in the basic tricot or milanese stitches or variants of these. The warp-knit fabric is run-resistant but less elastic than the weft.

Notes

knitting ['nɪtɪŋ] — *в'язання*
loop — *петля*
yarn [jɑ:n] — *пряжа*
to ally [ə'laɪ] — *об'єднувати(ся)*

to weave [wi:v] — *ткати*
to knot — *зав'язувати вузол*
to claim [ˈkleɪm] — *вимагати, претендувати*
ivory [ˈaɪvərɪ] — *слонова кістка*
celluloid [ˈseljulɔɪd] — *целулоїд*
tubular [ˈtju:bjulə] — *трубчастий*
weft — *тканина*

Text 15. Dry Cleaning

Dry cleaning is a process of cleaning fabrics without water. Special solvents and soaps are used so as not to harm fabrics and dyes that will not withstand the effects of ordinary soap and water. Dry cleaning began in France about the middle of the 19th century, at first in small plants, where it was done by hand; with the development of specialized machinery it has become an important industry. The danger of fire — at first a constant menace because of the large amounts of flammable materials in use — was largely overcome by concentrating the work in specially designed plants and by the use of a high-boiling petroleum product still commonly used in the United States. Newer chlorinated hydrocarbon synthetic solvents, such as perchlorethylene, are nonflammable but require precautions against their toxic fumes. The process of dry cleaning for ordinary fabrics is to place them in revolving washers where they are washed with the cleansing fluid and a special soap, rinsed with pure cleansing fluid, and then spun to remove most of the fluid. They are then dried with warm air in a tumbler. Delicate fabrics are done by hand. The cleansing fluids are reclaimed and used again. Unusual stains are given an expert test to determine the proper solvent; special stain removers include chloroform, ether, and carbon disulphide.

Notes

to withstand [wɪðˈstænd] — *вистояти, витримувати*
menace [ˈmenəs] — *небезпека, загроза*
precaution [prɪˈkɔ:ʃn] — *застереження*
toxic [ˈtɔksɪk] — *токсичний*
fume [fju:m] — *випар*
tumbler [ˈtʌmblə] — *тумблер*
carbon [ˈkɑ:bən] — *вуглець*

Text 16. Fan

Fan is a device for agitating air or gases or moving them from one location to another. Mechanical fans with revolving blades are used for ventilation, in manufacturing, in winnowing grain, to remove dust, cuttings, or other waste, or to provide draft for a fire. They are also used to move air for cooling purposes, as in automotive engines and air-conditioning systems, and are driven by belts or by direct motor. The axial-flow fan (e.g., an electric table fan) has blades that force air to move parallel to the shaft about which the blades rotate. The centrifugal fan has a moving component, called an impeller, that consists of a central shaft about which a set of blades form a spiral pattern. When the impeller rotates, air that enters the fan near the shaft is moved away perpendicularly from the shaft and out of an opening in the scroll-shaped fan casing. As a light, flat instrument manipulated by hand to cool the body or ward off insects, the fan is of tropical origin and probably stems from the primitive use of palm or other leaves. The long-handled, disk-shaped fan carried by attendants was from ancient times associated with regal and religious ceremonies. In China an early form of the hand fan was a row of feathers mounted in the end of a handle; in Greece linen was often stretched over a leaf-shaped frame; and in Rome wooden fans, gilded and painted, were used. In Europe during the Middle Ages the fan virtually disappeared until the 13th and 14th century, when Oriental fans were brought back by Crusaders and became fashionable for the wealthy. After 1500 the fan became generally popular; flag fans, disk-shaped fans, and tuft fans of ostrich plumes or peacock feathers, with handles of carved ivory or gold set with jewels, were common in women's wardrobes. In about 1600 the folding fan, developed in medieval Japan and introduced into Europe by way of China, became popular. The slats, of ivory, bone, mica, mother-of-pearl, or tortoise shell, were delicately carved and covered with paper or fabric. The fan reached a high degree of artistry, especially in France, in the 17th and 18th century. Delicately folded fans of lace, silk, or parchment were decorated with original designs and paintings by contemporary artists. The management of the fan became a highly regarded feminine art. The function and employment of the fan reached its high point of social significance in Japan.

Notes

blade — *лопать*
to winnow [ˈwɪnou] — *віяти*
shaft — *вісь*

centrifugal [sen'trɪfjugl] — *відцентровий*
to impel [ɪm'pel] — *приводити в рух*
attendant [ə'tendənt] — *служитель*
regal ['ri:gəl] — *царський*
ostrich ['ɔstrɪtʃ] — *страус*
peacock ['pi:kɔk] — *павич*
mica ['maɪkə] — *слюда*
tortoise ['tɔ:təs] — *черепаха*
parchment ['pɑ:tʃmənt] — *пергамент*

Text 17. Loom

Loom is a frame or machine used for weaving; there is evidence that the loom has been in use since 4400 B.C. Modern looms are of two types, those with a shuttle (the part that carries the weft through the shed) and those without; the latter draw the weft from a stationary supply. There are basically three kinds of shuttleless looms. The dummy shuttle, the most widely used, contains no weft but moves through the shed depositing a trail of yarn. A second type, the newest of looms, makes use of jets of air or water to force the weft through the shed. A third kind, called the rapier type and widely used in carpet weaving, uses steel rods to move the weft into the shed. The fundamental parts of all looms are the warp beam, a cylinder on which the warp threads are wound; heddles (rods or cords), each with an eye through which is drawn a warp thread; the harness, a rectangular frame set with a series of heddles operated to form a shed between the warp threads for the insertion of the weft threads; the reed, a comblike frame that pushes the filling yarn firmly against the finished cloth after each pick, or row; the breastbeam, over which the cloth is wound creating a tension with the warp beam; the cloth beam, on which the cloth is rolled as it is constructed; and the shuttle, if it is not a shuttleless loom. Vertical looms, such as the Navaho and some tapestry looms, developed from the practice of hanging the warp beam from a tree and holding the yarns taut with stones, pegs, or a weighted pole. The horizontal form, at first two poles holding the warp extended on the ground, was widely used for the Western European handloom and for the foot loom, the forerunner of the modern power loom. In the foot loom the harnesses were operated by treadles, leaving the hands free to pass and catch the shuttle. John Kay invented (1733) the automatic fly shuttle, and in 1760 his son Robert devised a drop box by which trays automatically brought bobbins of colored threads in line as desired. These aids to weaving encouraged inventions to speed up spinning, which in turn made faster weaving essential. Edmund Cartwright patented (1785) the first practical power loom, the basis of the modern loom with its multiplicity of automatic devices. By 1804, Joseph Marie Jacquard had perfected an attachment applicable to the power loom whereby any design might be woven on it. In the modern Jacquard, one repeat of the design is laid out on squared paper, then punched on cards that are laced into a continuous chain rotated on an overhead device. The cards are brought in contact with needles each controlling a wire that lifts a heddle when the needle passes through a hold in the card. In the Lefier robot, a design made on copper with insulating paint is transmitted by electricity to needles which lift the heddles.

Notes

loom — *ткацький станок*
dummy ['dʌmɪ] — *модель*
shed — *повітка; депо*
trail ['treɪl] — *стежка*
jet [dʒet] — *форсунка; двигун*
reed [ri:d] — *камиш; очерет*
to fill — *виконувати*
pick — *вибір; кирка*
peg — *кілóчок*
to warp [wɔ:p] — *викривляти(ся)*
forerunner ['fɔ:rʌnə] — *попередник*
treadle ['tredl] — *педаль*
to spin (span, spun) — *прясти; плести*
multiplicity [ˌmʌltɪ'plɪsɪtɪ] — *складність*
applicable ['æplɪkəbl] — *придатний*
to punch [pʌntʃ] — *штампувати*

Text 18. Fashion

Fashion in dress is the prevailing mode affecting modifications in costume. Styles in the Orient have been characterized by freedom from change, and Greek and Roman dress preserved the same flowing lines for centuries. Fashion in dress and interior decoration may be said to have originated in Europe about the 14th century. New styles were set by monarchs and prominent personages and were spread by travellers, by descriptions in letters, and, in costume by the exchange of the

fashion doll. The first fashion magazine is thought to have originated about 1586 in Frankfurt, Germany; it was widely imitated, gradually superseding fashion dolls. *Godey's Lady's Book*, established in the United States in 1830, remained popular for decades. In interior decoration the influence of designers, such as Chippendale, Sheraton, and Robert and James Adam, was apparent in the 18th century, but in costume the only influential designer at that period was Rose Bertin, milliner and dressmaker to Marie Antoinette. In Paris — the leading arbiter of fashion since the Renaissance — the fading influence of celebrities was coincident with the rise of designer-dressmakers in the mid-19th century. Paris *haute couture* has remained preeminent in setting fashions for women's dress. Designers such as Charles Frederick Worth, Gabrielle Chanel, Lucien Lelong, Elsa Schiaparelli, Cristóbal Balenciaga, Christian Dior, and Yves Saint-Laurent have had fashion houses in Paris. In recent years such American designers as Norman Norell, Mainbocher, James Galanos, Bill Blass, and Pauline Trigère have competed successfully with Parisian designers. London, in the early 19th century, became the center for men's fashions under the leadership of Regency dandies such as Beau Brummell. In the mid-1960s, London was again for a time the center of fashion influence. Fashions are adapted for mass production by the garment industries of New York, Los Angeles; and other cities.

Notes

to prevail [prɪ'veɪl] — *переважати*
to affect [ə'fekt] — *впливати*
to supersede [ˌsju:pə'si:d] — *заміняти*
milliner ['mɪlɪnə] — *модистка*
arbiter ['ɑ:bɪtə] — *арбітр*
coincident [kou'ɪnsɪdənt] — *який співпадає*
preeminent [pri:'emɪnənt] — *видатний, що переверщує*

Text 19. Some Major Fashion Designers

Gilbert Adrian (1903—59) worked in Hollywood, California. A vital influence in haute couture of the 1930s and 40s through private couturier work and costume designs for films, especially for the stars of C. B. DeMille and M-G-M movies, including Greta Garbo, Norma Shearer, Katharine Hepburn, and Joan Crawford. Created extravagant, draped evening gowns; hooded dresses; snoods; embroidered, padded evening jackets. Garbo dressed by him exclusively. Opened own house in 1940s.

Cristóbal Balenciaga (1895—1972) established houses of couture in Spain and in Paris (1937—68). Couturier to Europe's royalty and aristocracy. Major success achieved after World War II. Noted for his huge evening coats with dolman sleeves; long, full skirts; tunic and chemise dresses; fitted dressmaker suits; pillbox hats; perfumes; scarves; the seven-eighths coat.

Gabrielle Chanel (Coco) (1883—1970) established house of couture in Paris. An enormously influential designer from the mid-1920s. Noted for simple jersey dresses and suits; perfumes (Chanel No. 5); black or gray pullovers with white piqué collar and cuffs; box-jacket suits; costume jewelry; knit suits; trousers for women; textiles; clothes designed for comfort. Among the most imitated of all designers; had major resurgence of popularity beginning in 1954.

André Courrèges (1923—) established house of couture in Paris. Known for dresses and trouser suits with straight, flat line. Created the space age, unisex look that had a major success in mid-1960s.

Christian Dior (1905—57) established his main house of couture in Paris (1946). By 1958 had salons in 15 countries employing more than 2,000 people. Known particularly for the "New Look" of 1947 (narrow shoulders, constricted waist, emphasized bust, and long, wide skirt), nonfunctional but enormously popular in postwar era. Created short, waistless sack dress (early 1950s) and introduced the A-line dress (1956). Designs represented consistent classic elegance, stressing the feminine line. Succeeded by Yves Saint-Laurent as chief designer.

James Galanos (1925—) working in California. Known as a master of ready-to-wear fashions; full, loose dresses and chiffon coats over simple sheaths. Noted for use of silk fabrics.

Rudi Gernreich (1922—) working in California. Noted for ready-to-wear sportswear. Created a short-lived sensation with topless bathing suits and nightgowns. Makes popular and inexpensive knitwear, long, straight halter dresses. Often uses fabrics with geometric patterns and narrow stripes. Introduced plastic fabrics in futuristic modes.

Hubert de Givenchy (1927—) established house of couture in Paris. A disciple of Balenciaga and assistant designer to Schiaparelli, opened his own house in 1952. Noted for separate skirts and tops; unusual embroidered and printed fabrics; tubular evening dresses; sumptuous ball gowns; jewelled headbands; shawls; the princess silhouette; sleeveless coats; funnel necklines; perfumes. Designer of Audrey Hepburn's clothes and film costumes.

Edith Head (1907—1988), worked in Hollywood, Calif. Designed costumes for the movies beginning in the early 1930s. Received many Academy Awards: *The Heiress* (1949), *All About Eve* (1950), *Samson*

and Delilah (1951), *A Place in the Sun* (1952), *Roman Holiday* (1954), *The Sting* (1973). Important influence on American haute couture.

Lucien Lelong (1889—1958) operated Parisian house of couture from 1919 to 1948. Achieved major success in the 1930s and 40s. Noted for his perfumes, hobble skirts; bared shoulders; tailored suits with cut-away bodices; flared skirts; dresses with pleats, tiers, and diagonal draping; décolletage in back.

Mainbocher (Main Rousseau Bocher) (1891—1970) worked in the United States. Known for his very expensive, elegant evening clothes; cardigan sweaters with jewelled buttons; high-waisted, long, and lacy or transparent ball gowns. Opened his Paris house of couture in 1929 and his New York house in 1939. Designed war uniforms and made costume designs for a few stage productions.

Norman Norell (1900—1972) worked in California and New York. Noted for inexpensive casual wear as well as haute couture; lounging costumes; cloth coats; sequined cocktail dresses; chemise dresses; sweaters with evening skirts. Started his own firm making ready-to-wear clothing in 1960.

Paul Poiret (1879—1943) opened Parisian house of couture in 1904. Dominated French fashions from 1909 to 1914. Noted for his hobble-skirted day dresses and suits with light corsetting; walking coat and dress ensembles in novelty fabrics, often with touches of lace; short, printed hoop skirts over long sheath skirts. Made boyishness the vogue. Strongly influenced by art nouveau and Oriental designs. Refused to submit to changing tastes and died in poverty at 64.

Emilio Pucci (1914—1989) established showrooms in Florence, Capri, and Rome. Began to design elegant sportswear, especially ski outfits, in 1947. Created his own multicolored printed fabric with geometric and organic patterns. Used brilliant colors in silk blouses, bulky knit sweaters, underclothes, scarves, towels. Designed accessories including perfumes, belts, jewelry; objects such as table tops and car roofs.

Mary Quant (1934—) opened boutique in London. One of the originators of the "mod" or "Chelsea" look of the 1960s that made London the new center of fashion. Noted for miniskirts; vinyl boots; dresses with striking geometric patterns and strong colors; the "wet" look. First to design for a youthful clientele.

Yves Saint-Laurent (1936—) established houses of couture and boutiques in Paris and New York. Dior's foremost assistant and successor to him as head of the House of Dior at 21. Early collections were noted for their extreme, maverick quality. Opened his own Paris house in 1961, featuring "chic beatnik" look; knitted turtlenecks; thigh-length boots; skin-tight trousers; short jackets. Later designs include sophisticated tweed suits, pleated skirts, heavy costume jewelry. Designed for the Ballets de Roland Petit.

Elsa Schiaparelli (1890—1973) established house of couture in Paris (late 1920s to 1954) and New York showroom since 1949. A daring, flamboyant fashion innovator. Popularized brilliant colors, especially shocking pink. First to use synthetic fabrics and zipper fastenings and first to open own boutique. Noted for her perfume Shocking; small hats; angular, wide-shouldered suits and dresses; turbans; walking coats; evening sweaters; halter necklines; cocktail dresses with matching jackets; scarves. Created extravagant, daring, amusing designs (e.g., bouffant gloves ballooning to the shoulders).

Madeleine Vionnet (1878—1941) operated Parisian house of couture from 1918 to 1939. Known for her graceful, sensuous use of pure silks, organdies, chiffons, velvets, and clinging lamés. Created swirling evening gowns with remarkable use of bias cutting, transforming medieval and Greek-inspired styles into a look of sleek modernity. Diaphanous evening wear was antifunctional in the extreme. Made wide-sleeved coats and toques. Designed directly on half-scale mannequin dolls; collection of these is in the Union des arts de costume in Paris.

Charles Frederick Worth (1825—95) is a founder of the Maison Worth in Paris and London, arbiter of women's fashions for more than a century. First designed silks and then became court dressmaker to Empress Eugénie of France and Empress Elizabeth of Austria. Created the ancestor of the tailor-made suit; invented the puffed tunic called the Polonaise. His descendants continued business after his death. House of Worth in London still in operation.

Notes

snood ['snu:d] — *сітка для волосся; стрічка*
pad — *подушечка*
tunic ['tju:nɪk] — *туніка*
chemise [ʃɪ'mi:z] — *жіноча сорочка*
fitted — *готовий*
pillbox ['pɪlbɔks] — *коробка для шляп*
jersey ['dʒə:zɪ] — *тонка вовна*
pullover ['pul,ouvə] — *пулóвер, светр*
resurgence [rɪ'sə:dʒəns] — *відродження*
to constrict [kən'strɪkt] — *стискувати*
waist [weɪst] — *талія*
bust [bʌst] — *бюст*

sack — *полотно*
sheath [ʃi:θ] — *оболонка*
night-gown [ˈgaun] — *нічна сорочка*
stripe [ˈstraɪp] — *смуга*
sumptuous [ˈsʌmptjuəs] — *розкішний, пишний*
jewel [ˈdʒu:əl] — *коштовність*
headband — *пов'язка, стрічка*
funnel [ˈfʌnəl] — *воронка*
to cut away — *зрізати*
bodice [ˈbɔdɪs] — *корсаж; ліф*
flare [ˈfleə] — *спалах*
tier [ˈtɪə] — *ярус, ряд*
diagonal [daɪˈægənəl] — *діагональний*
cardigan [ˈkɑ:dɪgən] — *джемпер вовняний*
to lounge [ˈlaundʒ] — *байдикувати*
bulky [ˈbʌlkɪ] — *об'ємистий, важкий*
accessories [ækˈsesərɪz] — *речі туалету (множ.)*
turtle [ˈtə:tl] — *(морська) черепаха*
sensuous [ˈsensjuəs] — *чутливий*
bias [ˈbaɪəs] — *нахил*
sleek [sli:k] — *лискучий*
ancestor [ˈænsɪstə] — *предок*
to puff — *важко дихати*
descendant [dɪˈsendənt] — *нащадок*

5.

Section. Agriculture

Text 1. Artificial Fertilizers

1. The Essential Elements of a Fertilizer. The three elements nitrogen, phosphorus and potash are the most valuable ingredients of the soil, for they are found in smaller quantities in proportion to their needs, and are also more easily lost than some of the other elements.

All other elements, besides these three, have no value except as fillers.

2. Function of these Elements in Plant and Animal Growth. Although each element is absolutely essential to plant or animal growth, each of them has a specific function.

Nitrogen promotes leafage in plants. Green, luxuriant growth indicates a sufficiency of nitrogen. Often orchard trees have a great deal of foliage, which shows that an abundance of nitrogen is present in the soil. Phosphorus is found in some of the proteins, and since we find a greater amount of protein in the seeds than in the leaves and stems, it is thought that phosphorus plays an important part in seed formation. This element hastens root and stem growth, and especially seed growth, and for that reason hastens maturity, often an important factor in getting maximum yields. Potassium seems to assist in the formation of starch and sugar. As a consequence of the effect of potassium on leaf, root, and sugar in mangeles, the sugar production is more than double.

In animal bodies, nitrogen helps to make bone, tendons, muscles and other tissues. Phosphorus makes up a large part of the bones, ninety percent of bone content being lime and phosphorus. Potassium too aids in bone formation and other processes.

3. Kinds of Artificial Fertilizers. Just as there are essential elements in soil fertilizers, so there are, broadly speaking, three kinds of artificial fertilizers. Each is named after the element which makes up the main ingredient: thus we have nitrogenous, phosphatic and potassium fertilizers.

Nitrogenous Fertilizers. The chief sources of nitrogenous fertilizers are: 1) slaughter-houses; 2) sodium nitrate mines and 3) cotton-seed factories. Dried blood, tankage, and steamed bone meal come from the slaughter-houses. It was stated that the cheapest and most effective means of increasing the nitrogen in the soil was by growing legume crops. Occasionally such a crop may be ploughed under for the tops of legumes are richer in plant foods than the roots.

The legumes do not gather enough nitrogen from the air to add an appreciable amount of nitrogen to the soil where these crops are annually removed. Unless some legume is ploughed under, the balance in nitrogen may be maintained by the growing of a legume, but not increased. Consequently, manure, a legume crop, or artificial nitrogen, must be added if the balance of nitrogen in the soil is to be increased.

Phosphate Fertilizers come from phosphate rocks and slaughter-houses. The rocks are ground into fine powder. The product is called "Rock Phosphate". The bones of animals slaughtered in the packing houses are made into fertilizers. The phosphorus content of these fertilizers ranges from 10 to 25 percent, the average being probably 12.5 to 15 percent soluble phosphorus. The rock phosphates contain from 20 to 30 percent phosphoric acid. The phosphate fertilizers are probably the most important fertilizers, considering their value in growing plants.

To make possible the growth of clover or other legumes and the consequent addition of nitrogen from the inexhaustible supply in the air, it is necessary to maintain or to increase the amount of phosphorus in the soil.

Notes

fertilizer ['fə:tilaizə] — *добриво*
nitrogen ['naitridʒən] — *азот*
phosphorus ['fɔsfərəs] — *фосфор*
potash ['pɔtæʃ] — *поташ*
luxuriant [lʌg'zjuəriənt] — *буйний*
sufficiency [sə'fiʃənsi] — *достатня кількість*
starch ['stɑ:tʃ] — *крохмаль*
tendon ['tendən] — *сухожилля*
slaughter ['slɔ:tə] **house** — *бойня*

Text 2. Insects and Insecticides

The effective control of injurious **insects** demands a knowledge of the habit of the insects themselves, so that they may be attacked at the most vulnerable points.

Insects differ greatly in their habits and life history, that is why methods of control also may differ greatly not only with regard to individual insects but with regard to crops that are attacked by them.

Insects that live mostly in the ground and injure the roots of plants must be controlled in a different way from those that feed on foliage.

Insects attacking the cereal crops cannot be treated in the same way as those attacking the fruit and leaves of garden or orchard crops.

Injuries to vegetable and other crops may be prevented by various cultural preventive measures, such as clean farming and crop rotation. Cultural practice can be relied on in the case of some crops but not of all of them. With most crops artificial or remedial methods must be practised, that is, the application of materials that either poison or kill insects by contact with their tissues.

Fig.1 An example of a biting or chewing insect

These substances are known to be **insecticides.** Artificial methods may be classified as follows: 1) the application of poisons against biting insects; 2) the application of contact substances against sucking insects; 3) the use of poison gases.

When applying insecticides three factors must be taken into consideration: effectiveness against insects, cheapness of the material, and its application and harmlessness to insect hosts. Insecticides may be used in the form of sprays and dusts. Application of the insecticides in the form of a spray requires thoroughness of spraying. Dusting is often practised too. In some cases the results of the dust methods are very satisfactory and they give the possibility to protect orchards and fields at critical times. A large orchard can be treated in about one fifth of the time required by liquid spraying.

Insecticides are usually divided into three classes: internal poisons and those that kill by contact and fumigants.

Internal poisons are used against chewing insects and kill by being taken into the digestive tract.

The contact insecticides are not eaten but applied directly to the insect body and produce death in various ways: either by suffocation, by corrosive action, or by fumes that penetrate the breathing pores of the insects.

Until recently the modes of action of insecticides was not well understood. It was supposed that contact substances kill insects by stopping the breathing pores or plugging the tracheae, producing death by suffocation. Recent investigations show that insects are not readily suffocated. The volatile portions of kerosene, carbon, bisulphides, creolin, etc. are effective long before the liquid are absorbed by their tissues.

With the penetration of the volatile substances the nervous system is seriously affected, results resembling narcosis are produced and a disturbance of the respiratory activity occurs. Insect tissues soon become saturated when exposed to the vapours of the substances and death results through the inability of the tissue to absorb oxygen in the presence of these vapours.

The most effective poisons for the destruction of biting insects are: Paris green, arsenite of lime, sodium fluoride.

The main substances used as contact insecticides against sucking insects are: lime sulphur wash, soap, kerosene emulsion, tobacco decoction, wiscible oils, pyretrum, lime dust, carbolic acid, emulsion DDT, benzine gexachloride and others.

The main poisonous gases are: carbon bisulphide, hydrocyanic acid gas, sulphur dioxide fumes, tobacco, formalin, carbon tetrachlorid and others.

Notes

insect ['ɪnsekt] — *комаха*
insecticide [ɪn'sektɪsaɪd] — *засіб від комах*
vulnerable ['vʌlnərəbl] — *вразливий*
foliage ['fouliidʒ] — *листя*
remedial [rɪ'mi:dɪəl] — *лікувальний*
suffocation [ˌsʌfə'keɪʃn] — *задушення*
volatile ['vɔlətaɪl] — *непостійний; випаровний*
trachea [trə'kɪə] — *трахея*
kerosene ['kerəsi:n] — *гас*
narcosis [nɑ:'kousɪs] — *наркоз*
vapour ['veɪpə] — *пара*
lime ['laɪm] — *вапно; липа*

Text 3. More about Insects

Insects possess an external skeleton composed of a series of segments which is divided into three well defined regions: head, thorax and abdomen. The head bears a pair of antennae, a pair of compound eyes and often three simple eyes or occelli. Three pairs of legs are born on thorax and in the adult condition two pairs of wings can be seen. Some insects have only one. The wings are modified in different ways: in the butterflies they are covered with scales; in the beetles the front wings are hard and horny and are known as wing-covers under which the hind wings are folded when in repose. In many true bugs the front wings are of leathery texture except the tip, which is membranous. In the female the abdomen is often provided with a sharp ovipositor.

The mouth-parts of insects are adapted for feeding in various ways and on all kinds of plant tissue. There are chewing insects. These are insects such as grasshoppers whose mouth part is provided with a pair of hard horny jaws or mandibles with which the insect is able to bite off portions of plant tissue which are then swallowed.

There are sucking insects which have the mouth parts modified to form a beak containing four bristles united into a slender tube with which they puncture the tissues of the plant and suck out the juice.

Plant lice and true bugs belong to this group of insects. Some flies belong to the group of lapping insects. The mouth-parts of such insects are developed into a tongue-like organ with which they are able to lap or lick up liquids.

Insects breathe through a series of openings called spiracles extending along the side of the body. These openings connect with tubes called tracheae which subdividing again and again, extend to all parts of the body.

Most insects with the exception of some scale insects and certain forms of plant lice reproduce by means of eggs.

The newly hatched insect usually bears little resemblance to the adult. As it increases in size, its skin becomes too small, a new skin is formed beneath the old one and the latter is discarded. This is called molting. The period between two molts is called an instar. The number of instars varies in different insects from three to six or seven. Five is the more common number.

Some insects have an incomplete metamorphoses. That is, when the change from immature condition to the winged adult takes place without any material change in form. In others the transformation is

abrupt and striking. This is called a complete metamorphosis. In the case of incomplete metamorphosis the immature stages resemble the adult in form. The life cycle of the insect then consists of three stages: the egg, the nymph and the adult.

The true bugs and grasshoppers have incomplete metamorphosis. In the case of complete metamorphosis the immature stages of the insect bear little or no resemblance to the adult. Four stages are characteristic to this type of insect development: egg, larva, pupa and adult. Butterflies or moths, beetles and flies are insects which have complete metamorphosis.

The common natural means of dispersal of insects are flight, wind, animals and railways. But there are also barriers to the spread of insects: oceans, seas, mountains and deserts. Climatic conditions such as temperature and moisture are also important factors in insect distribution.

The habits of insects are variable, some being limited, others almost cosmopolitan in their distribution; some sensitive to temperature and moisture extremes, others more or less indifferent to these factors; some because on one or two hosts, others more or less general feeders, the problem of the determination of probable insect distribution is not an easy one to solve. The presence or absence of parasites complicates it even more. As a rule, however, insects diffuse most rapidly in the zone which they originate from and in the direction of least resistance.

A special branch of science, economic entomology, is busy studying all these factors and many others connected with insect pest.

Notes

skeleton ['skelɪtn] — *каркас; основа*
segment ['segmənt] — *відрізок, сегмент*
thorax ['θɔ:ræks] — *грудна клітка*
butterfly ['bʌtəflaɪ] — *метелик*
beetle ['bi:tl] — *жук*
repose [rɪ'pouz] — *відпочинок, спокій*
to swallow ['swɔlou] — *ковтати*
to hatch [hætʃ] — *вилуплювати(ся)*
to discard [dɪs'ka:d] — *відмовляти(ся)*
nymph [nɪmf] — *німфа*
grasshopper ['gra:s,hopə] — *коник*

Text 4. Feeding Dairy Cows

A cow's food consists of concentrates and roughage. The concentrates, as their name implies, are foods in which the nutritive energy is high in proportion to their weight and bulk, and they are from 75 to 100 percent digestible. In roughages, the nutritive energy is lower in proportion to weight, the digestibility being from 30 to 75 percent. The concentrates consist of grains and highly digestible materials produced from grains, while roughages are whole plants, with the exception of the roots. Pasture and silage are also usually included under the head of roughage.

In numerous experiments with cattle, the nutritive properties of grain and hay have been studied by feeding each kind of food separately for long periods. Cattle cannot be kept alive for more than a year or so on grain alone, but they may remain alive and in good health for many years on hay alone. High-producing cows, however, cannot be kept anywhere near their maximum milk production on hay alone, because they are not able to eat and digest the enormous bulk of this kind of food which would be necessary to supply the nutritive energy required for heavy milk production.

In order to keep high-producing cows in good health and obtain maximum milk production, one should feed them both hay and grain — the hay to provide some nutritive energy, but particularly certain nutritive essentials necessary to keep animals in good health; the grain — to provide a large amount of nutritive energy in such concentrated form that the cows can consume and digest enough of it for heavy milk production.

Nutritive energy is that part of the energy of the food which can undergo chemical changes within the body and thus supply the energy necessary to keep animals warm, to enable them to move about, and to make possible certain chemical changes within the body. The nutritive energy of any food can be measured and compared with that of any other food, and may be designated simply as its energy value. It would perhaps be better to describe the parts played by grain and hay in the nutrition of dairy cattle by saying that the chief function of hay is to supply certain chemical compounds required to keep animals alive and in good health, and that the chief function of grain is to supply the large amount of concentrated energy, required for heavy milk secretion.

Cows can be kept for many years in good health and near maximum milk production on rations of grain and hay alone without pasture or other green or succulent food. In order to do this, however, it

is necessary to pay particular attention to the kind of hay fed. Hay varies greatly in the quantity of various important chemical compounds that it contains.

If it were necessary to get along with only one kind of hay, it would be much better to use legume hay than grass hay. Legume hay contains more of almost every chemical compound necessary for nutrition than does grass hay. But experience has shown that cows will not eat as much hay or thrive as well on either legume hay or grass hay alone as they will on a combination of the two. The roughage of the dairy ration may, therefore, consist of about equal parts of legume hay and grass hay.

The vitamins are contained in much larger quantity in hay of good quality than in hay of poor quality. It is important, therefore, to supply cows with hay of good quality.

Notes

dairy ['dɛərɪ] — *молочний*
concentrate ['kɔnsentreɪt] — *концентрат*
nutritive ['nju:trɪtɪv] — *поживний, харчовий*
bulk [bʌlk] — *обсяг*
silage ['saɪlɪdʒ] — *силос*
hay ['heɪ] — *сіно*
to consume [kən'sju:m] — *споживати*
succulent ['sʌkjulənt] — *соковитий*
legume [le'gju:m] — *бобовий*
to thrive (throve, thriven) — *процвітати*

Text 5. Major Points in Judging Cows

In selecting cows attention should be paid not only to their qualities as milk producers but also to their general appearance. The points of conformation must be most closely associated with milk production. These major points are: 1) general appearance, 2) dairy character, 3) body capacity, and 4) mammary system.

In judging general appearance, breed characteristics such as colour, size, and horns, are taken into account; the same applies to the head, shoulder blades, back loin, rump, legs, and feet. A cow is said to be perfect in general appearance when she has an attractive individuality, revealing vigour and correlation of parts.

In considering general appearance it is best to view the animal from a distance. This makes it possible to see the animal as a whole. Such points as the relation of the size and the development of one

part of the body to that of another, the symmetry of form, the body lines and the conformity of the animal to a definite type are considered under general appearance.

Health and vigour are factors which must be considered in judging any class of breeding cattle. Associated with them are the factors of constitution and fertility. Constitution does not refer to the dimensions of the chest, but rather to the ability of the animal to withstand the strain of heavy milk production.

Concerning the importance of the major points, it may be said that so far as producing ability is concerned, without regard to the minor points, that cow is very likely to be the best which presents the best general appearance, surpasses in dairy character, and has the largest capacity for consuming feed, as shown by the length, depth and breadth of the body where the organs of digestion are located, the greatest lung, heart, and circulatory system, as shown by the development of the corresponding parts of the body, the greatest development of the mammary system, and at the same time is nearly perfect in health and vigour.

Notes

conformation [ˌkɔnfɔ:'meɪʃn] — *структура, будова*
horn [hɔ:n] — *ріг*
loin ['lɔɪn] — *філейна частина*
rump ['rʌmp] — *огузок*
vigour ['vɪgə] — *сила, енергія*
symmetry ['sɪmɪtrɪ] — *симетрія*
conformity [kən'fɔ:mɪtɪ] — *відповідність*
dimension [dɪ'menʃn] — *обсяг*

Text 6. Feeding Calves

The usual practice of letting beef **calves** to be nursed by their mothers until they reach weaning age is, of course, the most desirable method of cattle breeding. Occasionally, however, the cow dies, leaving the calf an orphan. There are times, too, when it seems more practical to wean the young calves that formally would continue to receive milk for several months. Whether it is possible for one cow to feed two calves or to provide nursing cows, the problem is easily solved. There are many instances, however, when no milk or at least a limited amount of it is available to the calf and one is faced with the problem of trying to look for other feeds.

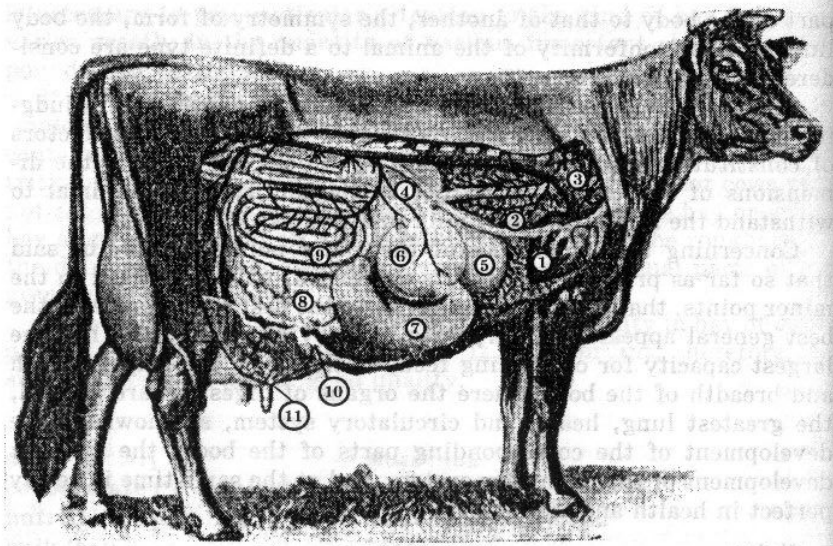


Diagram of cow showing organs:
1 — heart; 2 — lungs; 3 — gullet; 4— paunch (rumen or first stomach); 5 — reticulum (second stomach); 6—omasum (third stomach); 7 —abomasum (fourth stomach); 8 — small intestines; 9—large intestines; 10— milk veins; 11 — milk cistern.

It is well known that cattle have four separate stomachs. One of these, the rumen or paunch, is very large in the mature animal, and has large capacity for coarse feeds such as silage, hay and fodder. The feed for "rechewing" or rumination, commonly called "cud chewing" comes from the paunch. Incidentally no digestion other than by bacterial action takes place in the paunch. Digestion is left for the fourth or true stomach and is accomplished by enzymes found in the digestive juices secreted by the stomach. Additional digestion takes place in the small intestine. The amount and character of the digestive juices are dependent to some extent upon the character of the food eaten and upon the age of the animal. For example, the calf digests milk quite readily but does not digest more complex foods of plant origin as readily as the cow.

In mature cattle the capacity of the paunch is several times as large, as the combined capacity of the other three stomachs. On the other hand a calf slaughtered at birth reveals a paunch smaller than an ordinary tea cup but a true stomach, somewhat larger than a litre milk bottle. The calf's stomachs are arranged in this fashion because his food in early life consists primarily of milk. As he grows older his

digestive organs develop and he gradually becomes able to digest more complex feed until he can finally live entirely upon plant growth.

Because of his undeveloped paunch the calf has a limited capacity for feed. He must, therefore, take his food at frequent intervals and in limited amounts. It must be easily and quickly digested and contain all of the nutrients needed by his body. Should he be required to take a coarse bulky feed, he would not only have difficulty in digesting it but would be consuming a relatively small amount of digestible nutrients and likely one or more of the necessary nutrients would not be found in that particular feed. His chance, therefore, of receiving a balanced diet would be small.

Notes

to wean [wi:n] — *відніматu (від грудей)*
calf ['kɑ:f] — *теля*
paunch ['pɔ:ntʃ] — *брюхо; шлунок*
fodder ['fɔdə] — *фураж*
rumination [ˌru:mɪ'neɪʃn] — *жування*
to digest [dɪ'dʒest] — *засвоювати*
intestines [ɪn'testɪnz] — *кишки*
primarily ['praɪmərɪlɪ] — *в першу чергу*
capacity [kə'pæsɪtɪ] — *обсяг*

Text 7. Calves

Meeting the Nutrient Requirements

Milk. Milk is the natural food of the young animal, and it lacks but few nutrients. For the young animal milk is the most natural and most complete food available and it is with difficulty that milk can be excluded from the diet of the young.

Colostrum is thick, very yellow in colour, and contains nearly six times as much protein as is contained in ordinary milk. Contrary to popular opinion it is not much higher in fat content than ordinary milk. Colostrum so necessary to bone growth is noticeably higher in mineral content than common milk and the nutrients provided are very easily digested. The laxative properties of colostrum are important and it is believed that it may also have a beneficial germicidal effect. A calf started from birth on his mother's milk as nature intended is usually off to a good start.

Even though the digestive system of young calves is not fully developed they are capable of digesting and assimilating without dif-

ficulty the nutrients of milk. The protein content of milk is high and of good quality and meets the protein requirements for growth. The fat and sugar found in milk furnish concentrated energy in a form easily assimilated for the production of heat and fat. The high calcium and phosphorus content provides for rapid bone growth and if the cow is receiving a satisfactory ration, most of the vitamin requirement will be adequately accounted for. It can thus be seen that it is with difficulty that man can substitute other feeds for milk, and if he does, care in the selection of feeds is essential. There are few if any feeds better than milk for the young calf, but even milk is not 100 percent sufficient under all conditions. If the calf is to be fattened and developed properly he will need additional feed in the form of grain and a high-quality roughage, preferable a good legume hay. This supplementary feeding should start as soon as he will eat, which in most cases will begin at around one month of age. It is a good investment to allow the calf access to a creep in which ground grain and bright leafy alfalfa hay are provided.

Not all milk has the same effect upon the digestive tract. It is a well known fact that milk too rich in fat is likely to cause digestive disturbances.

Since there is considerable difference in the composition of milk from different cows even within a given breed, it is also good practice not to keep shifting the calf from one cow to another.

Mastitis or "garget" — udder disease of cows, is very dangerous to the well-being of calves, especially to the younger ones. Milk from cows so diseased should never be used for the calf. Feeding it may cause severe intestinal inflammation and scours, resulting in much sickness and even deaths among calves.

During the growing period the calf requires rather large amounts of protein. Not only must the supply of protein be adequate but it must be of good quality, containing the essential amino acids for growth, life, and well-being of the animal. Protein is that nutrient used for the production of lean meat or muscle, hair and hide. To limit the protein below bodily requirements slows up the growth and may result in a stunted calf. There are two general types of protein-rich feeds: 1) legume roughages and 2) protein concentrates.

Notes

nutrient ['nju:trɪənt] — *поживний*
laxative ['læksətɪv] — *проносне*
access ['æksəs] — *доступ*
creep [kri:p] — *повзуча рослина*
inflammation [ˌɪnflə'meɪʃn] — *запалення*

scour ['skauə] — *чистка*
hide ['haɪd] — *шкура; шкіра*
to stunt [stʌnt] — *затримувати ріст*

Text 8. Keeping the Calf Healthy

Ringworm is probably the most common ailment of young calves. It is a parasite which affects the top layer of skin, causing circular bare spots on the hide that are covered with crusts. Treatment consists of scrubbing the affected parts with a stiff brush until the scurf is removed. When this is done a strong solution of tincture of iodine should be applied. Three or four treatments will usually clear up the condition. A mixture of one part of tincture of iodine and three parts of glycerine is also good for treating ring-worms. It sticks better than tincture of iodine alone and is not so apt to flow over the skin area where it is not needed.

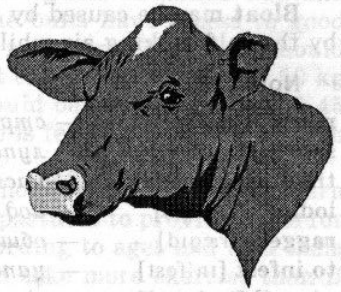


Fig. 3. Heifer with ring-worm

Pneumonia is common among calves especially during the fall and early spring months. The symptoms are coughing, listlessness, rapid and laboured breathing, and fever. Death may result in a few hours, or a few days.

Lice can do considerable damage among a group of calves. They cause excessive rubbing and a ragged appearance of the calf due to the loss of hair. The calf also becomes thin and unthrifty. Clean premises are the first step in lice prevention. If the calf is infested with lice, washing the calf and then wetting him with a diluted dip solution is quite effective. Two to three treatments at weekly intervals will be necessary. Kerosene emulsion is probably better for treating badly infested calves.

Scours is of two types, that resulting from indigestion and the infectious type. The former is usually caused by overfeeding, irregular amounts of feed, partially spoiled feed, and filth either in the feed or feeding utensils. To overcome the trouble, first remove the cause, then cut back slightly on the feed and be careful of the temperature of the milk and water if the calf is hand-fed.

Foul foot (foot rot) is usually at its worst in wet, muddy lots. It begins as an inflammation of the foot starting between the toes. It

may affect one or more feet. Swelling and redness are noted around the hoof head and in advanced stages the swelling spreads from the foot to the knee. The animal is very lame and displays signs of extreme pain. Unless treated the animal may die, or lose a foot. Treatment is very simple and consists of cleaning up the foot, especially between the toes, and applying a solution of formaldehyde and glycerine (half and half). Daily treatments for two or three days usually suffice.

Bloat may be caused by improper feeding of green alfalfa hay or by the calf sucking air while nursed.

Notes

ringworm ['rɪŋwə:m] — *стригучий лишай*
scurf [skə:f] — *лупа*
tincture ['tɪŋktʃə] — *настій*
iodine ['aɪədi:n] — *йод*
ragged ['rægɪd] — *обшарпаний*
to infest [ɪn'fest] — *нападати*
utensil [ju:'tensl] — *посуд*
swelling ['swelɪŋ] — *пухлина*
treatment ['tri:tmənt] — *лікування*

Text 9. Development of Young Stock

Calves to Weaning Age. Occasionally, a cow or heifer will not give sufficient milk to nourish a very young calf properly, in such a case it becomes necessary to obtain milk from another cow. However, unless the other cow gives more than enough milk for her own calf, this procedure is undesirable, as it obviously limits the milk supply for the two calves.

Calves on pasture may be fed the grain mixture in a shaded crib located near water and salt supplies. Calves fed grain prior to weaning are usually significantly heavier than similar calves receiving no grain. Furthermore, the grain-fed calves have less set-back when weaned. Calves not on pasture should have access to legume or mixed hay of good quality when they are about 3 weeks old. Grain should be fed twice a day at regular intervals, and the calves may be fed milk three times a day until they are consuming considerable grain and hay. After the noon feeding it is advisable to turn the calves into paddocks for 2 or 3 hours when the weather permits.

The bull calves should be separated from the heifers when they are 6 or 7 months old. Generally, calves (not being fitted for show purposes) are weaned at 7 to 9 months of age, depending largely on the quantity of milk they are still receiving from their dams and the conditions of the calves.

Young Bulls. For proper development of young bulls liberal feeding is necessary. A grain mixture such as 5 parts by weight of cracked or coarsely ground corn, 3 parts of crushed oats, 2 parts of wheat bran, and 1 part of linseed meal, with legume or mixed hay and silage, should serve this purpose. If the bulls have access to good pasture, little or no legume hay will be necessary. The grain should be fed, twice a day and in quantities not exceeding 700 gr per 50 kg of live weight. The feeding of silage should be limited to about 0.45 kg per 50 kg of live weight. When silage is fed it may be placed with the grain in the feed bunk or box.

So far as possible, it is desirable to house young bulls in a barn that can be connected with lots or small pastures to provide space for exercise. It is best to separate them according to ages and feed them in groups as they tend to eat better and take more exercise than if they are individually fed. Frequent haltering, leading and brushing tend to make bulls more docile and less difficult to handle.

Feeding and Care of the Herd Bull. The herd bull should not be allowed to run with the cows during the entire year. A separate enclosure should be provided for the bull, if possible. However, he may be turned out on pasture with the steers after the breeding season, if no provision can be made to keep him in a pasture by himself.

When the bull is to be put in heavy service, as, for example, when breeding for spring or fall calves, he will probably need a little extra feed for about 30 days in advance and also during the breeding season in order to be in good breeding condition.

If it is advisable to keep the bull in a thrifty breeding condition throughout the year, he will need space for exercise when not on pasture. Green pasture will meet a considerable portion of the requirements. In the absence of pasture, a lot will provide space for exercise, but the ration should contain green feed, silage, or carotene-rich root crops such as carrots and sweet potatoes. Some legume hay is necessary in the absence of any of the above carotene-rich feeds, but considerable straw or stover with a little grain and cottonseed cake, linseed meal, or other protein concentrate may be fed.

A bull in good breeding condition is likely to be somewhat temperamental. If he has been dehorned he will be somewhat easier to control, but under no circumstances should he be trusted. The more docile and gentle he appears the more careful should be his attendant.

As the calves grow older their grain ration may be slowly increased. The quantity of grain they will need depends on the quantity

and kind of other feeds given them. Calves will make better growth if they learn to eat a little grain mixture and legume hay of good quality when they are about 3 weeks old. At this time the grain mixture may be composed of equal amounts by weight of corn (preferably yellow), crushed oats, and bran. When calves are confined to a dry lot they may learn to eat the grain a little more readily, if an older calf that has learned to eat is placed with them.

Notes

heifer [ˈhefə] — *теля*
to nourish [ˈnʌrɪʃ] — *годувати*
pasture [ˈpɑ:stʃə] — *пасовище; вигін*
crib [krɪb] — *стійло; ясла*
prior [ˈpraɪə] — *до; попередній*
to wean [wi:n] — *одлучати, віднімати (від)*
paddock [ˈpædək] — *вигон*
linseed [ˈlɪnsi:d] — *льняне насіння*
silage [ˈsaɪlɪdʒ] — *силос*
docile [ˈdousaɪl] — *покірний*
enclosure [ɪnˈklouʒə] — *обгороження місце*

Text 10. Sheep

Sheep are produced for two purposes: wool and mutton. While all breeds produce both wool and mutton, sheep, according to the characteristics of the wool produced are further divided into three classes: 1) fine wool breeds, 2) middle wool breeds, 3) long wool breeds.

The fine wool breeds have smooth, wrinkled, or slightly folded skins. The folded skin increasing the wool of the Merinos is dense but short. The fine crimp in wool is very desirable; and the fineness, the crimp and the extra yolk in Merino wool give it its special value. The wool from the fine wool breeds is made into the finest fabrics.

The Merinos correspond to the dairy cow, for they are skinny and angular and have a specific purpose.

All their feed not needed for maintenance is used for wool production. Since wool is nitrogenous, the feed should be to some extent of that nature. Good feeding and good wool go together.

2) The middle wool breeds are: Hampshire, Oxford Down, Shropshire. The middle wool breeds are also known as the Down breeds and as the mutton breeds. They are somewhat larger than Merino sheep and have the conformation of good mutton producers. The wool is coarser and has a longer staple than that of the fine wool breeds. It is made into woollen garments. The longer fiber is conducive to a stronger warp and wool, making a thread which is difficult to break. Compare the breaking strength of a cotton and woollen thread. It will be observed that the long fiber in the wool will not pull apart but must be broken if it is to be severed. Cotton pulls apart easily.

3) The long wool breeds of sheep include the types: Lincoln and Romney March. The long wool breeds do not shear as heavy a fleece, but for strength of staple they are unexcelled. Their wool is made into coarse garments, rugs and carpets.

Sheep, because of their fleece, can be grown in high altitudes where the low temperature often prohibits the growth of other livestock. It is for this reason too that sheep do not require expensive stables; sheep stables need not be built so much for warmth as to keep the sheep dry.

Notes

mutton [ˈmʌtn] — *баранина*
yolk [jouk] — *жовток*
nitrogenous [naɪˈtrɔdʒɪnəs] — *азотний*
staple [ˈsteɪpl] — *основний продукт*

Text 11. Swine

The hog is the most efficient of all farm animals in converting grain crops into meat for human consumption. His efficiency as a meat producer is almost double that of cattle. It was stated that the average sow would farrow 114 days after she has been bred. In only a few instances would her gestation period be less than 112 or more than 116 days. A successful pig crop must be planned and breeding started so as to produce pigs within desired periods.

Several sows intended for rebreeding to one boar, should be weaned from their pigs only in small groups at a few days' intervals. Sows usually "come in heat" 3 to 5 days after weaning their pigs. The duration of the heat period is about 3 days and occurs every 20 or 21 days; sows will accept boars only during the heat period. It is believed that larger litters result from mating late rather than early in the period.

The age at which to breed gilts depends upon the development and maturity of the individual animal. A well-developed sow can be bred safely at the age of 8 months. Breeding too young may cause small litters, weak pigs, and trouble at farrowing time. In order to get maximum growth, breeders often delay breeding until gilts are past one year old or breed early and then raise only one litter the first year.

A method of shortening the time between litters without weaning the pigs too young is to separate the sow from the pigs for the night after they are 8 weeks old, returning the sow each day. A large percentage of sows will mate successfully about the fifth day following this treatment, with no ill effects on the nursing litter.

The boar pig should not start mating before 11—12 months old. The boar's vitality can be conserved by bringing the sows to a breeding pen when ready and allowing only one service for each sow. A well developed boar 11—12 months old may be used for two sows the same day, but should not be bred to more than five sows per week. In hot weather it is best to breed the sows either in the morning or in the evening, before feeding the boar.

The sow should be confined to her farrowing quarters about 3 days before she is due to farrow. Before moving the sow, the farrowing house should be properly cleaned, washed and repaired. The house or pen should be warm and free from dampness. Large sows need large pens. After drying, the quarters should be bedded with clean straw, preferably wheat or rye. When the sow is ready to farrow the coarse bedding should be replaced by a small amount of chaffy or chopped straw. The sow should be washed thoroughly with warm water and soap until all mud has been removed, before moving into her cleaned farrowing quarter. As farrowing time approaches the sow will become nervous and the milk flow will start about 12 hours or more before farrowing.

Thorough cleaning of the pen and washing the sow, especially her sides, belly and legs, just before moving her into the clean pen have proved very successful for preventing round-worm infestation and many minor pig diseases. In case of extremely cold weather and no satisfactory place for the saw to dry, a thorough brushing with a stiff dry brush will be of much value. Every particle of dirt and dust on the sow is likely to carry roundworm eggs or infectious germs.

A new pasture should be provided since hogs have used the same ground. The sow and litter should be hauled to this pasture in clean crates or boxes and not allowed to travel dusty and muddy old hog lots that will expose the pigs to roundworm eggs and germs.

Notes

hog [hɔg] — *свиня; кабан*
pen — *загін (для худоби)*
farrow ['færou] — *порося*
sow ['sau] — *свиня*
boar [bɔ:] — *кабан*
litter ['lɪtə] — *виводок*

to confine [kən'faɪn] — *обмежувати*
chaffy ['tʃɑ:fɪ] — *пустий, непотрібний*
to haul [hɔ:l] — *тягти*

Text 12. Care of Sow and Pigs

Age to Wean Pigs

Producers differ in opinion on the age at which pigs should be weaned. Pigs are weaned at all ages ranging from 5 to 12 weeks. If two litters are to be raised each year, the pigs should be weaned at about 8 weeks of age in order to rebreed the sow for the following litter.

The sows should be removed from the pigs at weaning time rather than removing the pigs from their familiar feeding grounds. Unless self-fed, increase the feed for the pigs, but do not let slop or milk accumulate in troughs and sour or become moldy.

Udder troubles may develop if the sows are over-fed at weaning time. It is a good practice to reduce the sow's feed a few days prior to the weaning date. If sows and litters are self-fed, build a creep around the feeders 2 or 3 days before weaning time to keep the sows away.

Trouble often results if the breeder attempts to wean a few of the pigs at a time, because the milk flow continues and some parts of the udders are not used. If the udders become caked and hard, the sow can be put with the pigs for a few minutes in order to prevent severe injury. This will not be necessary more than once or twice because the udder will then dry up satisfactorily.

Water

Hogs will not thrive without sufficient water, and gains are more costly when it is not supplied abundantly. Clean drinking water, which is not contaminated by surface drainage, is important in the prevention of disease and parasites. Selfwatering devices that furnish a continuous supply have proved satisfactory. If troughs are used, they should be constructed so as to keep the pigs from lying in them.

Good Pasture

Good pasture should be a part of every summer ration. Alfalfa, clover, rape, sweetclover, bluegrass, and many other crops are recommended for hog pastures. Any of these are excellent during the period when they are producing an abundant supply of fresh, succu-

lent forage. A good swine pasture is any combination so handled that it supplies fresh, growing feed from early spring until late fall, and one that does not fail in dry hot weather. It furnishes only a maintenance ration for young pigs and should be supplemented with grain to provide for gains.

Pasture

A good pasture has the following effect:

1) It lessens the amount of high-priced protein feed needed in the grain ration.
2) It increases health and vigour of the swine.
3) When properly rotated, it aids in sanitation and roundworm prevention.
4) It helps to maintain soil fertility.

Protein Requirements

The feeds commonly used for swine may be roughly divided into two classes: fattening feeds, such as corn, barley and rye that are rich in carbohydrates or fattening nutriment, but which do not carry a sufficient proportion of protein to meet swine needs; and growing feeds, rich in protein. Adding suitable protein feed to the fattening feeds reduces the amount of feed required per unit of gain and improves the thrift and vigour of the animals.

Sanitation

Sanitation in hog production requires the adoption of methods that prevent disease and conserve health. It is really a part of herd maintenance and must be combined with the necessary veterinary service to ensure the health and thriftiness of the herd.

Hogs are frequently forced to live in small, crowded, filthy quarters which are contaminated with disease-producing organisms. It is much more economical to prevent disease by sanitation, rotation of ground, and use of portable equipment than to attempt to maintain health under such conditions.

The buildings and exercise lots should be located on a clean, dry slope if possible rather than on poorly-drained ground. Old straw sheds may be infested with lice and disease germs. Lots surrounding the buildings should be ploughed often and the manure, corn-cobs and litter burned or removed.

Muddy hog wallows are unnecessary and should not be maintained except as an emergency in extremely hot weather. They are a source of infection. A cement wallow, fitted with a drain to allow cleaning may be practical. Hogs can withstand considerable heat if

they have a wallow and it will reduce the amount of shade that is otherwise needed.

Sunlight and drying kill many disease germs. The doors and windows should be sufficient in number and located so that the sun will shine directly over as much of the floor as possible at some time during the day. The use of pastures is another means of getting pigs to drop their worm eggs where the sun and heat will kill many of them.

Location

The buildings and equipment should be located on ground having good natural drainage. A building on a southern slope with a natural windbreak behind it and a sunny exposure throughout the day is most satisfactory. The hog lots should be as near pasture as possible. All of the equipment should be far enough from the house so that odours will not reach the house.

Notes

sow ['sau] — *свиня*
litter ['lɪtə] — *виводок*
sour ['sauə] — *кислий*
udder ['ʌdə] — *вим'я*
moldy ['mouldɪ] — *застарілий, непридатний*
to thrive ['θraɪv] **(throve, thriven)** — *досягати успіхів*
succulent ['sʌkjulənt] — *соковитий*
forage ['fɔrɪdʒ] — *фураж, корм*

Text 13. Animal Diseases (I)

Most livestock diseases can be prevented by good management: right feeding, proper shelter, cleanliness of stables, good pastures, suitable houses, and general equipment.

Faulty nutrition is one of the important causes of losses in farm animals.

Nutritional Diseases. Farm animals are subject to a number of nutritional deficiencies which cut down production, and may even reduce the animal's resistance to infections. Actual starvation may result from too small a ration, or the lack of certain mineral elements and vitamins in the feed, or from the poor quality of the protein. The protein ration varies accordingly to the kind of animal, its sex, and its function: young growing animals, pregnant and lactating females, and laying hens, require a higher percentage than the others. In

poultry feeding and in swine feeding the kind of protein used is especially important. For best results with these animals, proteins from several sources should be fed, and at least part of these protein feeds should be of animal origin, such as skimmilk, whey, buttermilk, tankage, meat scrap, or fish meal.

Brucellosis is the cause of about 85 percent of the abortions in cattle. It may cause premature birth of the calf as well as sterility, lowered milk production, and udder trouble in the cow. Susceptible animals contract the disease from contaminated food, or water, or directly from new born calves, fetuses or dicharges of infected animals.

Acetonemia (ketosis) usually occurs shortly before or during the first six to eight weeks after calving. Being affected by acetonemia the cows lower their milk production: this is the chief symptom as well as lack of appetite, nervous manifestation ranging from sluggishness to excitability and rapid loss of condition. Some cows are more likely to be affected than others.

"Big leg" (anasarca or edema) develops either in the front or hind legs and may extend to the shoulder, neck, and rump.

Animals affected with "big leg" lose weight rapidly, eat indifferently, and move about slowly. Occasionally saliva drips from the mouth. Swelling of the affected portion is a result of edema, or dropsy. In the early stages of the disease improvement usually promptly follows an appropriate change in the ration. Mild cases respond in three or four days when the animals are turned on pasture. Favourable results have been reported following the feeding of cod-liver oil, leafy alfalfa or other roughage.

"Blackleg", contrary to popular opinion, is a year-round disease, although the majority of cases occur in summer and in the fall. Blackleg may cause sudden death in animals under two years old, especially while on pasture, whereas older animals have greater resistance. An early symptom is lameness. Swellings which give a crackling sensation when pressed with the fingers, frequently occur in the heavily muscled portions. Death usually occurs within 48 hours after the first symptoms are noted.

Bloat is often responsible for heavy losses in cattle. If cattle are turned into damp, succulent clover or alfalfa, or are allowed to eat unaccustomed large quantities of green legume roughage, the feed may ferment in the rumen, or paunch, and produce so much gas that the animal cannot relieve itself by belching. Bloat may also occur in some animal on dry feed. Death may come within a short time after symptoms develop if the bloat is not relieved.

Notes

stable ['steɪbl] — *стайня*
deficiency [dɪ'fɪʃənsɪ] — *дефіцит*
ration ['ræʃn] — *раціон*
female ['fi:meɪl] — *жінка; жіночої статі*
poultry ['poultrɪ] — *свійська птиця*
whey ['weɪ] — *сироватка*
premature [ˌpremə'tjuə] — *передчасний*
sluggishness ['slʌgɪʃnɪs] — *млявість*
udder ['ʌdə] — *вим'я*
alfalfa [æl'fælfə] — *люцерна*
to crackle ['krækl] — *хрустіти*
clover ['klouvə] — *конюшина*

Text 14. Animal Diseases (II)

Nutritional Diseases

Vitamin deficiencies. Vitamins A and D are most likely to be lacking in livestock. Too little of vitamin D will cause rickets in young animals — calves, foals, pigs, lambs kids and chicks. Rickets may also be caused by too little calcium or phosphorus or by conditions interfering with their proper utilization, some of which are not well understood.

Animals suffering from rickets should be given steamed bonemeal. In order to supply vitamin D, they should be fed suncured roughage such as alfalfa hay, and allowed as much exposure to the sun as possible. Pigs may be fed rations containing 5 to 10 percent of alfalfa meal. These same measures will help to prevent rickets in animals that are kept housed. Calves, growing chicks and laying hens may require, besides minerals, vitamin D supplements. Cod-liver oil is satisfactory for calves. Poultry should be given cod-liver oil or other fish oils during the winter months.

Night blindness and certain reproductive failures in cattle are symptoms of vitamin A deficiency. Total blindness may develop. Another symptom is the swelling of the legs. There may be partial or complete interference with reproduction. Males are rendered unfertile while females either fail to conceive or abort their young.

Calves carried full term may be dead upon arrival or may die soon after birth. Swine also show night blindness and reproductive failure. Pigs may be born with deformities, such as cleft lips and imperfect

development of the mouth. All green forages and leafy, properly cured, bright green hay are good sources of vitamin A.

Vitamin A deficiency may occur when cattle are wintered in poor-quality hay or fattened on old corn, cereal grains or beet by-products with limited amounts of poor hay.

Longworms (dictiocaulos) are responsible for heavy losses in calves. These parasites crawl into the air passages and cause unthriftiness and pneumonia. (Death often results from pneumonia).

There is no satisfactory treatment for these worms. They can be prevented and controlled by keeping calves away from poorly drained pastures and by cleaning and disinfecting barns and lots. Mastitis (garget) is a serious disease among dairy cattle. It may be acute or chronic and cause not only a decline in milk production but destruction of the udder. The disease is spread by contaminated equipment or hands of the milker and by dirty barns and yards. It may follow injuries to the udder and improper milking. Repeated attacks may cause a gradual hardening of one or more quarters. The symptoms are clotted and watery milk, "caked bag", fever, pain, swelling, and change in the shape of the udder.

To prevent this disease many precautions are necessary: (1) keep the barn, stalls and gutters clean; (2) avoid overcrowding the cows and use plenty of bedding; (3) do not milk onto the floor; (4) dry off cows carefully; (5) treat minor wounds of udder and teats promptly; (6) avoid use of teat plugs and tubes; (7) allow no wet hand milking; (8) wash udder with soap and water and dry before milking; (10) wash and dry hands after milking each cow; (11) follow directions carefully when using a milking machine; (12) keep maintenance constant, or make changes gradually.

Poisonous plants may cause sudden and serious losses among the various types of livestock. The deadly nightshade, wild cherry, ground cherry whorled milk weed, white snakeroot, weed and young cocklebburs are the most common offenders. Losses can be prevented by destroying these plants or by keeping animals away from them.

Ringworm is a contagious disease of the skin caused by a fungus. It can be transmitted to other animals and to man either directly or by contaminated ropes, halters, mangers, stalls, etc. The round, scaly, hairless patches that characterize this disease are usually found on the shoulder, brisket, flank, rump, back, or head and neck. Scabs are sometimes formed on the skin. The area first affected becomes normal, but new spots often appear.

Stomach worms may cause serious harm to cattle, especially on poorly drained pastures. Severe infestation in young animals may even result in death. Symptoms of stomach worm infestation are loss

of condition, weakness, rough hair coat, and diarrhea. Preventive measures include (1) using only well-drained pastures, (2) providing drinking water from wells or from rapidly flowing streams and (3) practising sanitation and supplementing poor pasture with extra feed.

Sweet-clover poisoning occasionally causes serious death losses.

Swine

Abortion, infectious (brucellosis) in swine may or may not terminate in abortion. Diseased sows, whether they abort or not, may spread the infection at the time of farrowing, and infected boars may communicate the disease to sows at the time of service. The infectious type of abortion is communicable to cattle, but the cattle type is seldom found in swine.

Brucellosis of swine may be communicated to man.

Therefore do not handle aborted pigs or after-births without gloves.

Anaemia, nutritional (suckling-pig anaemia) is particularly prevalent in pigs that are farrowed in late fall, winter, and early spring and, because of inclement weather or for other reasons, are confined to floored pens without access to soil or vegetation. The disease may appear in young pigs two to seven weeks old.

Cholera is a highly fatal and contagious disease of swine that attacks vital organs. It is often complicated by inflammation of the bowels and pneumonia and ends in death in 3 to 10 days.

Although cholera may occur at any time of the year, it is particularly common in late summer and fall.

Symptoms of cholera in swine include loss of appetite, fever, dropping ears, gummy eyelids, weakness, red or purplish spots on the nose, ears, or abdomen, rough coat, vomiting and diarrhea or constipation. Some animals may die in two or three days after showing symptoms; others may survive a week or longer.

Sheep

Mastitis (caked udder or blue bag) is an infectious and contagious disease of the mammary gland. It may either be acute or chronic. The acute type occurs most often shortly after lambing and runs a rapid and usually a fatal course. The first symptoms are lameness and limping accompanied by loss of appetite. Ewes affected with chronic mastitis have hard lumpy udders.

Overfeeding on grain is a common cause of severe losses in feeder lambs. The losses usually occur either shortly after the lambs have been turned into a stalk field with a large amount of shelled corn scattered over the ground or late in the feeding period when the lambs are on full feed.

If lambs are allowed access to an entire field, many of them may overeat. The stomach becomes gorged with grain and fatal indigestion develops. Restricting the flock to a small area by means of a temporary fence or any other way will reduce losses from overeating to a minimum.

Scab (mange) is one of several serious diseases of sheep caused by parasites. Small mites that cannot be seen with the naked eye cause irritation and crusts or scabs on the skin, loss of wool, and unthriftiness. Sheep scab can be controlled by quarantining and dipping.

Notes

deficiency [dɪ'fɪʃnsɪ] — *відсутність; нестача*
live-stock ['laɪvstɔk] — *худоба*
rickets ['rɪkɪts] — *рахіт*
reproductive [ˌri:prə'dʌktɪv] — *відтворювальний*
cleft — *розщеплений*
to winter — *зимувати; кормити (взимку)*
barn ['bɑ:n] — *комора*
to clot — *зсідатися (про молоко)*
gutter — *водостічна канава*
promptly — *швидко, негайно*
contagious [kən'teɪdʒəs] — *заразний, інфекційний*
fungus ['fʌŋgəs] — *грибок*
halter ['hɔ:ltə] — *недовуздок*
manger ['meɪndʒə] — *ясла*
stall [stɔ:l] — *стійло*
scaly ['skeɪlɪ] — *вкритий лупою, струпом*
flank ['flæŋk] — *бік*
scab [skæb] — *струп; короста*
diarrhea [ˌdaɪə'rɪə] — *пронос*
well — *колодязь*
abortion [ə'bɔ:ʃn] — *аборт*
to terminate ['tə:mɪneɪt] — *завершувати, закінчувати(ся)*
boar [bɔ:] — *кабан*
inclement [ɪn'klemənt] — *суворий*
cholera ['kɔlərə] — *холера*
bowel ['bauəl] — *кишка; нутрощі (мн.)*
gummy ['gʌmɪ] — *липкий; набряклий*
constipation [ˌkɔnstɪ'peɪʃn] — *запор*
gland [glænd] — *залоза*
lamb [læm] — *ягня*
crust [krʌst] — *кірка*

Text 15. Grains and Grain By-Products

This classification includes such feeds as wheat bran, shorts, cowpeas. Of these feeds the most commonly used for calves are bran and shorts or middlings. They are considerably lower in protein than the protein concentrates previously discussed, but also higher in protein than the high carbohydrate concentrates. For this reason they enjoy an intermediate position as regards proteins and carbohydrates or energy value. Being rather bulky in nature they add to the palatability of the concentrated grain ration.

Minerals. To build a sound and healthy skeleton and body, adequate amounts of minerals, especially calcium and phosphorus, are required. A lack of sufficient minerals may be even more disastrous to the calf than a shortage of protein or carbohydrates. Should a mineral-deficient ration continue over long periods, skeleton development is abnormal, resulting in serious deformities. The calf's bones are unable to stand the increasing weight and may bend, become unsound in the joints and in some cases may even break. There is also a tendency for the calf to become unthrifty, listless, and to use his feed very inefficiently.

Vitamins. Luckily the cattle feeder is relatively free of vitamin troubles in his feeding operations with calves. Vitamin C is not needed by the calf, and vitamins A and B are quite likely to be present in the good grain mixture containing any grains. Vitamin D and to some extent vitamin A are found in limited amounts in good green leafy alfalfa hays and in the pasture grasses. Most milk contains some vitamin A and to a lesser extent vitamin D. If the calves show a tendency toward respiratory troubles, lack of thriftiness, and crooked legs with big joints when fed rations high in mineral, this is evidence of a lack of vitamin A and D. The condition can be corrected by feeding cod-liver oil which is rich in both vitamins. Cod-liver oil fed at the rate of one tablespoonful daily should prove ample.

Salt. Common salt is required by animals and should be provided either in the feed mixture or be available to the calf as such whenever he desires it. The latter way is a good practice, and for calves fine salt is better than block salt. A calf from birth until a year of age will require a little less than 28, 34 gr of salt per day.

Water. Too often the calf is made to get all his drink from milk. Even the small calf from two or three weeks on should have access to good clean water at frequent intervals. This is especially true in the summer. The water in winter should not be near freezing as is too

often the case. Ice water chills the calf and stops digestion until that water is warmed by the body heat. If the calf is to be kept thrifty, the water should also be clean.

Notes

bran [bræn] — *висівки*
middlings ['mɪdlɪŋz] — *другосортний товар*
palatable ['pælətəbl] — *смачний*
disastrous [dɪ'zɑ:strəs] — *згубний*
deformity [dɪ'fɔ:mɪtɪ] — *потворність*
unthrifty [ʌn'θrɪftɪ] — *неощадливий*
listless ['lɪstlɪs] — *млявий*
chill [tʃɪl] — *простуда*

Text 16. Parasites and Diseases of Hogs

1. Lice or mange usually appear first on young pigs a little while before weaning time. The pigs will begin to rub or scratch and an examination will usually reveal one or both of these parasites. The louse is an external parasite which lives by sucking the blood or lymph from the hog. They can be seen crawling over the hog's body, especially on the flanks, and back of the ears. Numerous eggs may also be seen, as they are attached to the hair very close to the body. Because the louse is a sucking insect, a contact insecticide is needed rather than a stomach poison. One of the most widespread and economical means of control is the use of crude oil or used crankcase oil diluted somewhat with kerosene. The problem is to get the pig completely covered. Crowd the hogs into a small pen in a corner then, pour the oil over their backs, using either a sprinkling can or an old broom. The excited pigs will jump upon each other until the oil has entirely covered them. Freshly oiled pigs are very susceptible to overheating and sunburn and should not be driven far in hot weather or placed on pasture without plenty of shade. Nowadays D.D.T. is widely used in controlling lice or mange on pigs.

2. Mange is a contagious under-skin disease causing severe itching. The condition spreads rapidly as the reproduction cycle for the mites is only about 12 to 14 days. The itching causes the hogs to rub and scratch which spreads the mite and infects hogs running together. The skin becomes rough and thick and reduces the value of the hog carcass. The greatest loss however, is due to the slower

rate of gain. Oil treatment applied in cases of lice has some value for mild cases, but when the mange is wide spread in the herd, it is most satisfactory to dip the infected animals. Probably the most common and effective dip is liquid lime-sulphur, the same as is used by orchards men.

3. Roundworms. The most widespread and detrimental swine parasite is the *Ascaris suis*, more commonly known as the roundworm. It is a large worm about the thickness of a lead pencil, usually found in the small intestine, although they often do much damage in the lungs, before reaching the small intestine the second time.

Notes

louse ['laus] (pl. lice) — *воша*
mange ['meɪndʒ] — *сверблячка, чесотка*
to scratch [skrætʃ] — *чухати(ся)*
lymph [lɪmf] — *лімфа*
flank [flæŋk] — *бік*
contagious [kən'teɪdʒəs] — *заразний, інфекційний*
itching ['ɪtʃɪŋ] — *сверблячка*
carcass ['kɑ:kəs] — *туша*
detrimental [ˌdetrɪ'mentl] — *шкідливий, збитковий*

Text 17. Wheat

Most widely used selected varieties of **winter wheat** (Ukrainka, Stavropolska, etc.) surpass the best American varieties.

The largest winter wheat producing areas are the southern regions of Ukraine, where the winters are mild. At one time these regions constituted 70 percent of the total wheat producing area. Nowadays the cultivation of winter wheat is spreading to the North.

Factors which will almost double wheat yields in our country are as follows: 1. The fertility of the soil. 2. The rotation of crops. 3. Barnyard manures. 4. Chemical fertilizers. 5. Early ploughing. 6. The time of sowing. 7. Plump and heavy grains for seed. 8. Proper rate of seeding. 9. Prolific and adaptable strains. 10. Combating of diseases and insects.

Early ploughing is an important factor in securing more wheat per hectare. Wheat yields greatly depend on the time of seeding in a given region or district. An early prepared soil conserves the soil moisture much better than a soil that is prepared late. The grain and

straw yield is almost in direct proportion to the amount of available moisture present at seeding time. A few suggestions may be made: 1) As throughout the wheat belt the amount of moisture at seeding time is often very limited the soil should be prepared in such a way that a maximum of the rainfall may be conserved. 2) Any seed bed containing a fair amount of available moisture will produce such a stand of wheat that the dangers from winter killing are minimized. 3) Later sowing may be employed when plenty of soil moisture is present, and thereby the Hessian fly may be almost wholly, if not entirely, avoided. Wheat demands a mellow, well prepared, compact seed bed. Thoroughly disking the soil before ploughing insures a uniform, mellow seed bed and is recommended as good farm practice. Late ploughing should not exceed under ordinary conditions 18—20 cm. The soil for wheat should be thoroughly disked to insure a uniform mellow seed bed.

The rate of seeding wheat is a very complicated problem. One must take into consideration climate and soil conditions, the tilling of the soil, the time of seeding wheat, the quality of seed, the method of seeding, etc.

About 4 million of winter wheat seed are to be sown per hectare in arid steppe-land region, 5 million in black soil regions and 6 million in other regions.

Barnyard manures aid in increasing wheat yields. Black soil should be manured at the rate of 18—20 ton per hectare, the soil of the northern regions at the rate of 30—35 ton per hectare. Fertilizers should be applied as well.

Combating the enemies of wheat is a large and important factor in its production. There are two classes of enemies of wheat, fungi and insects. Of the fungous diseases there are three that are important, namely, the loose smut, the stinking smut and the rust.

Notes

to surpass [sə:ˈpɑ:s] — *перевершувати*
manure [məˈnjuə] — *гній, добриво*
plump [plʌmp] — *повний*
prolific [prəˈlɪfɪk] — *родючий*
thereby [ˈðɛəˈbaɪ] — *таким чином; за допомогою*
fly — *муха*
mellow [ˈmelou] — *стиглий*
to till — *обробляти землю*
smut [smʌt] — *сажа; бруд*

Text 18. The Cotton Plant

Oats

1. Seed selection. One of the essential things in increasing yield is the selection of good seed.

2. Fertilizers and manures. The use of fertilizers and manures with cotton has become a well-established custom. Cotton draws heavily on the land for nitrogen, potash and phosphorus; and in applying fertilizers regard for its needs must be considered. Experiment has shown that it gives excellent returns, on as much as 453 kg of high grade fertilizer per hectare. Besides, the effect of the fertilizer on the following crop is almost as noticeable as it is on the cotton. Barnyard manure should be applied to cotton when possible, the water holding capacity of the soil being improved in this way. The plant food in the manure also helps to improve the crop, though this is perhaps the smallest return from farm manure on cotton.

3. Enemies of cotton. Cotton enemies are divided into two general classes — fungous diseases and insect enemies. Bacteria may play some part, but certainly very little. The bacterial blight, while in almost every field of cotton, causes very little damage in most cases.

We can only mention here the enemies of cotton by name: the fungous diseases are cotton wilt, cotton rust, root rot, cotton leaf blight, and some others.

The insect enemies are the cotton caterpillar, cotton red spider, cutworm and nematodes.

The best way to control most of these pests is by selection of seed free from disease and insect enemies, and by crop rotation.

4. Harvesting cotton. If cotton is left in the field during stormy, rainy weather, the quality will deteriorate. If the cotton is left exposed to the weather for any length of time after it is picked, it will lose its brilliant silky colour, and be reduced in grade. Cotton should be harvested as quickly as possible after the bolls are well opened. This will insure a clean crop. For the best effect it should be stored a few days before it is ginned.

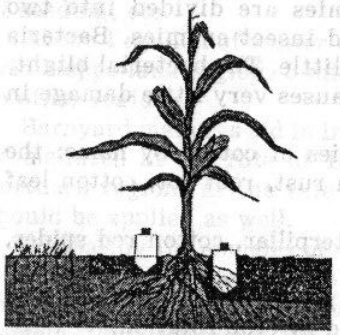
5. Use of cotton. Cotton fiber is not only used for making fabrics: it has many uses in addition to this. Being almost pure cellulose it is easily converted into nitro-cellulose compounds. It is also dissolved and spun into artificial silk, made into viscose celluloid and artificial India rubber.

The seed now furnishes large quantities of oil that is made into olive oil, butterine, cottolene (lard), salad oils, oleomargarine and various compounds. The meal is a highly concentrated feed for animals. It is one of the richest of the protein feeds. The meal is also used in fertilizers as a source of nitrogen. The hulls are now used mostly as feed for cattle and sheep.

Notes

manure [mə'njuə] — *гній, добриво*
blight ['blaɪt] — *тля*
caterpillar ['kætəpɪlə] — *гусениця*
spider ['spaɪdə] — *павук*
nitrogen ['naɪtrɪdʒən] — *азот*
hull [hʌl] — *шкарлупа*

Text 19. Vegetable Gardening



The right and the wrong way of cultivating corn

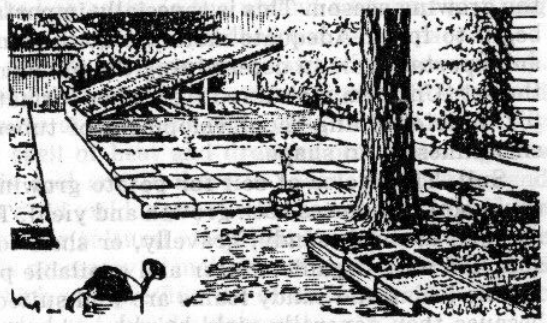
It may be stated in general terms that vegetables contain about 75 to 90 percent water, 5 to 15 percent carbohydrates, 1 to 2 percent protein, 0.7 to 1.0 percent ash, and a small amount of fats.

That the mineral elements in vegetables are extraordinarily wholesome, no one questions. Their liberal use in the dietary will result in better health and longer life. Vegetables add bulk to the food, vary the diet and are most satisfactory as a summer food because they are not as high in calorific value as the more solid foods.

Saving space in the garden. Space and time are saved by the use of "companion crops", "succession crops" and "marker crops". When two crops are growing on the same soil at the same time they are known as companion crops. Lettuce and beets may be growing side by side. These are "companion crops". A "succession crop" follows another crop. A "marker crop" is used to show the location of seeds planted, which germinate slowly. Thus, radish seeds and other quick germinating seeds may be planted in the same row with beets, parsnip, and onion seeds to mark the spot where these slowly germinating seeds were planted.

Some garden suggestions:

1. Do not make small beds or patches in the garden.
2. Never make paths in the garden, for they act as the best conductors for the escape of soil water.
3. Do not plant tall growing plants by small growing ones.
4. Never till the soil when it is too wet.
5. Make the rows as long as possible.
6. Plant seeds in rows just far enough apart so that they can be cultivated most easily, either by hand or with a cultivator.
7. Place the permanent plants near the edge of the garden.
8. Cultivate freely after each rain, when the soil is in good condition.



A hotbed and cold frames

Notes

wholesome ['houlsəm] — *здоровий, корисний*
to germinate ['dʒə:mɪneɪt] — *проростати*
parsnip ['pɑ:snɪp] — *пастернак*
apart [ə'pɑ:t] — *на віддалі*
edge ['edʒ] — *край*

Text 20. Potato Growing

The potato is a cool-climate plant, and a moderate temperature is necessary for its best growth. Therefore, early-spring planting usually assures that the crop will be well established before the period of high temperatures. The potato grows best in regions where the mean summer temperatures are relatively low, generally not exceeding 29° C, and where ample soil moisture is available during the growing season. Adequate moisture is especially important from the time tubers begin to form until slightly before harvest.

In most years, rainfall in southern regions is sufficient for the production of the early and main crops. In nearly all areas the fall crop would be materially benefited if irrigation water could be applied at critical periods during the growth of the plant. The ideal

condition is a uniformly ample supply of soil moisture throughout the growing season. This is especially important from the time tubers begin to form. Adequate moisture at the time of tuberization plays an important role in determining the number of tubers formed, or of the set. Uniform moisture after tuber formation is an important factor in determining the development of tubers, especially their size, smoothness, and shape.

Soil. The choice of soil for potato growing is very important because soil influences both growth and yield. The best soil for potatoes are well-drained, sandy, gravelly, or shale loams, and loams well — supplied with organic matter and available plant food; well-drained, friable loams and sandy loams are well suited for potato production, because they generally yield brighter skinned and better shaped tubers. Generally speaking the early potato crop is grown in sections where the soils are predominantly loams and light sandy loams, because these types of soils warm up faster than do the heavier types. The heavier soils such as clays and clay loams, are more difficult to prepare and often tend to puddle in periods of high rainfall if worked at the wrong time. Certain soils should be avoided because they lack the necessary physical and chemical qualities or are infested with disease-producing organisms. Soils that are neutral or alkaline or that have produced many scabbed tubers are likely to produce diseased potatoes. Heavy, poorly drained clay and clay loam having tight subsoil and poor tilth are also likely to produce small crops of ill-shaped, poor quality tubers. Premature ripening of vines and consequent reduction in yield occur also on deep sandy soils that tend to blow, are subject to leaching, or possess low water-holding capacity. An ideal potato soil must be high in fertility, friable, deep, and with an acid to slightly-acid reaction. Soil type definitely influences the shape of the tuber, light, well-aerated soils producing better shaped tubers than heavy soils. Sandy soils are excellent for early potatoes, but in dry seasons the crop may suffer for lack of moisture. Heavy clays fail to produce tubers of good quality or shape — sandy loams and medium loams are the most satisfactory upland soils. Peat and muck are excellent potato soils when they have adequate surface and subsoil drainage. Because of their high percentage of organic matter, and lower temperature they yield more heavily than mineral or upland soils, when properly managed.

Time of Planting. The time of planting depends upon the prevailing climatic conditions. Experiments conducted by many agricultural experiment stations on time of planting show definitely that the largest yields are secured when planting is early. Potatoes should be planted

in our upland soil before it is safe to plant corn. Peat and muck soils as a rule cannot be worked as early as the upland soils and planting may have to be delayed until a proper seedbed can be prepared.

The critical period in the life of the potato occurs when it is developing its tubers, and it is very essential that the climatic conditions should be as favourable as possible at this time. The yield is very materially lessened if a protracted spell of heat and drought occurs during this period. If the weather is cool and if there is adequate moisture and proper disease control, a good yield is practically assured, provided the plants have been given proper cultural attention. In sections where the season is longer than it is necessary to mature a crop, the problem is to select a planting date which will provide the most favourable climatic conditions during the period of tuber development.

Depth of Planting. Since the tuber-producing stolons are formed above the seed pieces, it is important that seed pieces be planted deep enough to permit the development of a good set of tubers. The early crop should not be planted as deep as the main one. A depth of less than 10 cm on light soils is sufficient for the early crop and 6 cm for the main crop on heavy soils. The planting should be shallower in heavy than in light soils. Shallow planting in seasons of dry weather will result in small tubers. On the other hand, in more favourable seasons the tubers in shallow hills will push out of the soil and become sunburned.

Spacing and Rate of Planting. The distance between plants and between rows varies considerably as to the varieties. The spacing within the row and the distance between rows are determined in some localities by the natural fertility of the soil, its moisture-holding capacity and the supply of available plant food that is to be applied to the crop.

The quantity of seed to plant per hectare depends not only on the spacing but also on the size of the seed pieces. The spacing between tubers is usually 20—30 cm and the distance between rows may be 70 cm. When rows are less than 30 cm apart the use of a cultivator becomes difficult. Spacing in the row and the distance between rows should be such as to obtain a maximum yield of potatoes and at the same time permit tractor cultivation.

Cultivation. Cultivation practice will vary according to the type of soil and the district in which the potatoes are grown. The control of weeds is the principal benefit derived from cultivation, besides the objectives in cultivation are to aerate the soil, encourage root growth and supply soil covering for the developing tubers. In general, but two systems, level and ridge cultivation, are practised in

the regions producing late potatoes. In the level system the weeder or smoothing harrow is usually used once or twice before the plants emerge. The teeth are angled back so as not to disturb the sprouted seed piece. Deep cultivation close to the rows follows as soon as the plants are high enough to distinguish the rows. In the ridge method, riding or walking cultivators are used to loosen the soil and to destroy weeds between the rows. Horse hoes with disks or wings are used after each cultivation to throw up earth and smother weeds along the row. With motorized equipment, cultivation and hilling are done in one operation. In the early cultivation the sprouting seed or young plants are buried once or twice to smother young weeds near the plants and protect the young potato plants from late frosts. The first cultivation should be deep and close to the plants. The soil between the rows should be stirred and every effort should be made to keep it loose.

Harvesting. The date of digging potatoes should be influenced largely by the condition of the crop. The tops should be dead and the tubers should be thoroughly hardened so that the skin will not peel easily or bruise. Potatoes can be dug when vines are still green, but maximum size of tubers is secured only if the vines are allowed to grow until the tops are dead. Potatoes should be picked up within a few minutes after digging and placed in the shade when they are dug during hot weather. Potatoes exposed to bright sunshine will rot quickly in storage.

The harvesting season for most late crops of the North begins in September and extends into late October. The crop is harvested with the elevator type of digger hauled either by a pair of horses or by a tractor.

Prevention of Mechanical Injuries. In general, more attention needs to be given to the prevention of mechanical injuries at the time of harvest. Skinned, bruised, or cut tubers will shrink more rapidly than sound ones. Also, disease-producing organisms may enter injured potatoes and cause decay. Allowing potatoes to mature before digging will help to prevent mechanical injury.

Notes

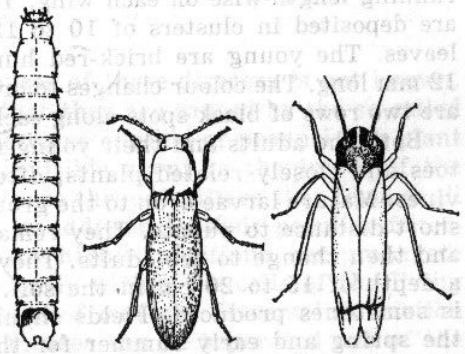
mean [mi:n] — *середній*
ample ['æmpl] — *достатній*
gravel ['grævl] — *гравій*
hale ['ʃeɪl] — *глинистий сланець*
loam ['loum] — *грунт (родючий)*
friable ['fraɪəbl] — *крихкий, рихлий*

to puddle ['pʌdl] — *трамбувати*
peat [pi:t] — *торф*
muck [mʌk] — *гній*
protracted [prə'træktɪd] — *тривалий, довгий*
drought ['draut] — *посуха*
shallow ['ʃælou] — *неглибокий*
objective [ɔb'dʒektɪv] — *мета*
to aerate ['eɪəreɪt] — *провітрювати*
ridge ['rɪdʒ] — *гребінь гори*
harrow ['hærou] — *борона*
to sprout ['spraut] — *пускати пагони; рости*
hoe ['hou] — *сапа́; мотúга*
to hill [hɪl] — *окучувати*
bruise [bru:z] — *синець*
vine ['vaɪn] — *повзуча рослина*
shrink [ʃrɪŋk] — *пересихати*
to cause [kɔ:z] — *спричиняти, викликати*
decay [dɪ'keɪ] — *розпад; гниття*

Text 21. Insect Enemies of Potatoes

There are many insects which are extremely destructive to potatoes; wire-worms, potato tuber moth, eastern potato leafhopper, eastern potato flea beetle, tuber flea beetle and the true potato aphids, white grubs and seed corn maggot are occasionally troublesome in some districts.

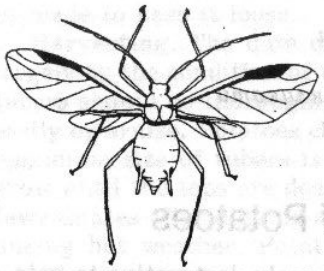
Wireworms. Wireworms are the most destructive insect pests of potatoes. These hard, shiny, yellow worms bore into the potato tubers and into seed pieces. The adults are slender, brown or black, hard-shelled beetles known as click beetles. They are present in the adult stage for but a short time in the spring during the mating and egg-laying period.



Wireworm lavra **Wireworm adult** **Inter-mountain leafhopper**

Almost their entire life of several years is spent beneath the surface of the soil.

Intermountain Potato Leafhoppers. Adult intermountain potato leafhoppers are slender, wedge-shaped, pale green insects about 3 cm long. In the adult stage they apparently pass the winter in grass and weeds, at the margins of fields and elsewhere. They emerge in the spring and begin laying eggs in the tissues of their favourite host plants. The eggs hatch in about a week to 10 days, and the nymphs, which are smaller than the adults and wingless, feed upon the leaves of the host plant. Their feeding causes a speckled, white-stippled appearance of the leaves, especially the lower ones. These insects do not cause severe damage to potatoes and are not responsible for early maturity of potato vines.



Aphid

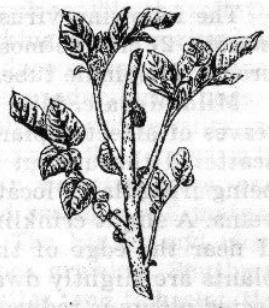
Aphids. The true potato aphid is very destructive to potatoes in some regions.

Other aphids occur on potatoes but rarely cause damage. Leaves which are heavily infested curl, turn yellow or brown and die. Aphids are small, green or greenish-yellow, softbodied insects which feed in clusters, chiefly on the undersides of leaves. The winged forms migrate to potatoes from other plants or adjacent fields.

Colorado Potato Beetles. Adults of the Colorado potato beetles are plump, yellow and black striped insects. There are five black lines running length-wise on each wing. The eggs are orange-yellow and are deposited in clusters of 10 to 12 on the undersides of potato leaves. The young are brick-red hump backed larvae about 10—12 mm long. The colour changes to orange as the larvae grow. There are two rows of black spots along each side of the body.

Both the adults and their young feed upon the foliage of potatoes and closely related plants, often completely defoliating the vines. Mature larvae drop to the ground and burrow into the soil a short distance to pupate. They remain in this stage 5 to 10 days and then change to the adults. They pass the winter as adults at a depth of 15 to 20 cm in the soil. A partial second generation is sometimes produced. Fields should be watched closely during the spring and early summer for the presence of the beetles on the young plants. If only a few beetles are found they may be destroyed by hand with little effort and thus many later infestations prevented. Such procedure might easily delay for some time the need for expensive spraying or dusting machinery.

Dusting potato plants with calcium arsenate is effective in controlling the potato beetle. Calcium arsenate dust applied with a hand duster is especially recommended for use in home gardens and in large fields where the insects are found in only a few scattered places. Calcium arsenate dust is diluted at the rate of 1 part to 3 parts of inert carrier such as talc, diatomaceous earth, hydrated lime or low-grade flour.



Section of potato plant showing Colorado potato beetle at work

Notes

moth [mɔθ] — *метелик*
flea [fli:] — *блоха*
beetle ['bi:tl] — *жук*
grub [grʌb] — *личинка*
to bore [bɔ:] — *бурити*
click — *клацання*
wedge [wedʒ] — *клин*
wingless ['wiŋlɪs] — *безкрилий*
speckle ['spekl] — *п'ятно*
larvae ['lɑ:vi:] — *личинки*
burrow ['bʌrou] — *нора*

Text 22. Diseases of Potatoes

Potato diseases can be divided into three groups based on cause: 1) those produced by viruses, 2) those of a parasitic nature caused by bacteria and fungi, and 3) those produced by adverse environmental conditions.

Virus Diseases

The exact nature of the causes of these diseases is not known. However, evidence indicates that they are caused by the so-called filterable viruses. A filterable virus capable of producing a plant disease is a microscopically invisible agent in the juices of the plant which has the ability to pass through filters that remove all ordinary bacteria and fungi. In addition to their peculiar filterable properties, these viruses are highly infectious, can propagate themselves rapidly and abundantly within the cells of the living plant, but not in any other type of medium. Recent information indicates that a certain few viruses can be separated out of the plant juices in a crystalline form and still retain their infectious nature for an indefinite period.

The following virus diseases of potatoes are recognized: 1) mild mosaic, 2) crinkle mosaic, 3) rugose mosaic, 4) leaf roll, 5) witch's broom, 6) spindle tuber, 7) calico, and 8) giant hill.

Mild Mosaic. Mild mosaic is characterized by a mottling in the leaves of affected plants. Lighter green areas of irregular size are scattered throughout the normal green of the leaves, these areas being irregularly located in the leaf blades and not limited by the veins. A slight crinkling accompanies the mottling. This crinkling, if near the edge of the blades, causes the edges to be wary. The plants are slightly dwarfed. Tests have shown that the yield of infected plants is reduced by about one third in comparison with that of healthy plants.

Crinkle Mosaic. Even for the initiated it is sometimes difficult to distinguish between crinkle and mild mosaic. The symptoms of both troubles blend into each other to such an extent that differentiation is sometimes impossible. It could be said, therefore, that crinkle mosaic is an exaggerated case of mild mosaic — not that they are the same or that they are produced by the same virus. The mottling is more distinct and the lighter coloured areas are more numerous.

Notes

virus ['vaɪərəs] — *вірус*
fungus ['fʌŋgəs] (pl. **fungi** ['fʌŋgaɪ]) — *грибок*
to propagate ['prɔpəgeɪt] — *розмножуватися*
rugose ['ru:gous] — *зморшкуватий*
calico ['kælɪkou] — *коленкор, мітканьль*
dwarf [dwɔ:f] — *низькорослий; карлик*
medium ['mi:djəm] — *засіб, спосіб*
crinkle ['krɪŋkl] — *складка*

Text 23. Growing Peas

Soils and Their Treatment

Desirable Soil Characteristics. Peas succeed on a variety of soils provided they are well drained but not so porous as to lose moisture rapidly. Clay loams are ideal if well supplied with humus and lime, but the maturing of the crop is generally retarded in stiff clays. Light, gravelly soils may give a moderate yield, producing a small vine growth, with an abundance of small pods. However, the crop may mature too quickly. Unless there is a retentive subsoil the plants

are likely to suffer from drought if there is much sand in the soil. On the other hand, sandy soils permit early working in the spring and respond readily to fertilizers. Muck soils produce a growth of vines that is too luxuriant and give a rather limited production of pods.

The land should be uniform in slope, drainage and fertility, so that the whole crop will reach maturity uniformly. Peas growing in sandy or gravelly spots ripen before those in wet clay areas, and peas in the more exposed and better drained sections will mature before those in the low spots in the field. The higher and more sloping gravelly soils are less suitable for pea growing. Southern exposures are seldom selected, because such sites tend to hasten the maturity of the crop.

The pea plant reaches its best development on rich, mellow soils of a non-acid character that are well drained but retentive of moisture. A sandy loam seems best for all early varieties, but a loam or a silty loam gives the best results with the late varieties.

Humus is usually lacking in soils that have been subjected to intensive farming for a number of years. Peas need organic matter. This material should be incorporated in the soil with the preceding crop. Ample dressings of manure or the ploughing under of a sod crop will not only supply plant food but will provide humus, which will keep the soil open and mellow and assist in conserving moisture. Second-growth clover as well as the vetches and rye, is a crop used for this purpose.

Peas need an abundance of moisture and do best in regions where the rainfall is well distributed throughout the growing season. This indicates that soil should be well supplied with moisture and that a good seedbed should be formed, because cultivation, in the ordinary sense of a moisture conserver, is not usually performed. Next to drainage, moisture is one of the important controlling factors in successful pea growing.

Drainage is one of the main points in successful pea culture, for it removes the free water, which would be harmful to the young pea plants if left to stagnate in the surface soil or the subsoil. The removal of the surplus water permits the free circulation of air and serves to dry the land early in the spring, allowing the early working of the soil. Drainage indirectly warms the soil and makes it possible to sow peas at an earlier date. Drainage improves the physical character of the soil and imparts to it the power to hold that moisture needed for the later growth of the pea plant. It stimulates deep penetration of the roots by lowering the water table, making the plants less likely suffer from drought.

Moisture. A proper amount of moisture is an important factor in fruit growing. A loose soil and subsoil are adapted to the growing of some fruits because they permit, the root system to go down and thus be removed from the surface soil, which fluctuates to a greater extent in its water content. A clay soil becomes saturated at the surface so quickly that it is not well adapted to fruit production, for much of the water falling upon it runs off. The first essential is to catch a maximum amount of soil moisture. It is for that reason that a loose soil is preferred. After the water has been caught it must be conserved. This can be done best with the soil mulch. The importance of the proper moisture supply for fruit production can hardly be overemphasized.

Notes

pea [pi:] — *горошина, горох*
porous ['pɔ:rəs] — *пористий*
clay ['kleɪ] — *глина*
to retard [rɪ'tɑ:d] — *затримувати*
stiff — *тугий*
abundance [ə'bʌndəns] — *велика кількість*
pod — *стручок*
retentive [rɪ'tentɪv] — *що зберігає; що затримує*
luxuriant [lʌg'zjuərɪənt] — *буйний (рослинність)*
uniform ['ju:nɪfɔ:m] — *однорідний; рівний*
to tend — *мати тенденцію*
mellow ['melou] — *стиглий*
to incorporate [ɪn'kɔ:pəreɪt] — *об'єднувати*
to stagnate ['stægneɪt] — *застоюватися*
surplus ['sə:pləs] — *надлишок, надмірний*
drainage ['dreɪnɪdʒ] — *дренаж, осушення*
to penetrate ['penɪtreɪt] — *проникати; просочувати(ся)*
moisture ['mɔɪstʃə] — *вогкість, волога*
loose [lu:s] — *вільний; недбалий*
to fluctuate ['flʌktjueɪt] — *вагатися*
to saturate ['sætʃəreɪt] — *насичувати*
to adapt [ə'dæpt] — *пристосовувати(ся), адаптувати(ся)*
to remove [rɪ'mu:v] — *переміщати; знімати, усувати*

Text 24. Fruits and Berries

Strawberries, plums, currants and gooseberries can be grown in all parts of our country. Red and black raspberries, though equally distributed regionally, are capricious in their reaction to soils, water supply and diseases. They may be a success on one piece of ground and a failure on the one adjoining. Grapes are well adapted to central and southern regions and they withstand considerable abuse and still yield some fruit nearly every year. Plums are the most widely adaptable and apples the most popular fruits in the orchard, but only hardy varieties resistant to disease should be planted. They must, along with the rest of the fruit garden, be protected from farm animals and cared for properly after planting, if they are to be successful.

Pollination. Most small fruits are self-fertile, and single varieties may be planted in the garden. In most gardens, however, two or more varieties are desirable to lengthen the season or add variety in flavour. Most varieties of tree fruits are self-sterile and many varieties are inter-sterile. Therefore it is necessary to plant inter-sterile varieties near each other to insure fertilization of the blossoms and a set of fruit. A strong colony of bees set somewhere near the fruit garden during bloom helps to insure pollination. Growers are cautioned not to spray the orchard with lead arsenate or calcium arsenate during the period of full bloom, as these kill the honeybees and other pollinating insects and thus prevent proper pollination. If one must spray the orchard during this period to control apple scab or partially control fire blight, only lime sulphur or bordeaux should be used.

Strawberries. Use only strong, deep-rooted plants from last year's runners for spring planting. Such plants have straw-coloured, rather fleshy roots, in contrast to the black, wiry roots of other plants. Strawberry plants may be dug from the garden patch if the plants are healthy.

Raspberries. Nursery stock is desirable, because patches are nearly always diseased or infested with injurious insects.

Notes

strawberry ['strɔ:bərɪ] — *суниці; полуниці*
currant ['kʌrənt] — *смородина; порічки*
gooseberry ['guzbərɪ] — *агрус*
raspberry ['rɑ:zbərɪ] — *малина*
capricious [kə'prɪʃəs] — *капризний*
adjoining [ə'dʒɔɪnɪŋ] — *що прилягає; сусідній*
to withstand — *ви́стояти, протистояти*
abuse [ə'bju:s] — *образа; зловживання*

to caution ['kɔ:ʃn] — *застерігати*
injurious [ɪn'dʒuərɪəs] — *шкідливий*

Text 25. Grapes for Different Regions

Factors Affecting Varietal Adaptation. The species composition of grape varieties has an important bearing on their adaptation to various sections of the country, because this determines the character of growth of the vine, its hardiness, earliness or lateness of flowering and maturing its fruit, resistance to fungus diseases and insect pests, tolerance to drought, and other inherent properties.

There are a number of other factors, concerned primarily with environmental conditions, that affect varietal adaptation. Among these may be mentioned: 1) the severity of winter temperatures, 2) the length of the period from the last killing frost in the fall, 3) the amount, seasonal distribution, and availability of moisture, 4) the average temperature level of the growing season, 5) the physical and chemical character of the soil, 6) the relative humidity of the air during the growing season, 7) the amount and quality of sunshine, and 8) the latitude, which determines the day length and season as well as the period of winter dormancy.

On some areas the severity of winter cold precludes the growing of any grapes at all, and even in more favoured locations it sharply restricts the types and varieties that can be grown successfully.

The most important other single factor determining varietal adaptation, particularly in the northern parts of the country, appears to be the length of the period free from killing frosts. None of the standard varieties are able to mature a crop in a period less than 90 days free from killing frosts: and in regions having a growing season of 90 to 150 days, only the most hardy varieties thrive. With the exception of those varieties derived largely from southern species, most of the standard varieties succeed best where the frost free period is 150 to 180 days. They may grow and produce crops in regions having longer growing seasons, but there is an increasing tendency, as they are grown farther south, for the berries to mature unevenly in the cluster and for the vine to become gradually weaker and to die while it is still relatively young.

Winter Protection of Grapes. On some areas the harmful effect of drying winter is as great as that of low temperatures. In such cases adequate winter protection may sometimes be obtained by providing suitable windbreaks. Shocks of corn placed to the windward of vines are sometimes used for this purpose.

Where winter protection is necessary, cultural practices that aid in the early maturing of the wood are beneficial. Cultivation should cease early in the season, and the growing of a cover crop may help to mature the canes.

Whatever type of winter protection is to be used, the pruning and training of the vines should be such as to facilitate protection. If the vines are headed low and the canes are attached to a suitable trellis during the growing season, they can be released in the fall, laid along the vineyard row, and the soil thrown over the heads of the vines and the canes by a plough.

Notes

bearing ['beərɪŋ] — *поведінка; відношення*
pest — *шкідник; чума*
fungus ['fʌŋgəs] — *грибок*
tolerance ['tɔlərəns] — *терпимість*
inherent [ɪn'hɪərənt] — *властивий, притаманний*
to preclude [prɪ'klu:d] — *усувати, запобігати*
dormancy ['dɔ:mənsɪ] — *бездіяльність; сплячка*
to restrict [rɪs'trɪkt] — *обмежувати*
cluster ['klʌstə] — *пучок*
to prune ['pru:n] — *підрізати (гілки)*
to facilitate [fə'sɪlɪteɪt] — *полегшувати*
cane ['keɪn] — *комиш, очерет*
trellis ['trelɪs] — *шпалера; решітка*

Text 26. Diseases of the Carrot Seed Crop

Diseases of Carrots in Relation to Diseases of Other Crops

In order to rotate crops to advantage as a disease control measure, the interrelations of the major diseases of carrots and other crops must be understood. So far as is known, bacterial blight of carrots does not affect any other crop plants. Gray mould (Botrytis), which causes a very destructive root rot of carrots, is important also on lettuce, beans, and peas. Sclerotinia, which is sometimes of importance as a root rot of carrots, is the cause of the worst disease of lettuce, and may cause severe damage to celery, cabbage and related crops, beans and peas. Bacterial soft rot affects not only carrots, but also potatoes and beets, and to a lesser extent, other vegetable crops. Botrytis, sclerotinia, and bacterial soft rot are soil-borne. All may be introduced into a field on rotting roots. Sclerotinia may be seed-

borne in beans and possibly in other crops. Sclerotinia and Botrytis are spread also by air-borne spores which may be scattered far and wide by the wind from piles of susceptible, decaying vegetable refuse.

From the standpoint of disease control, small grains, grasses, corn, alfalfa, and sweet clover are the most desirable crops for rotation with carrots. Potatoes and sugar beets are satisfactory, while lettuce, peas, beans, and celery are the most objectionable.

Infected carrots are one of the chief sources of the serious aster yellow disease of the lettuce seed crops. The disease is not soilborne but, because infection spreads to weeds along the head lands and ditch banks, crop rotation is of some importance in its control.

Symptoms of Bacterial Blight. The disease may affect any part of the plant, causing the infected tissues to turn dark brown or black. Bacterial exudate is not always conspicuous, but sometimes is present in great abundance giving affected leaves a glistening and later a glazed appearance. The sticky, yellowish exudate may flow down the stems from umbel and stem lesions, hardening in large drops.

On the leaves sometimes only the tips of a few segments are affected, turning dark brown or black. Sometimes the leaf blight phase is very conspicuous, giving the plants a scorched appearance. Stem and pedicel lesions may be so severe as to cause death of the portion of the plant above the lesion. Some flower umbels may be completely blasted as a result of more or less complete invasion by the bacteria or by girdling of the peduncle below the seed umbel. The root lesions are small brown to maroon, scabby spots, usually with black centers, and sometimes showing a grayish bacterial exudate.

Symptoms of Diseases of the Roots. 1) Black rot caused by *Alternaria radicina*. Black, sunken, corky areas on the root; black spore masses of the fungus may be conspicuous. Sometimes a destructive rot in storage and the most serious root rot of the seed crop.

2) Sclerotinia or watery soft rot caused by *Sclerotinia sclerotiorum*. A soft watery decay caused by a white fungus which produces rather round-edged sclerotia embedded in the mycelium and appearing as dark humps under the fungus mats. Apparently the most commonly destructive rot in storage and sometimes serious in the following seed crop. Especially common when the root crop was planted after beans, peas, or lettuce that had been heavily damaged by the disease.

Diseases of the Roots. The full extent of losses by root rots of carrots is not easily estimated. In addition to some losses in the root crop before harvest, and rather frequent moderate to heavy losses in stand in the seed crop commonly amount 10 to 20 percent of the roots planted and sometimes are so severe that the crop is abandoned. Part of the loss has resulted from shortage of labour at critical times and shortage of suitable storage space. A rather general belief that some loss from rots is unavoidable has led to much greater losses than need occur. Since storage rots have caused grave concern there is a tendency to plant more carrots for stecklings than would seem adequate in order to have "enough". Frequently, flooded corners of fields have been planted to make space for more roots. Rotted roots have been sorted out and those contaminated with rot organisms placed in storage. The extra roots to take care of losses have overtaxed the storage space and so jeopardized the whole lot.

Notes

carrot ['kærət] — *морква*
rot — *гниль; гниття*
bean [bi:n] — *біб; квасоля*
to a great extent [ɪks'tent] — *значною мірою*
susceptible [sə'septəbl] — *вразливий*
standpoint ['stændpɔɪnt] — *точка зору, погляд*
aster ['æstə] — *айстра*
ditch [dɪtʃ] — *рів, канава*
conspicuous [kən'spɪkjuəs] — *помітний, видимий*
lesion ['li:ʒn] — *пошкодження, ушкодження*
scorched ['skɔ:tʃt] — *обпечений; обпалюваний*
to blast [blɑ:st] — *руйнувати*
to girdle ['gə:dl] — *оточувати*
maroon [mə'ru:n] — *каштановий колір*
sunken ['sʌŋkən] — *затоплений; запалий (щоки)*
to embed [ɪm'bed] — *вставляти; впроваджувати*
hump [hʌmp] — *горб, пагорок*
to abandon [ə'bændən] — *залишати; відмовлятися*
to jeopardise ['dʒepədaɪz] — *ризикувати*

Text 27. Alfalfa

Alfalfa is the equal or superior of any other plants as a soil builder. Alfalfa is a legume, and the legumes have the capacity through the bacteria, that cause nodules on the roots to fix the nitrogen from air in the soil. On account of the deep and extensive root system alfalfa leaves much vegetable matter in the soil. This additional organic matter improves the physical and chemical condition of the soil. The deep, penetrating roots secure most of their plant foods from depths where the grasses do not penetrate. This rests the sur-

face soil. Much plant food thus gathered from lower strata is kept near the surface of the soil. The second large advantage of alfalfa production is that it produces more hay per hectare annually than does timothy or clover. Alfalfa is readily eaten as a hay by practically all farm animals and for meat production, for growing animals, and for milk production it has no equal among the hay plants. Alfalfa is drought resistant. It will grow in the arid regions where few other good hay plants will grow. It can therefore be produced upon otherwise waste lands. Alfalfa is grown in order to produce alfalfa hay; and as has already been shown, alfalfa excels the other crops in producing nutrients for the growing animal. Alfalfa is extensively grown on account of the immense amount of protein it produces. Alfalfa produces almost twice as much protein per hectare as red clover does and four times as much as timothy or sugar beets. The high lime and protein content make alfalfa an excellent feed.

Factors Aiding Increased Yields of Alfalfa. The Soil. The kind of soil upon which alfalfa is grown is the first essential to sucessful alfalfa production. Rich bottom loams comprised of soils made of clays, silt and sand are best suited to alfalfa growing. The soil must be fertile, having plenty of humus and some lime-mellow and friable, and in first-class mechanical condition.

Alfalfa is sensitive to an acid or sour soil and will not grow in such a soil until the acidity is corrected by the addition of lime. The subsoil should be loose, pervious, and in a condition to admit the deep penetrating roots of the alfalfa plant. The roots of alfalfa are on an average 120 to 200 cm long and a soil that contains surface hardpan will therefore not admit alfalfa roots. They will not penetrate a hard soil or subsoil. Alfalfa will not grow on wet soil. Deep, well-drained soils are required to secure the best results.

A Good Seed Bed. Seed bed preparation is an important factor in alfalfa production. The seed bed should be mellow but firm, and free from weed seeds. Ploughing and preparing the soil 6 or 8 weeks in advance of seeding, and cultivating it about a week after each rain, prepares the soil by giving the bacteria in the soil a longer chance to make plant foods available, and by destroying weed seeds. If the seed bed does not contain the bacteria which are essential to its growth, then the soil should be inoculated. The soil from the old-alfalfa field should be broadcasted without drying as soon as possible over the field to be inoculated. The work should be done on a cloudy day if possible, and the soil harrowed in immediately after it is scattered.

Cultivating Alfalfa. Cultivation of alfalfa is also an important factor in its production. The life period of alfalfa ranges from three

to six years ordinarily. However under good care in some conditions it has grown for twenty-five or more years. Some varieties are longer-lived than others. Weeds are alfalfa's worst enemy. The disk harrow has been recommended as the best tool to eliminate weeds from alfalfa. The grasses and weeds must be kept out of alfalfa if it is to have a long life. Proper cultivation prevents the necessity of ploughing up alfalfa fields, and therefore reduces its production costs. Barn-yard manure may increase the alfalfa crop.

Notes

alfalfa [æl'fælfə] — *люцерна*
penetrating ['penɪtreɪtɪŋ] — *проникливий, гострий*
depth [depθ] — *глибина*
to rest — *давати спочинок*
stratum ['streɪtəm] **(pl. strata)** — *пласт, шар*
timothy ['tɪməθɪ] — *тимофіївка (кормова трава)*
arid ['ærɪd] — *сухий, посушливий*
to excel [ɪk'sel] — *переважати*
to comprise [kəm'praɪz] — *охоплювати, містити*
pervious ['pə:vɪəs] — *який пропускає (вологу)*
to inoculate [ɪ'nɔkjuleɪt] — *робити щеплення*
harrow ['hærou] — *борона*
manure [mə'njuə] — *гній, добриво*

Text 28. The Clovers

The cereals belong to the grass family of plants. The grasses have fibrous roots, hollow, jointed stems and narrow, long leaves. The legumes of the field and garden have long tap-roots, their stems are not jointed nor hollow, and their leaves are oblong and trifoliate. Corn, oats and wheats as well as most of the cereals, are comparatively rich in starches and fats, and hence are carbonaceous. They yield heat energy. The clovers, alfalfa, soy beans and cowpeas are richer in protein in comparison to the cereals, and are therefore nitrogenous. They yield relatively less heat energy, but more physical energy. The cereals as a feed keep animals warm; the legumes give them physical strength. The cereals have the finest fattening qualities among feeds that come from the vegetable kingdom; while the legumes have the power of producing the greatest amount of growth of bone, muscle and tissue.

The leading legumes of agricultural importance are red clover, white clover, sweet clover, alsike clover, crimson clover, alfalfa, soy beans and cowpeas.

Advantages of Red Clover

Red clover has several advantages: the roots of red clover feed deeper than the grasses and hence tend to rest the surface soil; the deep tap-roots of red clover open up the soil and subsoil, and thereby improve the physical condition of the soil; red clover gathers nitrogen from the soil air and through the bacteria which form nodules on the roots and stores of nitrogen in the soil; red clover fits into a system of crop rotation, and tends to check the enemies of other farm crops; red clover pasture or hay is an excellent feed, being rich in protein and lime. It balances the ration for live stock and the soil as well.

Causes of Red Clover Failures. The following are the main causes of red clover failures. Seeding upon an improperly prepared seed bed is one of the first causes for red clover failures.

White Clover

White clover is the most important pasture legume. It is perennial and grows best in moist, well-drained black loam series of limestone formation. White clover propagates itself by seeds and by its trailing stems. The trailing stems grow roots at each node. These two facts, added to the fact that white clover is a long-lived perennial ensure the plant excellent means for perpetuation. When white clover is seeded in mixtures, from 3 to 6 kg of clover seed are used per hectare. White clover seed is like alsike clover seeds but smaller, and has a pale yellow colour.

White clover should be found in every pasture for three reasons: 1) It is a legume and therefore balances a blue-grass feed. 2) It is a legume, and therefore stores nitrogen in the soil, thus aiding blue-grass in its growth. It grows in midsummer when blue-grass does not do so well.

Sweet Clover

Sweet clover, at one time considered a noxious weed, is rapidly coming into common use for the following advantages that it possesses: 1) It will grow in almost any type of soil. 2) It produces a lot of excellent feed—more than can be produced by some of the other crops. 3) Sweet clover is well liked by sheep, swine, horses and cattle after they become accustomed to it. 4) Sweet clover is a good preparatory crop for alfalfa, for it opens up the soil and if the sweet clover was

inoculated it provides in abundance the bacteria essential for alfalfa production. 5) As an improver of the soil, sweet clover has hardly any equal. Note deep penetrating root characteristics of the sweet clover plant. And also note the abundance of nodules formed by the free nitrogen-gathering bacteria. 6) Sweet clover is a biennial and needs to be resown only every two years. This is an advantage over many other crops that have to be sown or planted annually.

Notes

clover ['klouvə] — *конюшина*
cereals ['sɪərɪəlz] — *хлібні знаки*
fibrous ['faɪbrəs] — *волокнистий*
hollow ['hɔlou] — *пустий, порожній*
oblong ['ɔblɔŋ] — *довгастий*
corn — *кукурудза (амер.)*
oats ['outs] — *овес*
hence [hens] — *отже*
crimson ['krɪmzn] — *малиновий колір*
perennial [pə'renjəl] — *багаторічна рослина*
limestone ['laɪmstoun] — *вапняк*
to trail ['treɪl] — *тягти(ся), звисати*
to perpetuate [pə'petjueɪt] — *увічнювати*
noxious ['nɔkʃəs] — *шкідливий*
biennial [baɪ'enjəl] — *дворічна рослина*

6.
Section. Atomic Energy

Text 1. The Energy of the Atom Serves Peace and Progress

Not a single advance in the history of world science and engineering has given mankind a lever for progress that can be compared with the release of the potential energy of the atomic nucleus or the use of the colossal energy in man-made thermo-nuclear transformation. All the energy used by man and all other life on earth (the energy of fuel, water, wind, life, the brain) owe their origin, in the final analysis, to the spontaneous thermo-nuclear process taking place in the sun, a process of combustion like that in the hydrogen bomb, only more prolonged. Now the time has come when man will no longer have to limit himself to the insignificant portion of the sun's tremendous energy that is conserved on our planet in one form or another, but will be able to create his own sun on earth!

Nuclear power opens up completely new technical and economic potentialities. Specialists have estimated that the amount of energy in the uranium and thorium reserves in the earth's crust is from 10 to 20 times greater than that in all the deposits of coal and oil put together. It is clear, besides, that the resources of these elements have been explored to a lesser degree than the resources of coal and oil. Thus the commercial use of nuclear power, which has already begun, leads mankind out of the inevitable impasse to which the limited resources of carboniferous fuel would have eventually brought it.

The development of nuclear power production in a world where different social systems peacefully coexist will allow the technically

advanced countries to help the others expand power industries and, concomitantly, their economies as a whole.

The atomic industry supplies science and engineering with radioactive elements whose radiations are employed in medicine, hygiene, the food industry, fault detection, automatic control, geological prospecting, and many other fields.

Radioactive tracer atoms have become a necessary and effective instrument in investigations in all spheres of science and technique where various substances have to be detected and their transformations and movements studied. They have found applications in chemistry, physics, metallurgy, the mechanics of gaseous, fluid, and solid bodies and, practically, in biology with its wealth of departments and trends; they have led to new methods of work and to new discoveries. This is the second aspect of atomic-age science and technique, an aspect whose contours have not yet been fully defined. Before our very eyes it is moving faster and faster from the realm of semi-fantasy to the realm of daily life: pulpometers for suction dredges, and neutron corings in oil-fields are commonplace things today.

Notes

lever ['levə] — *важіль, підойма*
nucleus ['nju:kliəs] — *ядро*
nuclear ['nju:kliə] — *ядерний*
spontaneous [spɔn'teɪnjəs] — *добровільний*
combustion [kəm'bʌstʃn] — *згоряння*
hydrogen ['haɪdrɪdʒən] — *водень*
potentiality [pə,tenʃɪ'ælɪtɪ] — *можливість*
to estimate ['estɪmeɪt] — *оцінювати*
uranium [juə'reɪnɪəm] — *уран*
inevitable [ɪn'evɪtəbl] — *неминучий*
impasse [æm'pɑ:s] — *безвихідне становище*
eventually [ɪ'ventjuəlɪ] — *зрештою*
coexist ['kouɪg'zɪst] — *співіснувати*
concomitant [kən'kɔmɪtənt] — *супутний, супровідний*
hygiene ['haɪdʒi:n] — *гігієна*
to detect [dɪ'tekt] — *виявляти*
tracer ['treɪsə] — *дослідник*
contour ['kɔntuə] — *контур*
dredge [dredʒ] — *драга; землечерпалка*

Text 2. Nuclear Physics

Fundamental Particles and Rays

Modern physics has discovered a complicated array of fundamental particles of which all matter is composed. These particles are to a variable extent present in the devices used in modern nuclear technology. Each produces biological effects; each has its own characteristic penetration properties. To these particles we must add electromagnetic radiation, usually called gamma rays or X-rays, the photons, quanta, or units of which can also produce biological effects.

The word "ray" or "radiation" is used to mean a beam of wave type radiation, as in a ray of light or X-ray, and also a stream of particles, as in cathode rays or alpha rays. Often when a ray of any kind strikes an atom or molecule, regardless of whether or not this atom is part of a biological system, it may knock an electron out of the atom. The process of knocking charged fragments out of previously neutral atoms or molecules is called ionization.

It is by measuring the amount of ionization that radiation is most usually detected or identified. The most usual detecting devices are the Geiger counter, proportional counters, and ionization chambers, Wilson cloud chambers, and photographic emulsions. In the Geiger counter, the ionization initiates a discharge for each ionizing event that takes place in the counter. For example, the passage of a particle through the counter, if the particle produces ionization, is such an ionizing event. In the proportional counters and ionization chambers, the ions produced are collected and measured directly. In the Wilson chamber, the condensation of vapor along the tracks of ionizing particles leaves cloud trails, which like the vapor trails of airplanes, can be photographed. In photographic emulsions, ionizing events themselves leave developable tracks, and the actual trail of a particle can be seen. Thus emulsions are like continuously sensitive cloud chambers. Emulsions are small, light, easily transportable, and will accumulate all the radiation they receive until development.

Notes

particle ['pɑ:tɪkl] — *частка; крихта*
array [ə'reɪ] — *порядок; велика кількість*
beam [bi:m] — *промінь*
counter ['kauntə] — *лічильник*
to accumulate [ə'kju:mjuleɪt] — *акумулювати, скупчувати(ся)*

Text 3. Atomic Structure

All elementary forms of matter are composed of very small unit quantities called atoms. The atoms of a given element all have the same size and weight. The atoms of different elements have different sizes and weights. Atoms of the same or different elements unite with each other to form very small unit quantities of compound substances called molecules.

Atoms are composed of a positively charged central core or nucleus, surrounded by a cloud of negatively charged electrons. The charges are equal, so that the atom is electrically neutral. Atoms form chemical elements, as hydrogen, iron, or lead. Two or more atoms sticking together form a molecule. Molecules form chemical compounds.

Nucleus is the central part of the atom, which makes up most of the weight of the atom and is charged with positive electricity. Atomic nuclei are, it is now believed, made up of two kinds of fundamental particles, protons and neutrons.

The total number of particles of both kinds in the nucleus is given by the rough atomic weight. The number of protons is given by the atomic number. The number of neutrons can thus be found by subtracting the atomic number from the atomic weight. For example, in uranium-238, the total number of protons and neutrons is 238. The number of protons alone, given by the atomic number of uranium, is 92. Hence, by subtraction, the number of neutrons is 238—92=146.

Proton is a small particle with a positive electric charge equal numerically to the negative electric charge of the electron, 1.60×10^{-19} coulomb. A single proton makes up the entire nucleus of the ordinary hydrogen atom. The nuclei of atoms of other substances contain a number of protons given by the atomic number of the element.

Neutron is a particle with no electric charge, but with a mass approximately the same as that of the proton, about 1.67×10^{-24} gram. In nature, neutrons are locked up in the nucleus of an atom, but they can be knocked out in various kinds of atom-smashing experiments.

The neutrons, because of their lack of charge, readily penetrate other nuclei. The new nucleus thus formed is sometimes stable, but often unstable. These unstable nuclei decompose spontaneously and may emit protons or neutrons, or clusters of two protons and two neutrons, called alpha particles. They may emit electrons, a process called beta decay; or they may radiate gamma rays, or occasionally several of the above in succession.

Electron is the smallest known particle having a negative electric charge. The part of an atom outside the nucleus is made of electrons,

the number of which, being equal to the protons in the nucleus, is the same as the atomic number of the atoms. An electric current in a wire consists of the motion of electrons through the material of the wire. A current of 1 ampere corresponds to the passage of 6.24 billion billion electrons in one second. In radio tubes and in cathode ray (television) tubes, the current is carried by a stream of electrons. The beta particles emitted by certain radioactive materials are high-speed electrons.

The nucleus contains most of the mass of the atom. The electron weight is only about one two-thousandth part of the total. The number of protons in the nucleus determines what chemical elements the nucleus represents and is called the atomic number of the element, which varies between 1 (hydrogen) and 92 (uranium). The number of protons plus neutrons determines the atomic weight which varies between 1 (hydrogen) and 238 (uranium) for the naturally-occurring elements. Atoms may have the same number of protons and a different number of neutrons, in which case they are atoms of the same element but of different weights. Such differing atoms are called isotopes.

For an atom in its normal state the number of protons in the nucleus is equal to the number of electrons revolving around it, and the atom as a whole displays no electric charge. A few electrons may readily be removed from, or added to, an atom leaving it with surplus of positive or negative charge.

A few examples will make these matters clearer.

1. The **Hydrogen Atom.** In the normal condition the hydrogen atom (Fig. 1) consists of a positive nucleus and 1 planetary electron in orbital motion about this nucleus. Later developments in physics have shown that the electron cannot be accurately considered as if it were in orbital motion about the nucleus. For an elementary discussion, the concept of orbits is helpful. When the electron is by any means torn away from the hydrogen atom, the nucleus alone remains with a single positive charge of electricity on it. It is then a positive hydrogen ion which is the same as a proton. With it is associated almost all the mass of the hydrogen atom. The positive charge on this single proton is just equal to the negative charge on the electron, so that the atom in the normal condition is neutral.

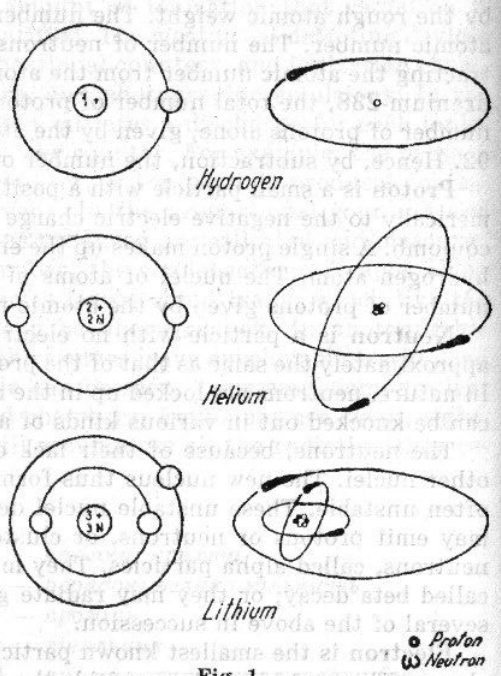


Fig. 1

2. **Helium.** — When we pass from hydrogen, which has an atomic weight, an atomic number, and an atomic charge of unity, we next come to helium with an atomic weight of 4 and an atomic number and nuclear charge of 2. The helium nucleus, with which is associated most of the mass of the helium atom, consists of 2 neutrons and 2 protons. Outside the nucleus are 2 electrons. These electrons are not now considered as point charges revolving as planets about the nucleus but as diffuse rings of electricity occupying the entire orbit. When the atom is in the excited state, the electrons can move in a great number of different orbits. When an electron passes from one of these orbits to another, a characteristic line of the helium spectrum is emitted. If one of the planetary electrons has been detached from the atom, a helium ion is produced (Fig. 1), with a single positive charge on it. The normal helium atom has no affinity for other electrons. For this reason, helium does not unite with other elements. It is one of the inert gases and is monatomic.

3. **Lithium.** — In the lithium, besides the nucleus which has 3 units of positive electricity on it, there are 3 planetary electrons. These electrons, according to the picture of the atom suggested by Bohr, revolve in different planes. The two inner electrons are bound more closely by attractive forces to the nucleus than is the outer electron. When lithium is ionized, it loses 1 electron, and the residue of the atom then has 1 unit of positive electricity on it and is known as a lithium ion. This outer electron determines the valency of lithium. When lithium enters into chemical union, it shares this outer electron with the element with which it combines. Under certain circumstances, a second electron may enter the outer orbit. The lithium atom is then charged negatively and becomes a negative ion. The possible orbits in which these planetary electrons can move are more complex than they are in either hydrogen or helium. The positions and characteristics of these orbits are determined from an analysis of the spectrum that the lithium atom can emit.

4. **Beryllium.** — If an atom of beryllium loses one of its four outer electrons, it becomes a positive ion carrying one charge of positive electricity. When it loses both of the outer electrons, it is a double–

charged positive ion. These outer electrons determine the valency of the beryllium atom, and it shares these 2 electrons with the other atoms with which it unites in forming chemical compounds. A study of the spectrum of beryllium makes it possible to locate the various orbits in which these electrons are capable of moving in agreement with the Bohr theory. The greater the number of planetary electrons, the more complex these orbits become. They are distributed in three dimensions and have such positions and shapes that they account for the observed lines in the spectrum on the basis that light of a definite frequency is emitted whenever an electron passes from one orbit to another.

Atomic Weight. — This term is used to denote the weight of any atom as measured on an arbitrary scale based on the weight of an oxygen atom. It is found that the weights of atoms of the other elements can be expressed very nearly as whole numbers. These whole numbers are called the rough atomic weights. The atomic weight of ordinary hydrogen is 1; that is, a hydrogen atom is roughly one-sixteenth as heavy as an oxygen atom. The atomic weight of heavy hydrogen is 2; helium 4; lithium atoms occur in two varieties, with weights 6 and 7. The figure giving the rough weight of an atom on this scale is also the total number of protons and neutrons contained in the nucleus of the atom.

The precise atomic weights differ somewhat from these whole numbers by approximately one-thousandth of the total weight. This difference, however, is of decisive importance for estimating the energy released on the formation of these atoms in accordance with the mass-energy equivalence relation.

Mass Number. — This is another term for the rough atomic weight; approximately the weight of the nucleus. It tells the total number of protons and neutrons in the nucleus. It should not be confused with atomic number, which gives at once the number of protons in the nucleus and the number of electrons outside the nucleus.

Notes

molecule ['mɔlɪkju:l] — *молекула*
core [kɔ:] — *ядро*
to charge [tʃɑ:dʒ] — *заряджати*
to subtract [səb'trækt] — *віднімати*
to penetrate ['penɪtreɪt] — *пронизувати*
stable ['steɪbl] — *сталий*
to emit [ɪ'mɪt] — *випромінювати, виділяти*
in succession [sək'seʃn] — *послідовно*
ampere ['æmpɛə] — *ампер*

billion ['bɪljən] — *мільярд (амер.); більйон*
tube — *електронна лампа*
stream [stri:m] — *потік*
surplus ['sə:pləs] — *залишок; решта*
concept ['kɔnsəpt] — *поняття*
helium ['hi:ljəm] — *гелій*
planetary ['plænɪtərɪ] — *планетарний; планетний*
to diffuse [dɪ'fju:z] — *розповсюджувати*
affinity [ə'fɪnɪtɪ] — *подібність, спорідненість*
inert [ɪ'nə:t] — *інертний*
residue ['rezɪdju:] — *осад, залишок*
valency ['veɪlənsɪ] — *валентність, атомність*

Text 4. Isotopes

One of the most widely publicized aspects of work on atomic energy is the use of radioisotopes. The nucleus of an atom is built up of protons and neutrons. In all the atoms of a given element, the number of protons in the nucleus is constant; it is called the atomic number and it determines the chemical properties of the atom. With this fixed number of protons there may be associated a varying number of neutrons. This means that all the atoms of any particular element have the same chemical properties, but their masses may differ (because the mass of an atom is equal, approximately, to the sum of the masses of the protons and neutrons in the nucleus). These different forms of the same element are known as isotopes of the element. The isotopes of one element differ from one another in their physical, not their chemical, properties. Some isotopes are stable; the differences between them are solely those arising from the difference in mass, for example, different amounts of bending in a magnetic field, different rates of diffusion, etc. Other isotopes are radioactive, that is their nuclei break down spontaneously and emit particles or electromagnetic waves, or both; radioactive isotopes differ from one another in, for example, the type and energy of the particles they emit, and in their half lives. At least one radioactive isotope is known to exist for all known elements. The two features of radioactive isotopes that give them their technological importance are that they are indistinguishable in their chemical properties from the stable isotopes of the same element, and that they emit radiation which can be detected by various means, such as photographic films, electronic instruments like Geiger-Müller counter, and the scintillations pro-

duced in certain phosphors and organic crystals. In this way they can be detected in the presence of considerably larger quantities of stable atoms of the same element, by methods which ordinarily do not require any interference with the substance in which the atoms are embedded. Stable isotopes, on the other hand, differ from one another only in the masses of their atoms; the presence of a small quantity of one isotope among a large mass of another can be determined by instruments like the mass spectrometer, but the process is somewhat complicated and requires that the specimen should be obtained in a form suitable to the instrument.

Explanation of Isotopes. — Figures 2 and 3 show diagrammatic representations of atoms of lithium and neon. The small dark circle represents the nucleus. The number of protons and the number of neutrons in it are indicated in each case. The small circles represent the electrons that are outside the nucleus. There are two kinds of lithium. In one kind there are 3 protons and 3 neutrons in the nucleus and 3 electrons outside the nucleus. In the other kind of lithium there are 3 protons and 4 neutrons in the nucleus and 3 electrons outside it. In each case the net charge on the nucleus is 3 units of positive electricity and the number of planetary electrons is also three. The external structure of the atoms is identical. The charge on the nucleus is the same, but the mass of the nucleus is in one case six and

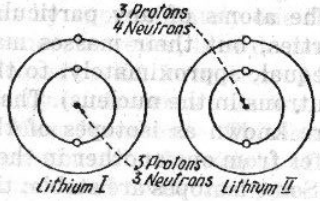


Fig 2. Diagrammatic representation of the isotopes of lithium

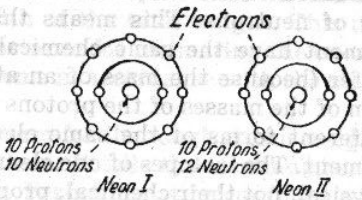


Fig 3. Diagrammatic representation of the isotopes of neon

in the other case seven times that of hydrogen. In the neon atom, there are 10 protons and 10 neutrons in the nucleus in one case, and 10 protons and 12 neutrons in the other case. Each kind of neon has 10 electrons outside of the nucleus. Since the extranuclear electrons determine the chemical and physical properties of the atoms, both kinds of neon are chemically and physically identical. The net charge on the nucleus is the same in both cases. One kind of neon has, however, an atomic weight of 20 and the other an atomic weight of 22. Ordinary neon is a mixture of these two kinds of neon and has therefore an atomic weight between 20 and 22.

Notes

solely ['soullı] — *виняткова*
to bend — *спрямувати*
indistinguishable [ˌındıs'tıŋgwıʃəbl] — *нерозрізненний*
scintillation [ˌsıntı'leıʃn] — *виблискування*
to embed [ım'bed] — *впроваджувати, вставляти*
specimen ['spesımın] — *зразок, взірець*
neon ['ni:ɔn] — *неон*
external [eks'tə:nl] — *зовнішній*
indentical [aı'dentıkl] — *однаковий*
extra ['ekstrə-] — *екстра-, поза-, над-*
net — *чистий*
weight ['weıt] — *вага*

Text 5. Radioactivity

Radioactive Substances. — In 1896, it was found that compounds of uranium emitted rays that gave an impression on a photographic plate covered with black paper. They were able to pass through thin sheets of metal and other substances that are opaque to light. They also possess the important property of discharging a body that is electrified, either positively or negatively. This property of discharging an electrified body is found due to the fact that these rays produce ions in the gas through which they pass.

It was soon found that this property of emitting penetrating radiations is not confined to uranium and its compounds. Thorium and its compounds and minerals containing thorium have the same property. Such substances are said to be radioactive.

By studying radioactive minerals which contained uranium and thorium the Curies found that these minerals often contain a substance which is much more radioactive than either uranium or thorium. This element was finally isolated and called *radium*. It is derived chiefly from pitchblende and in the pure state possesses the property of radioactivity in an astonishing degree. In order to obtain a few decigrams of radium, it is necessary to start with several tons of pitchblende. If the pitchblende were not examined by an electrical method, the radium in it could not be detected.

Nature of the Radiations. — Three different types of radiations are emitted by radioactive substances. These radiations for brevity are called *alpha rays*, *beta rays*, and *gamma rays*.

1. The alpha rays are very easily absorbed by thin metal foil or by a few centimeters of air. They affect a photographic plate, cause

many bodies to fluoresce brilliantly, and ionize the air through which they pass. They consist of positively charged particles projected from the parent atom with a velocity about one-tenth the velocity of light. They are deflected by an electric or a magnetic field.

2. The beta rays consist of negatively charged particles which are projected from the atom of the radioactive substance with a velocity which is nearly, but not quite, as great as the velocity of light. In an electric and magnetic field they are deflected just as cathode rays are deflected. Because of their larger velocities and smaller mass, they are much more penetrating than the alpha particles. They produce much less ionization in the gas through which they pass than do the alpha particles and are less active photographically than alpha particles.

3. The gamma rays are extremely penetrating, and are not deflected by either a magnetic or an electric field. Their nature is entirely different from that of the alpha or beta rays. They are electromagnetic pulses like very penetrating X-rays.

Absorption of Alpha Rays by Matter. — If a layer of radioactive material is deposited on a plate and successive thin sheets of aluminium leaf are placed over this layer, the activity of the alpha rays passing through these sheets is gradually reduced. It is best to work with a pencil of rays which are nearly parallel, so that the length of path travelled by each particle is nearly the same. If such a pencil of rays is allowed to fall on a fluorescent screen, the number of particles falling on the screen can be found by counting the scintillations produced by the impact of these particles against the screen. The decrease in the number of these scintillations as different sheets of aluminium are added gives a measure of the power of the aluminium to absorb these rays. The number of scintillations per second on the screen remains constant until the thickness of the material reaches a certain critical value. When this critical value is reached, the scintillations suddenly cease. As the distance travelled in air is increased, the number of scintillations at first remains the same but decreases rapidly near the end of the range. There is thus for each substance a definite thickness that all the rays can penetrate. This critical thickness is the range of the particles for that substance. This range depends only on the velocity of the rays and the nature of the absorbing substance. The range of these particles from radium *C* is 7.0 cm in air at atmospheric pressure.

If the rays are travelling through a layer of gas, at least part of their energy is used to ionize the gas through which they pass.

Scattering of Alpha Particles. — In the discussion of the absorption of alpha particles by matter, it was assumed that these particles travel in straight lines. In the main, this assumption is true. There

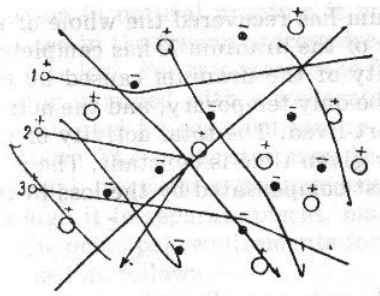


Fig.4. Scattering of alpha particles

is, however, a possibility that a collision between an alpha particle and a molecule may produce a deflection of the former from its original path. By observing the scintillations on a fluorescent screen, Geiger found that in many cases the individual alpha particles were deflected from their original paths before reaching the end of their course. In passing through a thickness of gold equivalent in stopping power to a layer of air 3.68 cm thick, the alpha particles suffered an average deflection of 7 deg. Once in a while a particle was deflected through a much larger angle than this. The smaller the velocity, the greater is the scattering.

Nature and Properties of Beta Rays. — The beta particles are electrons moving with very high velocities. They have a penetrating power which is much larger than that of the alpha particles and will pass through absorbing sheets of matter which are 100 times as thick as that required to stop the alpha particles. The less the velocity with which these particles move, the more easily they are absorbed. The ratio of the charge to the mass of these quantities can be determined by the same methods that were used to obtain this ratio for an electron. This ratio is found to have the same value that it has for an electron.

Nature and Properties of Gamma Rays. — As already pointed out, the gamma rays are entirely different in nature from the alpha and the beta rays. They are electromagnetic disturbances, while the alpha and the beta particles are material particles. The gamma rays do not carry a charge of electricity and are not deflected by either an electric or a magnetic field. They are like the most penetrating type of X-rays. When their intensities are large enough, they produce a luminosity on a fluorescent screen and affect a photographic plate. Their wave lengths have been measured and are found to be less than the wave lengths of the most penetrating X-rays.

Disintegration of Uranium. — Uranium and its salts have been found to give off alpha, beta, and gamma rays. Crookes found that by a single chemical operation it is possible to obtain uranium that is not photographically active. At the end of this chemical operation, there is a small residue to which was given the name of uranium X. This residue is many hundred times as active, weight by weight as uranium itself. When this residue (uranium X) and the uranium from which it was extracted are laid aside in separate vessels for 2 or 3

months, it is found that the uranium has recovered the whole of its original activity, while the activity of the uranium X has completely disappeared. The loss of the activity of the uranium caused by the chemical treatment thus proves to be only temporary, and the activity of the uranium X is equally short-lived. The total activity of the uranium and the uranium X at any given time is constant. The gain in the activity of the uranium is just compensated by the loss in the activity of the uranium X.

Notes

compound [ˈkɔmpaund] — *сполука*
plate — *пластинка, лист*
opaque [ouˈpeɪk] — *непрозорий*
to confine [kənˈfaɪn] — *обмежувати*
radium [ˈreɪdɪəm] — *радій*
to derive [dɪˈraɪv] — *походити*
pitch — *ступінь, рівень*
brevity [ˈbrevɪtɪ] — *стисліcть*
to fluoresce [fluəˈres] — *світити(ся)*
parent [ˈpɛərənt] — *основний*
to deflect [dɪˈflekt] — *відхиляти(ся)*
to project [prəˈdʒekt] — *проектувати*
pulse [ˈpʌls] — *вібрація*
collision [kəˈlɪʒn] — *зіткнення*
deflection [dɪˈflekʃn] — *відхилення*
scintillation [ˌsɪntɪˈleɪʃn] — *виблискування, мерехтіння*
disturbance [dɪsˈtə:bəns] — *перешкода*
intensity [ɪnˈtensɪtɪ] — *інтенсивність*

Text 6. Nuclear Reactors

A nuclear reactor or pile (from the shape of early models) is a device using a fission chain reaction for the production of heat, radiation or radioactive materials. The two principal categories into which they may be divided are: (a) thermal reactors, in which the fission is produced by neutrons of thermal energies, and (b) fast reactors in which the fission chain is supported by neutrons of energies more than 1 Mev. There are intermediate reactors, also, using neutrons with energies of a few hundred electron-volts.

For fission by thermal neutrons, however, the cross section is 3.92 barns, which is quite adequate. It will now be seen that a chain

reaction in natural uranium is practicable only if the fast neutrons released in the fission process are reduced to thermal energies before they are lost. For this reason the fissile material in a natural uranium reactor is mixed with a moderator — a material in which neutrons are retarded by repeated elastic collisions, without appreciable absorption. The moderator may be intimately mixed with the fissile material, forming a homogeneous reactor, or may be distributed through it in separate pieces, making a heterogeneous reactor.

The principal requirements for a nuclear reactor may now be summarized as follows —

(a) a supply of fissile material;
(b) in a thermal reactor, a moderator;
(c) devices for controlling the rate at which the chain reaction proceeds;
(d) arrangements for removing the heat generated by the operation of the reactor;
(e) a shield to contain the radiations emitted by the reactor;
(f) arrangements for removing the radioactive fission products from time to time.

By a bit of simplification, the reactor can be described as an atomic furnace that supplies the heat from which electricity is generated. There are some long rods suspended along the wall. These are called "working" or "technological" tubes. They are graphite cylinders with uranium-loaded tips, and the few dozens are enough of a reserve to keep the plant going for six months or more.

Uranium is a very rich power-producer. How rich may be judged from the following figures: the plant uses 30 grams of uranium in 24 hours where a thermal power plant of the same capacity (5,000 kw) would require as much as 100 tons of coal. And this although the plant utilizes only some 25 percent of the heat released by the fission process.

The reactor is encased in a cylindrical steel jacket resting on a concrete foundation and surrounded by a huge water tank and a thick ring of concrete. The steel jacket is lined with graphite and the central part consists of hexagonal graphite blocks with vertical charging holes into which are inserted uranium-loaded rods. Some 60 of these are needed to start a chain reaction, but it requires 128, with a total of 550 kilograms of uranium, to keep the reactor working at capacity level.

Notes

fission [ˈfɪʃn] — *розщеплення*
to release [rɪˈli:s] — *звільняти; випускати*
fissile [ˈfɪsaɪl] — *що розщеплюється*
moderator [ˈmɔdəreɪtə] — *регулятор*

appreciable [ə'pri:ʃəbl] — *що піддається оцінці; помітний, значний*
absorption [əb'sɔ:pʃn] — *всмоктування*
homogeneous [ˌhɔmə'dʒi:njəs] — *однорідний*
heterogeneous ['hetərɔ'dʒi:nɪəs] — *різнорідний*
to summarize ['sʌməraɪz] — *підсумовувати*
to proceed [prə'si:d] — *продовжувати*
shield [ʃi:ld] — *щит*
furnace ['fə:nɪs] — *піч; топка*
capacity [kə'pæsɪtɪ] — *об'єм*
to encase [ɪn'keɪs] — *упаковувати*
concrete ['kɔnkri:t] — *бетон; бетонний*
tank ['tæŋk] — *резервуар*
hexagonal ['hek'sægənəl] — *шестикутневий*

Text 7. Possible Classes of Reactors

There are three general classes of reactors to be considered are slow, intermediate, and fast, where these adjectives refer to the relative speeds of the neutrons causing fission.

Slow-fission Reactors.— Gleep and Bepo are examples of a slow-fission reactor; the neutrons are slowed to thermal energies by means of a moderator. The nuclear fuel may be natural uranium, uranium enriched in uranium 235 (i. e., containing several times the natural proportion of 0.7 percent uranium 235), or one of the two artificial fuels, plutonium 239 or uranium 233. A natural uranium, graphite-moderated reactor is a big thing; if heavy water were used as moderator the volume of the core could be reduced from five to ten times, and if enriched uranium were used as fuel a still greater reduction would be possible. No reactor of this kind has yet been built that will run at the desired high temperatures.

Intermediate Reactors. — The next class of reactors, called intermediate reactors, lies between slow- and fast-fission reactors in both design and function, since most of the fissions are produced by neutrons slowed down to energies intermediate between the high energies of fission neutrons and the low energies of thermal neutrons; this energy range is also called the resonance range, because the fission cross-sections of the fuel atoms relative to other cross-sections may be usefully higher than in the thermal region owing to resonance effects in the nucleus. Intermediate reactors employ some moderator, which need not be a very light material like carbon, and can be smaller physically than corresponding slow reactors.

Fast-fission Reactors. — The third class is the fast-fission reactor. In this, fission is produced by neutrons whilst they are still moving with the high speeds with which they are born. No moderator is needed. The fuel may be uranium greatly enriched in uranium 235, or plutonium 239 or uranium 233. The heat generated in fission would be removed and transferred to the power system by a coolant flowing past the metal-sheathed fuel elements.

Within each class of reactor, there are several possible variants in the design. For example, a slow-neutron reactor may use natural uranium or enriched uranium as a fuel, graphite or heavy water or perhaps beryl as a moderator, air or helium or water or a liquid metal as a coolant. And after choosing a particular reactor, all the main dimensions must be chosen to give the best compromise for the particular purpose for which the reactor is required, so that a very great number of designs are possible, and the choice of the best ones for detailed study or for construction is difficult.

Notes

graphite ['græfaɪt] — *графіт*
resonance ['rezənəns] — *резонанс*
intermediate [ˌɪntə:'mi:djət] — *проміжний*
whilst ['waɪlst] — *в той час як; поки*
to enrich [ɪn'rɪtʃ] — *збагачувати*
coolant ['ku:lənt] — *охолоджений*
to sheathe [ʃi:ð] — *обшивати металом*

Text 8. Cloud-Chamber Method of Observing Collisions

A number of ingenious methods have been devised for observing atomic collisions. One of the most important of them is the cloud-chamber method, by means of which the tracks of the colliding particles are photographed before and after the collision. If a rapid expansion takes place in a vessel containing saturated water vapor, a fog is formed, provided that there are nuclei about which the water vapor can condense. When swiftly moving electrified particles pass through such a vessel, ions are produced along the tracks of the particles. These ions serve as centers about which the water vapor can condense when a suitable expansion takes place in the chamber. The fog that is thus produced by the expansion is confined to these tracks and serves to locate the path of the moving electrified particle. By photograph-

ing these tracks, the behavior of the particles before and after collision can be studied.

The Positron. — When a strong magnetic field is impressed on a cloud chamber, charged particles moving across the magnetic field are deflected and made to move in circular paths. By observing the tracks made by these particles, it is possible to determine the mass and the charge of the particles responsible for each track. A positron has the same mass as an electron, but it carries a positive charge just equal in magnitude to the negative charge on the electron.

The Neutron. — When an element like beryllium is bombarded by alpha particles, uncharged particles of great penetrating power are emitted. These particles have nearly the mass of a proton, i. e., nearly the mass of the nucleus of the hydrogen atom. They are called neutrons. The name indicates that they are uncharged particles. They may be thought of as the atoms of an element with an atomic number equal to 0 and atomic weight equal to 1. Symbolically they are characterized by $_0n$. Because the particles are without charge, they have very large penetrating power. They move with very large speeds and consequently have great energies. They transfer their momentum and energy to the lighter elements of the compounds through which they pass. If they pass through a compound containing hydrogen, protons are ejected with high velocities and great penetrating power.

In 1932, Urey, found from the study of the spectrum of hydrogen that there is a second form of hydrogen which has nearly double the atomic weight of ordinary hydrogen. It combines with oxygen to form heavy water with a molecular weight of 20 as compared with 18, the molecular weight of ordinary water. This form of heavy hydrogen is present in ordinary hydrogen in the ratio of about 1 part in 5,000. It can be separated from ordinary hydrogen by an elaborate electrolytic process. The nucleus of heavy hydrogen consists of a neutron and a proton, but the nucleus of ordinary hydrogen consists of 1 proton only.

Protons and Neutrons in the Nucleus. — According to the present point of view, the nucleus of an atom is made up entirely of protons and neutrons. There are no electrons as such in the nucleus.

The number of protons determines the atomic number. The sum of the number of protons and neutrons gives the atomic weight. When an alpha particle is ejected by a nucleus, 2 protons and 2 neutrons in close combination escape from the nucleus. When a beta ray is ejected from a radioactive substance, such as radium, probably a neutron is transformed into an electron and a proton. The electron escapes, but the proton remains in the nucleus, leaving the nucleus with one additional positive charge on it.

Notes

ingenious [ɪn'dʒi:njəs] — *винахідливий, дотепний*
to devise [dɪ'vaɪz] — *придумувати, винаходити*
track [træk] — *шлях*
to collide [kə'laɪd] — *зіткнутися*
expansion [ɪks'pænʃn] — *поширення, простір*
saturated ['sætʃəreɪtɪd] — *насичений*
to condense [kən'dens] — *згущати(ся)*
swiftly — *швидко*
vessel ['vesl] — *посуд*
magnitude ['mægnɪtju:d] — *величина; значущість*
beryl ['berɪl] — *берил*
momentum [mou'mentəm] — *сила; рух*
to eject [i:'dʒekt] — *вивергати; викидати*

Text 9. Atomic Power for Aircraft

Basic Principles

The basic principles of an atomic power plant for aircraft propulsion involve the use of the heat developed by an atomic chain reaction and the transformation of this into kinetic energy.

This may be done in several different ways — we could allow it to form steam, and from this derive kinetic energy through a steam engine. Or we could allow it to heat gases to be utilized in a combustion engine, a gas turbine, or a ramjet. It is fairly obvious that a steam engine would be impracticable for use in an airplane, and it appears that a gas turbine or ramjet would be the best methods of utilizing atomic heat for aircraft propulsion.

The actual chain reaction, giving rise to this heat, takes place as a result of the fission of the nuclei of such elements as the U-235 isotope of uranium, or the Pu-239 isotope of plutonium with escaping neutrons. The nuclei then break up because of instability, and give rise to heat as a result. For those who wish to delve deeper into this phenomenon, it can be explained thus:

If all the decomposed particles of the nuclei were put together it would be observed that there had been a decrease in mass in the decomposition process, and this decrease causes radiation and heat.

The Atomic Reactor. — Having established the process by which heat is given off, it now can be seen what is involved in the design of the unit in which the chain reaction takes place — the so-called atomic reactor, or pile.

Factors to Consider. — There are four factors to consider in the design of this reactor:

1. The chain reaction must be maintained; that is, steps must be taken to ensure that the escaping neutron, which we want to cause fission by hitting one of the nuclei, does not escape altogether without doing anything. One method of accomplishing this is by slowing down the neutrons by the use of "moderators" and "reflectors"— these take the form of a case round the pile, and have the effect of reflecting the escaping neutron back into the center of the pile again so that the neutron is bounced about sufficiently to find a nucleus into which to bump.

2. It is necessary to make sure that use can be made of the heat developed. This can be accomplished by ducting the hot air to either a heat transfer tank, or directly to a gas turbine or ramjet.

3. Another problem is protection from radioactivity. This is done by suitable shielding. It is the shortwave gamma rays which are, by far, the most serious, and these can be shielded only by heavy layers of lead at present, though there is little doubt that, with the present rate of scientific advancement, some more suitable, lighter material will be found by the time atomic aircraft become a reality.

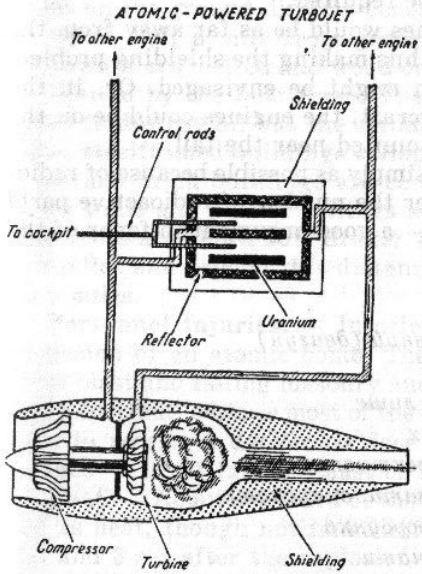
4. The final problem is control. Basically, this can be accomplished by inserting neutron-absorbing rods into the pile. In other words, those rods are inserted to absorb the neutrons instead of allowing them to bounce about breaking up nuclei. So, movable rods are installed into the reactor which, when halfway in, hold the unit in balance, and when gradually taken out increase the power.

What it Will Look Like. — We are now, therefore, in a position to see roughly what our atomic reactor will look like — it probably will be enclosed in a heavily shielded cylindrical body, with inlet and outlet pipes for gas, or liquid (depending upon the propulsive medium being used). In the center of the cylinder there is the uranium or plutonium, and around this a reflector. The whole unit then is controlled by movable rods.

Notes

propulsion [prə'pʌlʃn] — *просування, поштовх*
to utilize ['ju:tɪlaɪz] — *використовувати*
turbine ['tə:baɪn] — *турбіна*
to delve [delv] — *дошукуватися*
to bounce ['bauns] — *підказувати*
duct [dʌkt] — *трубопровід*
to insert [ɪn'sə:t] — *вставляти*
to install [ɪn'stɔ:l] — *встановлювати*
Pu = plutonium

Text 10. Types of Atomic Power Plants



There are three types of atomic power plants suitable for aircraft. They are a closed-cycle propeller-turbine, a turbojet and a ramjet.

If the closed-cycle propeller-turbine is used, the air is compressed at the front of the engine, and bled off from here to the atomic reactor, which then would heat it up tremendously. It would pass through a heat exchanger to vaporize water or mercury, and the steam then would pass through to the turbine, expand, and drive the turbine, which, in turn, would drive the air screw.

The steam then would be condensed in an air-cooled condenser, and fed back to the compressor inlet, thereby completing the cycle. The main disadvantage with this type of system, however, is that forward speeds are restricted by the use of the propeller, and as one can realize almost any desired forward speed without noticeable increase in the use of uranium, we are not, therefore, taking full advantage of the atomic power.

The turbojet engine does take full advantage of atomic power. It merely uses the atomic reactor to replace the present-day combustion chambers. The compressor compresses the air, and forces it through the reactor. The air is heated by convection, and then passing back to the turbine where it expands sufficiently to provide enormous thrust, and also keep the turbine rotating, which, by virtue of an interconnecting shaft, keeps the compressor moving. This type of power plant could give us almost any desired speed.

The ramjet is the simplest engine of the three, in that we mount the reactor right in the engine itself, just aft of the entry duct. The air is compressed by the fast moving aircraft, and then passes directly through the reactor, where it is heated. Coming out of the reactor it passes into the exhaust nozzle where it expands and gives tremendous thrust.

The disadvantage of this engine, however, is that the aircraft must be flying fast for it to function at all, so some type of rocket-assisted take-off probably would be required.

The best position for the engines would be as far away from the pilot and passengers as possible, thus making the shielding problem much easier. A wing-tip position might be envisaged. Or, in the case of a twin-engine turbojet aircraft, the engines could be on the wing-tips with a single reactor mounted near the tail.

The engines should be made as simply as possible because of radioactivity in the parts — the smaller the number of radioactive parts there are to maintain, the better — a good argument in favor of the ramjet.

Notes

jet [dʒet] — *реактивний (двигун)*
screw [skru:] — *гвинт*
merely ['mɪəlɪ] — *тільки, лише*
thrust [θrʌst] — *поштовх*
virtue ['və:tju:] — *сила, ефективність*
to exhaust [ɪg'zɔ:st] — *викачувати, випускати*
nozzle ['nɔzl] — *сопло, форсунка*
to envisage [ɪn'vɪzɪdʒ] — *передбачати*
tip — *кінчик; наконечник, нахил*

Text 11. Effect of an Atomic Bomb Explosion

When the bomb is exploded and for a few seconds afterwards great quantities of radiation are released, including heat, light, ultra-violet and γ-rays. The fission reaction liberates neutrons and the radioactive products decay with emission of β-rays as well as a few α-particles. During this period the blast wave is travelling outwards at a speed of about 700 m.p.h.. As the ball of fire ascends its place is filled by air which rushes in and the resulting storm of wind fans the flames begun by the initial heat flash. As the fires grow this convection current increases and the conflagration which begins a few minutes after the explosion may continue for some hours.

Most of the fires are caused by mechanical damage to gas pipes, electric supply circuits, domestic stoves and so on; the direct incendiary effect of the heat flash is relatively small.

Damage to Buildings. — The effects of the bomb are conveniently classified in relation to distance from ground zero, that is, the point on the ground directly beneath the explosion.

Up to half a mile from ground zero, tiles and outer layers of stonework are melted and wood or other inflammable materials may be ignited by the heat flash. These effects combine with the blast wave to destroy all but the strongest buildings. At a distance of a mile, steelframed buildings collapse due to distortion of the framework and brick buildings are completely destroyed. At 1.25 miles brick walls and plaster ceilings are largely destroyed and windows and doors are blown out. Broken doors and windows are common at 2.5 miles and beyond this distance slight damage may be found up to 8 miles.

Personnel Injuries. — Injuries of several kinds may follow the explosion of an atomic bomb. The greater part of casualties result from blast and falling masonry and from burns. Radiation damage is less important, because most of the individuals near enough the ground zero to receive a dangerous dose of γ-rays or neutrons will suffer serious — if not fatal — blast or burn injuries.

Heat. — About one-third of the energy of an atomic bomb is liberated as heat, though not immediately. Most of it comes off between 0.3 and 3 sec after the explosion and half of it appears in the first second. Two possibilities of protection suggest themselves —

(a) At points outside the half-mile radius within which nothing survives, the heat flash does not penetrate the walls of a building and can be absorbed even by ordinary thickness of clothing.

(b) If exposed parts of the body, such as hands and face, can be covered within a second of the explosion the dose of thermal radiation is approximately halved and the chance of injury from this cause is appreciably reduced.

Ultra-violet Radiation. — The ultra-violet radiation forms less than 0.1 percent of the energy output of the bomb and most of it appears in the first millisecond after the explosion. Observations on the victims of atomic bomb at Hiroshima and Nagasaki suggest that almost all of the burns are due to thermal radiation and that the ultra-violet rays do not present a serious additional hazard.

γ-rays. — γ-radiation comes directly from the fission process and indirectly from the neutrons liberated in the explosion, some of which engage in reactions with elements in the bomb as it explodes. This prompt γ-radiation comes a few microseconds after the detonation. A further substantial delayed emission comes from radioactive decay of the fission products.

Cosmic Rays. — In the early investigations of radio-activity a small residual ionization was found to exist in a gas even in the absence of radioactive sources. Most of this residual ionization disappears when the ionization chamber is screened by enclosing it in a thick layer of lead. At first this residual ionization was attributed to radiations coming from the ground or the atmosphere. By sending recording electroscopes up in balloons, it was later found that this ionization increases as the height above the surface of the earth is increased. At a height of 9,000 m it has a value about forty times as great as at sea level. This result is inconsistent with the idea that these radiations come from the surface of the earth or the atmosphere. It thus becomes necessary to assume that they come from regions outside the earth's atmosphere — from interstellar spaces.

In 1925 and 1926, some scientists studied the ionization in closed vessels at different depths below the surface of water in mountain lakes and found that the ionization due to these radiations decreases with the depth of the vessels below the surface of the lake. These results together with other results obtained at high altitudes, especially those obtained in stratosphere flights and balloons of various kinds, firmly established the fact that these radiations come to earth from interstellar spaces. These radiations are now known as cosmic rays. Most of the effects observed at sea level or at higher altitudes seem to be due to rapidly moving charged particles, probably electrons, positrons, and protons. These particles display a wide range of energy which is dissipated as the particles pass through matter.

Notes

mph= miles per hour — *миль за годину*
conflagration [ˌkɔnflə'greɪʃn] — *пожежа; спалювання*
circuit ['sə:kɪt] — *ланцюг; кругообіг*
incendiary [ɪn'sendjərɪ] — *підбурюючий, запалювальний*
conveniently [kən'vi:njəntlɪ] — *зручно*
to ignite [ɪg'naɪt] — *загорятися, займатися*
casualty ['kæʒjuəltɪ] — *аварія, нещасливий випадок*
masonry ['meɪsnrɪ] — *із цегли*
hazard ['hæzəd] — *ризик, небезпека, випадок*
residual [rɪ'zɪdjuəl] — *залишок; різниця*
to assume [ə'sju:m] — *вважати*
to dissipate ['dɪsɪpeɪt] — *розсіювати, розганяти*

Text 12. Atomic Power Becomes Electricity

The most fissionable of the natural isotopes of uranium is U-235, but there is only 0.7 percent of it in naturally-occurring uranium. The plant uses artificially enriched uranium in which the U-235 content is about 5 percent.

The fission process is based on the disintegration properties of the uranium nucleus. The neutrons released by disintegrating nuclei penetrate into other nuclei and split them too, and so it goes on. This chain reaction extends to all the rods and gives off a colossal amount of heat.

This heat is taken up by the flow of water in the thin-walled steel tubes running through the core of each of the rods. The water is driven under tremendous pressure — 100 atmospheres — and therefore does not boil though it leaves the reactor at a temperature of 270° C. In passing through the rods, the water becomes radioactive and consequently dangerous to personnel. For that reason it circulates in a closed circuit, known as the primary contour, communicating its heat through heat-exchangers to the water in the secondary contour, which is thus converted into steam for driving the turbine.

That is how atomic energy is transformed into electrical energy. Of course, this is only a very general outline of the process, which is remarkable for its combination of complexity and simplicity.

Notes

fission ['fɪʃn] — *розщеплення*
fissionable ['fɪʃnəbl] — *розщеплений*
to disintegrate [dɪs'ɪntɪgreɪt] — *роздрібнювати, розпадатися*

Text 13. Particle Accelerators

Atoms are so small that all our knowledge of their structure and behaviour must be obtained indirectly. The electrons which are responsible for most of the chemical and physical properties of an element are easily displaced or detached and a good deal of information about the outer parts of the atom can be collected by moderately simple techniques. Study of the nucleus is more difficult, for the particles comprising it are very firmly bound together and only the most vigorous disturbance will separate them. A common — and fruitful— method of investigation is the exposure of suitable targets to bombardment with high-energy particles or

radiations, and a variety of particle accelerators have been devised for this purpose during the last twenty-five years.

The simplest particle accelerator consists of a glass vessel containing two electrodes to which a potential difference is applied. The particles, which must be charged, are introduced into the tube and are attracted towards one or other of the electrodes, gaining energy as they approach it. Electrons are obtained by using a heated filament for the negative electrode, and protons are produced in a hydrogen-filled discharge tube from which positive ions pass, by a small hole in the cathode, to the main accelerating tube. Helium used in the same way provides a supply of α-particles.

Notes

accelerator [æk'seləreɪtə] — *прискорювач*
to detach [dɪ'tætʃ] — *роз'єднувати*
moderately ['mɔdərɪtlɪ] — *помірно*
technique [tek'ni:k] — *техніка*
to obtain [əb'teɪn] — *одержувати, здобувати*
filament ['fɪləmənt] — *нитка (накалу), волоконце*

Text 14. Gleep — the Graphite Low-Energy Experimental Pile

Gleep is a slow neutron reactor using graphite as a moderator and natural uranium and uranium dioxide as fissile material. It was constructed to meet two main requirements, viz. to run at as high a power as possible without elaborate cooling arrangements and to compare slow neutron absorption cross-sections of the elements by the pile modulation method.

The pile is built in the form of a right octagonal prism of graphite lying on one of its sides. The reacting core is cylindrical (length 5.24 m., radius 2.86 m.) with the uranium rods lying horizontally in the form of a line lattice of pitch $7^1/_4$ in.; the reflector forms the repumps of large enough capacity. As with all-metals, the experienced skill of the founder is essential for good results, but granted this and proper mold materials that do not liberate gas, sound and strong castings of almost any desired shape can be made. The metal machines well with tungsten carbide-tipped tools and copious coolant. Machining is a completely safe operation despite the occasional spectacular but nearly smokeless fires that occur if the turnings get hot enough to ignite.

Though uranium is not very plastic at room temperatures, it does have reasonable ductility and can be shaped to a limited extent. For extensive working, it is necessary to heat it, either high within the alpha range or into the gamma range where it has extreme plasticity, comparable with beta brass but even softer. Deformed grains (particularly those of certain critical orientations in relation to the deformation) will recover by "polygonization" before recrystallization starts, hence it is difficult to produce very fine grain size. Such sub-grains are formed also on transformation, and the large grains that at first glance appear in the microstructures of castings will often be found on closer examination to consist of many sub-grains differing slightly in orientation.

Uranium metal can be fabricated by most of the usual metal-shaping methods. It has been forged, made into rod by both rolling and extrusion, into wire by drawing, and into sheet by rolling. Sheet can be cupped once its peculiarities have been mastered. Its welding is difficult.

Uranium exists in three different allotropic modifications, with transitions at about 668° and 774° C. It melts at 1133° C. The alpha phase, stable below 668° C, has an orthorhombic unit cell. It has a layer structure composed of corrugated sheets of atoms, the distance between atoms in the sheets being much less than the distance between sheets, in a similar manner to the structure of antimony, arsenic, and bismuth.

Notes

to cast ['kɑ:st] — *лити, відливати (метал)*
tungsten ['tʌŋstən] — *вольфрам*
carbide ['kɑ:baɪd] — *карбід*
copious ['koupjəs] — *багатий*
spectacular [spek'tækjulə] — *ефектний*
ductility [dʌk'tɪlɪtɪ] — *в'язкість, гнучкість*
to forge [fɔ:dʒ] — *кувати*
extrusion [eks'tru:ʒn] — *виштовхування*
to weld — *зварювати; об'єднувати*
to corrugate ['kɔrugeɪt] — *зморщувати(ся)*

Text 15. Atomic Bomb

The atomic bomb is a fast reactor, using high-energy neutrons to support an explosive chain reaction in ^{235}U or ^{239}Pu. The amount of fissile material in a bomb of the kind used in Hiroshima may be roughly estimated from the published information that its explosion

releases the same energy as 20,000 tons of TNT. A simple calculation shows that the mass of ^{235}U needed to achieve this result is about a kilogram. The bomb probably contains rather more, since some is presumably lost in the explosion before fission is complete.

The bomb is detonated by bringing together a number of pieces of fissile material, each too small to support a chain reaction, but having a combined mass greater than the critical amount. The bomb dropped over Hiroshima consisted of two pieces of fissile material, each smaller than the critical size with a gun mechanism to shoot one into another. A later type used at Nagasaki contained 36 moulded pieces of high explosives, each with two detonators, arranged on the surface of a plastic sphere, so that the explosive force was directed inwards. Inside was a hollow shell of plutonium containing a radium-beryllium neutron source.

Air Burst. — The greatest destructive effect is probably obtained when the bomb is detonated at a height of 1,000 — 2,000 ft above the ground. The following sequence of events then occurs. The temperature at the centre of the explosion quickly reaches 1,000,000° C and after a few microseconds the residue of the bomb becomes incandescent, forming the ball of fire. After 0.1 msec the temperature has fallen to 300,000° C and the ball of fire expanded to a diameter of 90 ft. Its brightness at this stage, viewed from a distance of 6 miles, is about 100 times the brightness of the sun as normally seen from the earth. After 15 msec the diameter of the ball of fire is 600 ft and its surface temperature is 5,000° C — about the same as that of the sun. The shock wave resulting from the detonation has now passed out of the ball. After 1 sec the ball of fire has grown to 900 ft in diameter and the shock wave is 600 ft further on. The ball of fire does not grow much more, but begins to rise and after 10 sec has gone up by 1,500 ft. Its violet colour at this stage is probably due to emission of light from excited atoms and molecules in the air. After 8.5 min it has reached a height of 30,000 ft and continues upwards at about 18 ft/sec until it comes to the beginning of the stratosphere or until it reaches a height at which its density is equal to that of the surrounding air. The bubble then spreads out into a mushroomshaped cloud several miles across and lingers for an hour or two before it is gradually dispersed by the winds. Some of the dust sucked up by the ball of fire may fall out, contaminated by the fission products, but most of the residual radioactivity remains in the cloud and settles over a large part of the earth's surface during the weeks which follow.

Notes

bomb [bɔm] — *бомба*
calculation [ˌkælkjuˈleɪʃn] — *обчислення*
to detonate [ˈdetəneɪt] — *вибухати, підривати*
inward [ˈɪnwəd] — *всередину, всередині*
burst [bə:st] — *вибух*
violet [ˈvaɪəlɪt] — *фіолетовий*
to linger [ˈlɪŋgə] — *затримувати*
bubble [ˈbʌbl] — *бульбашка*
to disperse [dɪsˈpə:s] — *розсіювати*
TNT = trinitrotoluene, trinitrotoluol

7.
Section. Civil Engineering

Text 1. Building Materials

Mortar

The mortars used in bricklayers' work consist of an admixture of lime, or Portland cement, and sand. A knowledge of the properties of these materials is very necessary to the craftsman, if he is to obtain the best results from his labours.

Lime is manufactured by the calcination, or burning, of a carbonate of calcium, of which chalk is the commonest example. During calcination, decomposition occurs, and carbonic acid and water are driven off, an oxide of calcium (quicklime) remaining.

If water be added to lumps of quicklime, rapid combination ensues, great heat and volumes of steam being generated. The lumps disintegrate with a series of small explosions, and are eventually reduced to a very fine powder. This process is termed *slaking*; and when making mortar it is highly necessary that it should be thoroughly carried out, as any unslaked particles subsequently expand and seriously damage the work.

Limes may be divided into three distinct classes —

1. Rich limes.
2. Poor limes.
3. Hydraulic limes.

Rich limes contain not more than 6 percent of impurities, slake very rapidly, and are entirely dependent on external agents for setting power. They are chiefly used for interior plasterers' work.

Poor limes contain from 15 percent to 30 percent of useless impurities, and possess the general properties of rich limes, only to a lesser decree. They are only fit for unimportant work.

Hydraulic limes contain certain proportions of impurities, which, during calcination, combine with the lime, and endow it with the valuable property of setting under water, or without external agents. The proportions of these impurities determine whether a lime *is eminently, moderately*, or only *feebly* hydraulic. The principal limes used in making mortar for constructional work are of the Greystone variety. These have hydraulic properties, and will take a large proportion of sand, without weakening their setting powers. The usual proportions are from two to four parts of sand to one of lime.

The ***setting of lime*** depends largely upon its absorption of carbonic acid from the atmosphere. The particles return to their original form of a carbonate, and crystallize. These crystals have a tendency to adhere to anything rough, such as sand or the surfaces of a brick.

Pure lime mortars built into thick walls never harden in the interior. The crystallization of the exterior of the joint when set prevents access of carbon dioxide to the inside of the wall. For this reason, pure lime mortars should not be used for constructional work, only those which are not entirely dependent on external agents. For more important work, where great strength is required, Portland cement is used instead of lime.

Portland Cement is an artificial cement, manufactured by calcining chalk and clay, or river mud containing certain chemical constituents in definite proportions. The chalk and clay are ground and mixed into a slurry, which after being strained through very fine sieves, is pumped into an orifice in the top of an inclined revolving cylinder. A blast of intense flame is directed through this cylinder, which is lined with firebrick. As the slurry drops through the flame, it is burned into small clinkers, which are afterwards ground exceedingly fine in specially constructed mills, and then passed through sieves, having as many as 35,000 meshes to the square inch. The powder is aerated by being spread on wooden floors, with an occasional turning, to ensure the thorough slaking and cooling of all particles. It is then put up in sacks ready for use.

This process of aeration has now been superseded in many cement works by the addition of a small quantity of gypsum (plaster of Paris), which retards the otherwise rapid-setting tendency of a freshly-ground cement.

Sand. — When used for mortar, sand should be angular in grain, free from clay or dirt, and moderately coarse. If too fine, the proportion of lime or cement will have to be considerably increased.

Mixing. — This should be carried out on a close-boarded platform, or stage. In the case of *lime mortar*, sand is best measured when brought to the stage, and the heap opened out into the form of

a ring. The correct proportion of lime is measured into the ring, clean water being added to start the slaking, and more as the process advances. When the generation of steam ceases, the mass should be stirred with a long-handled, hoe-shaped tool called a larry, until a thick, cream-like consistency is obtained. The sand may then be gradually drawn into and thoroughly mixed with the lime by means of the same tool. The mortar should be allowed to stand for some days before use and again well beaten up with larry and shovel.

For ***cement mortar***, the sand is measured and heaped on the stage, and a bottomless box of definite capacity is placed on the top of the sand. This box is filled with cement, and then removed. The dry heap is turned over at least twice and opened out into a ring. Clean water is added in sufficient quantity to wet the whole mass, which is then thoroughly mixed in the same manner as lime mortar.

Cement mortar should be used directly after being made, and should not be subjected to further mixing after setting has commenced. If this is done, the cement rapidly loses its strength, and further repetition would render it practically inert.

The ***proportions*** of sand and cement or lime, are from two to four parts of sand to one part of either, according to the class of work for which the mortar is required.

Another mortar mix which is becoming popular, and which some engineers have proved to be stronger for some classes of work such as reinforced brickwork, is 4 parts of sand to 1 part of Portland cement and 1/8th part of lime.

On large works, mixing is usually performed in a *mortar mill*, which consists of a pair of heavy millstones and a pan, or container into which the measured ingredients are fed. The mill, by reason of its large and rapid output, has a distinct advantage over hand-mixing. It also has many disadvantages unless operated by a reliable man. Grinding may be carried on to such a stage that the sand is ground so fine as to render the original quantity of lime or cement inadequate. Cement mortars may be also ground long after the initial setting has commenced, and thus rendered useless for the required purpose.

Notes

admixture [əd'mɪkstʃə] — *суміш*
cement [sɪ'ment] — *цемент*
lime ['laɪm] — *вапно*
oxide ['ɔksaɪd] — *окис*
lump [lʌmp] — *грудка*
to ensue [ɪn'sju:] — *виникати, випливати*
to slake ['sleɪk] — *гасити (вапно)*

hydraulic [haɪ'drɔ:lɪk] — *гідравлічний*
impurity [ɪm'pjuərɪtɪ] — *бруд*
constituent [kən'stɪtjuənt] — *складова*
sieve [sɪv] — *ре́шето, сито*
exceedingly [ɪk'si:dɪŋlɪ] — *надзвичайно*
to supersede [sju:pə'si:d] — *заміняти*
to retard [rɪ'tɑ:d] — *затримувати*
consistency [kən'sɪstənsɪ] — *послідовність*
to reinforce [ˌri:ɪn'fɔ:s] — *підсилювати*

Text 2. Building Stones

Classification. — Building stones are classified in a general way under the heading of igneous, sedimentary, and metamorphic rocks.

Igneous Rocks. — These are formed by fusion below the earth's surface.

Sedimentary Rocks. — All sedimentary rocks, which include sandstones and limestones, come under this heading. They are formed in deposits by the agency of water or winds, and are known as stratified rocks.

Metamorphic Rocks. — These may be either of the above when changed in formation by heat and pressure. Marbles and slates come under this heading.

Granites. — Granites are igneous rocks made up of granular particles, the latter being crystalline, and usually composed of quartz, felspar, and mica.

Granite has never flowed out over the earth's surface as lava, but became consolidated at a great depth under extreme pressure.

Quartz. — The durability of granite depends largely upon the amount of quartz and its combination with other minerals, quartz being practically indestructible. Quartz, sand, and the chemical named *silica* may be said to be interchangeable terms.

Felspar is the most easily distinguished mineral and its colour varies considerably. The pink felspar is known as orthoclase, and is a potash felspar; this constituent is very characteristic in granite. Sometimes the white soda or lime felspar known as plagioclase is found. Felspars are commonly found with about equal quantities of quartz.

Mica is of two kinds: Muscovite, which is potash mica (light); and biotite, which is a dark brown, iron and other substances being present. The light micas are more stable.

The proportions of mica should be small compared with quartz and felspar. Hornblende and augite sometimes occur and take the place of mica; the stone is then known as a syenite.

Iron pyrites produce oxidation and hydration either in the form of local spots, or as a uniform tinge of brown, and should always be looked upon as a fault.

The characteristics of a good granite are: fineness of grain, the disposition of the various minerals forming the mass, and the high percentage of quartz present.

Sandstones. — Sandstones are formed by the disruption of preexisting rocks due to the action of winds or moving water, the particles being deposited in beds, or strata. The chief constituents are the original quartz crystals (or grains) and the cement that binds them together. The quality of a sandstone depends upon the cementing material. The presence of an inferior cementing material is the chief cause of disintegration upon the exposed surfaces. The cementing materials are numerous, and may be silica, clay, iron oxides, calcite, or dolomite. Usually there is a combination of these substances, but one kind predominates. Sometimes the grains, or quartz crystals, are consolidated by heat and pressure as in quartzite. Sandstones vary from fine grain to coarse grit stone, whilst the colour depends chiefly upon the cementing material. Red, brown, and yellow are due to oxide of iron. White owes its colour to the combination of clear quartz with white argillaceous or clay-containing matter free from iron stains.

If the stone contains a high percentage of mica distributed along the planes of bedding it is known as a micaceous sandstone. Great care should be exercised in placing sandstones in the building so that the laminae are horizontal.

Limestones. — The chief characteristic of limestones is the presence of a large proportion of carbonate of lime. They were formed chiefly by the accumulation of shells or calcareous skeletons of marine or fresh water organisms, which were deposited as sediment in the waters of seas or lakes. The common or chalk limestones are more suited for the production of lime. The oolitic limestones are of marine origin; they are composed chiefly of carbonate of lime, with other substances, such as carbonate of magnesia, silica, alumina, and iron. The oolite resembles the roe of a fish, and results from the accumulation of carbonate of lime around the small nuclei of fragmentary shells or grains of mud or sand. They are of spherical or oval shape, and can easily be seen with the naked eye. They vary in hardness and texture; some are fairly fine, others coarse and porous.

All limestones are soft when first quarried, but harden on exposure to the atmosphere.

The stone should be uniform in colour throughout in the case of both sandstones and limestones.

Notes

igneous ['ɪgnɪəs] — *вогненний*
slate — *шифер; грифельна дошка*
granular ['grænjulə] — *гранульований, зернистий*
felspar ['felspɑ:] — *польовий шпат*
mica ['maɪkə] — *слюда*
lava ['lɑ:və] — *лава*
disruption [dɪs'rʌpʃn] — *розрив; відрив*
marine [mə'ri:n] — *морський; флот*
fragmentary ['frægməntərɪ] — *уривчастий*
to quarry ['kwɔrɪ] — *видубовувати (з кар'єру)*

Text 3. Walls and Partitions

General Features to Be Considered. — Some important factors that influence the selection of the materials and construction of walls for buildings are the following:

1. ***Architectural Appearance.*** — Although the shape of an industrial building may affect its aesthetic value considerably, the exterior walls are generally the features that determine whether or not its appearance is pleasing. Of course, along with the texture, color, and pattern of the exterior surface of the wall material must be included the pilasters, paneling, and any other elements that contribute to the total effect of the ensemble. For example, a high, long, blank wall almost certainly will be unattractive regardless of the nature of the surface of the material of which it is made. Shadow lines, vertical and horizontal offsets, changes in color and texture, arrangement of windows, and the details of the trim are some means whereby an architect may skilfully enhance the appearance of a structure. Architectural elevations and perspective drawings are extremely useful in helping one to determine and to judge what are the best answers to these problems.

2. ***Cost.*** — The cost of the material used for the solid portions of the exterior walls is usually a relatively small part of the total cost of a building; the difference in cost of one desirable material over that of a less desirable one is still less important. Nevertheless, the aesthetic effect produced by the structure is permanent and will continue long after any reduction of initial expenditure is forgotten. On the other hand, 12-in. brick walls naturally cost more than corrugated

metal or transite coverings. The engineer should consider all important features, then make his choice upon the basis of value received both real and intangible.

3. ***Suitability.*** — Associated with these matters of appearance and cost should be that of the general suitability of the wall material for the structure in which it is to be used, and that of its harmony with neighboring structures. It is difficult to define the former quality because of the varying uses to which structures may be put, the climate of the region, the availability of materials, insulating properties, and the different kinds of construction that may be desirable and practicable. For instance, a 60- by 200-ft. building with walls of neat yellow face brick may appear out of place among buildings with corrugated metal siding, not because the new building of itself is unsightly but because it emphasizes the difference between the new and the old. It is even more self-evident that a building with corrugated, galvanized metal siding may appear incongruous when set among others having attractive walls of red bricks, concrete, or stucco.

4. ***Durability.*** — Of itself, a wall covering need not last longer than the rest of the structure, or the purpose for which the structure is built. The former situation seldom arises except in the case of buildings with combustible frames and roofs but with fireproof walls; in general, the durability and weather-resisting qualities of the walls and roof determine the useful life of the building. The latter — the purpose for which a structure is built — has a way of changing as time goes by. Many a "temporary" structure erected years ago is still functioning, or its owner wishes that it would continue to do so. Hence the use of cheap, temporary wall coverings is likely to prove costly in the long run on account of maintenance charges and replacement in order to continue the building in unintended service. Good, durable materials are usually worth their cost.

5. ***Strength.*** — Aside from wall-bearing structures and those erected in regions that are subjected to earthquakes, the strength of wall materials is seldom critical unless the structural supports are improperly designed, or the walls are too thin and tall. Resistance to wind should be provided for, and buckling of thin walls under their own weight should be prevented. It is the structural frame rather than the wall itself that should generally be relied upon to hold a thin, flimsy wall in place.

6. ***Weight.*** — The weight of a wall may be especially worthy of consideration when continuous windows are used, because the lintels and any spandrel beams must carry to the columns all the wall loads supported by these members. Heavy brick or masonry walls may therefore add considerably to the cost of the framing. Even in other cases, lightness is often advantageous.

7. ***Resistance to Fire.*** — Combustible materials, such as wood, may be well adapted to use as walls except for the hazard of fire; incombustible materials like steel may be fire-resistant although not truly fireproof. The inherent dangers and the risks involved should be studied in each case before anyone makes his selection of the material to be used.

It is difficult for one to illustrate and compare all — or even nearly all — possible types of wall construction.

The sequence of the types of wall discussed is based largely upon their light weight rather than upon their relative desirability.

A large amount of development and experimental work is being carried on with the object of securing lighter, cheaper, and better walls than those that have hitherto been in common use. These will be especially important in tall, multistory buildings; lightness alone is not so important in factory buildings. Even in the case of industrial structures, the use of prefabricated panels may bring about considerable changes in one's ideas of suitable construction.

Notes

partition [pɑ:'tɪʃn] — *перегородка; розчленування*
offset ['ɔ:fset] — *відвід (труби)*
to enhance [ɪn'hɑ:ns] — *збільшувати*
elevation [ˌelɪ'veɪʃn] — *висота; ескалатор; ліфт*
expenditure [ɪks'pendɪtʃə] — *витрата*
corrugated ['kɔrugeɪtɪd] — *зморщений*
to insulate ['ɪnsjuleɪt] — *ізолювати*
to galvanize ['gælvənaɪz] — *покривати цинком; гальванізувати*
incongruous [ɪn'kɔŋgruəs] — *невідповідний*
stucco ['stʌkou] — *штукатурка*
flimsy ['flɪmzɪ] — *слабкий*
advantageous [ˌædvən'teɪdʒəs] — *вигідний; сприятливий*
combustible [kəm'bʌstəbl] — *займистий; горючий*
hazard ['hæzəd] — *небезпека*

Text 4. Walls of Bricks and Concrete-Masonry Units

In many cases, **bricks** — and **concrete blocks**, too — are very satisfactory for use in the construction of walls. They are strong, durable, prefabricated units that can be erected easily. Bricks gen-

erally present a pleasing appearance and can be obtained with various qualities, colors, and textures. On the other hand, they are heavy.

The quality of the mortar and the excellence of the workmanship used in its construction are likely to control the strength, waterproofness, and durability of a brick wall. The bricks themselves are generally manufactured under well supervised and controlled conditions; this should, but may not, be equally applicable in the case of the field work.

Brickwork should be constructed with completely filled joints, and the bricks themselves should be placed in accordance with some predetermined pattern that gives adequate bond; e. g., crossing of joints by adjacent bricks so as to knit the work together. These conditions apply to curtain walls that are supported by spandrel beams from floor to floor as well as to those which are used to carry superimposed loads.

Bearing walls made of bricks, and those built of concrete blocks and similar materials, may be suitable for small buildings and for multistory structures that approximate the office-building and apartment-house type of construction. When the floors are supported upon steel beams, bar joists, precast-concrete joists, and wooden beams, these members may be erected easily as the walls are built. The masonry work may then be carried on from floor to floor, using the previously erected floor framing as a working platform. This is likely to result in considerable saving of money because of the avoidance of costly scaffolding outside the walls. Furthermore, the floor slabs may be poured after the floor framing above them is in place, thus ensuring a minimum of damage to the completed floor, as well as eliminating the cost of temporary coverings over the floors.

Curtain-wall construction is often used for brick walls of important industrial plants. Here the brick work is a filler and is supported both vertically and laterally by the framework of the structure. When the spandrel beams are faced with bricks on the outside, it is best to make the wall thick enough so that its center of gravity will be somewhat back from the edge of the vertical support. This generally requires 12-in. walls. It is also important to see that the brickwork is steadied by, and is tied to, the spandrel beams and columns sufficiently to transmit to them all probable lateral forces. Scaffolds for the use of the masons may be hung from the top of the completed framework.

In reinforced-concrete construction there is a real question as to whether or not the spandrel beams should be covered with a veneer of bricks. This should be decided upon the basis of architectural appearance as well as of economy.

Brickwork may be reinforced with steel so as to act somewhat like reinforced concrete although, of course, it is limited in strength and usefulness. High parapet walls, and others that are not braced at their tops, may have pilasters or buttresses reinforced as vertical cantilevers, and the walls between them may be reinforced as horizontal beams.

Another use of reinforcement in brick construction is for the purpose of knitting the brickwork together to resist earthquake tremors. It is obvious that the walls should also be mechanically attached to the skeleton framework of the structure.

When planning reinforced brickwork, one should consider the joints and the way the bricks will be laid up. In horizontal joints, the sizes of rods should not exceed 1/4 in., as otherwise the joints will become too thick. It is desirable also to have these small rods galvanized because bond stresses are generally small, whereas corrosion and staining might be harmful.

Solid brick walls alone are not good insulators. Sweating at the inside surface during cold weather is also to be avoided. Furthermore, the heat capacity of heavy walls may retard the rate of warming up a room on a winter morning, and it may similarly cause a room to remain hot for some time after the walls have once become heated by the summer sun.

One way to remedy these disadvantages is to build the walls so that they are of the hollow-cavity type. The brickwork should be carefully bonded together; corrodible metal ties should not be trusted for this. The air spaces should also have drains (small tile or other pipes, or split tiles) at their bottoms in order to remove any leakage and condensation. Special bricks with holes through them may, if laid properly, serve partly in remedying insulation and condensation troubles.

It is not customary to insulate brick walls of industrial plants except for offices, multistory buildings for some types of manufacturing, and other cases of special nature. In any case, the materials should be resistant to moisture and vermin, and there should be means for draining away any accumulated moisture.

The prevention of leakage of moisture through brickwork is a matter deserving thoughtful study. The proper mortaring of all joints is one helpful feature; flashing is another. Some details of brick-wall construction have already been illustrated. All such details should be studied carefully in advance so that the main structure can be planned to suit them.

There are many conflicting ideas about how to install flashing and even about the best materials to use. Flashing may be especially desirable under copings, at window heads, at floor lines and above steel

spandrel beams — even above concrete ones. Whether the flashing is copper, felt and asphalt, or some other material, care should be used to avoid planes of weakness in the walls, and to see that the walls are supported properly and that lateral shearing forces can be resisted.

Incidentally, horizontal surfaces of brickwork left exposed to the elements are likely to disintegrate at the joints. This should be remembered when chimneys, parapets, platforms, areaways, and perhaps even window sills are planned.

Notes

prefabricated [pri:'fæbrɪkeɪtɪd] — *збірний (будинок і т. ін.)*
texture ['tekstʃə] — *будова, структура*
workmanship ['wə:kmənʃɪp] — *майстерність, кваліфікація*
scaffold ['skæfəld] — *риштування*
slab — *плита*
to steady ['stedɪ] — *робити міцним*
mason ['meɪsn] — *каменяр*
beam [bi:m] — *балка, брус*
lateral ['lætrəl] — *бічний, боковий*
veneer [və'nɪə] — *фанера*
parapet ['pærəpɪt] — *поруччя; парапет*
buttress ['bʌtrɪs] — *підпора, опора*
tremor ['tremə] — *тремтіння; коливання*
insulator ['ɪnsjuleɪtə] — *ізолятор*
corrodible [kə'roudəbl] — *корозійний*
leakage ['li:kɪdʒ] — *витік*

Text 5. Roofs

Desirable Qualities. — For what qualities or characteristics should a designer look when he is planning a roof? Here lightness, strength, waterproofness, insulation, fire resistance, cost, durability, and low maintenance charges are of prime importance. Without a good, tight roof, the usefulness and value of a building may be greatly impaired. There is, however, considerable overlapping in practice so that one cannot draw absolute lines of demarcation between roofs to be used on this or that type of structure.

A few comments regarding the desired qualities previously listed are the following:

1. ***Lightness.*** — The desirability of light weight is especially great in the case of long-span roofs. For purlin spans under 15 or 16 ft.

and for trusses less than 40 ft. long, the sizes of members may be controlled largely by advisable minimum sections, or, at least, the increase in the cost of the framework because of larger dead loads will be slight except in the case of timber framing. The designer must be careful to avoid letting his desire for lightweight roof construction make him negligent of the other characteristics that may be important, too. He should remember to fasten down such roofs as well as to hold them up, because suction during gales may lift them.

2. ***Strength.*** — There is generally considerable uncertainty regarding the intensity of live loads for which roofs should be designed. Flat roofs in snowy climates may actually have to carry at least 40 lb. per sq. ft. of horizontal projection; when surrounded by parapets, they may be loaded even more heavily. Although unit weights vary greatly, one may assume that 1 ft. depth of hard, dry, windblown snow weighs 10 lb. per sq. ft.; if a cold rain falls upon such snow, the load may be increased from 25 to 50 percent before there will be enough drainage action to take off the excess water, even when the roof has a moderate slope. If the inlets or scuppers are filled with ice, the load upon flat roofs with parapets may become relatively heavy. Sloping roofs having a pitch of 3:12 or greater may accumulate extensive snowdrifts on the leeward side, but water falling subsequently will drain off to a large extent.

3. ***Waterproofness.*** — The attainment of waterproofness of a roof is frequently dependent upon the common sense and good judgment used in working out the details of construction and drainage. Obviously, the roofing or covering itself must be watertight, or able to shed the water. The following five general types of roofing are used:

a. ***Built-up Bituminous Membranes.*** — These are usually made of layers of roofing felt or fabric coated with asphalt or tar. A series of layers or plies is built up by lapping successive layers, thus obtaining a large, continuous, waterproof sheet of excellent durability. Frequently, this type of roofing is covered with small gravel while the bituminous material is soft. This is done to provide a surface that will resist wear and will not become too soft and sticky under a hot sun; the gravel does not add to the waterproofness. When such roofings are likely to be walked upon frequently, it is advisable to cover them with tiles laid in asphalt, or with some other suitable material. Such built-up roofing is especially advantageous for flat roofs.

b. ***Prefabricated "Pilot" or Other Bituminous Roofing Papers.*** These are generally low-priced but relatively short-lived. As it is difficult to keep the joints tight, they are not used on flat roofs. These roofings are easily and cheaply applied, but the material is readily damaged by workmen walking on the roof, by wind, branches of trees, and ice.

c. ***Metallic Sheets.*** — These may be noncorrodible materials like copper and aluminium, or they may be "tin" or galvanized steel. In some cases, small sheets or strips may be soldered at lapped joints to form continuous membranes of large area; on sloped roofs, the batten type may be used. They should, however, be fastened down securely to prevent vibrating in the wind, or even being ripped off, and they should be provided with frequent contraction joints so that they will not be ruptured by tensile stresses produced by low temperatures. For this, vertical ribs or soldered, upstanding joints are suitable if planned so as to avoid interference with drainage. Nails holding down a copper roofing should be copper also in order to render long service.

d. ***Shingles.*** These may be made of wood, slate, bituminous material, asbestos-cement, or even terra-cotta tile. Since they are laid with staggered joints and large laps that, of themselves, are not watertight, they are for use on sloping roofs only. Because of the sizes and types of industrial structures, shingles are not used extensively except for minor buildings.

e. ***Corrugated Sheets.*** These may be copper, aluminium, galvanized iron or steel, asbestos-protected metal, or transite. Unlike the materials previously described, corrugated roofings need not be laid on some form of sheathing or supporting medium; they are designed to span from one purlin to another. Since the joints between adjacent sheets are lapped but seldom made watertight, these sheets are basically a sort of shingle, and hence should not be used on roofs having a slope of less than about 3:12 unless the laps are cemented. The fastenings must be firm and durable, and the structure should be so designed that workmen can get at the connections to install them properly.

Notes

to impair [ɪm'pɛə] — *погіршування*
demarcation [ˌdi:mɑ:'keɪʃn] — *розмежування*
truss ['trʌs] — *в'язка; укріплення*
negligent ['neglɪdʒənt] — *недбалий, неуважний*
intensity [ɪn'tensɪtɪ] — *напруженість*
snowdrift ['snoudrɪft] — *замет*
attainment [ə'teɪnmənt] — *досягнення*
asphalt ['æsfælt] — *асфальт*
tar [tɑ:] — *смола*
to rupture ['rʌptʃə] — *розривати*
shingle ['ʃɪŋgl] — *галька, голяк*

Text 6. Fire Resistance

The ability of a roof to resist fire from without and within the structure is so important that an engineer should consider the hazards very carefully before he uses combustible materials in the construction of roofs of important structures. Heavy timber framing with tight, thick sheathing and devoid of "kindling wood" is often so slow burning that it is suitable for various structures; wood may also be treated with chromated zinc chloride or other chemicals that retard its combustion greatly.

The designer should remember that large, flat, tight, horizontal surfaces made of wood will not burn easily; similar surfaces in a vertical or steeply sloping plane will burn more readily. If the air cannot circulate easily so as to provide an adequate supply of oxygen, combustion will be retarded. Exposed platforms, open construction composed of small members with free circulation around them (such as stairways), wooden partitions and floors without fire stops to prevent the flow of air, vertical shafts, and hatchways — these are the kinds of construction that may endanger the safety of a wooden building. Therefore, wooden sheathing on a roof may not be too great a fire hazard if the supporting framework is incombustible, and if the contents of the building are not highly inflammable.

On the other hand, bare steel, although incombustible, is not fireproof but may soften and yield when heated sufficiently. Concrete of adequate proportions will endure considerable heat unless it becomes badly spalled by the effects of heating and then chilling by cold water, or unless the heating effect lasts long enough to dehydrate the cementaceous compounds. Bricks, tiles, and even ordinary plaster on metal lath are, of themselves, fire-resistant to a considerable extent. Most of the ordinary roofings, except wooden shingles and bituminous coverings, will not burn easily, if at all.

Steel Floors. — There are several types of steel floors, and floors with steel parts to carry the loads, where concrete or some other material serves as a filler to close up the spaces and to form a suitable surface.

Bare steel plates are frequently useful for platforms, floors that are subjected to the wear of metallic wheels, floors that are heated severely or subjected to the spatter of molten materials, parts of floors that may have to be dismantled and re-erected frequently, and for the flooring on hatch covers that must be strong and light in order to facilitate handling them. Checkered floor plates are rolled with various patterns, the purpose being to secure a nonskid surface. This is an impor-

tant feature because flat steel is slippery when wet or greasy. Steel gratings are used frequently instead of solid plates because, for the same weight of steel per square foot, the former are stronger and stiffer. However, the designer should not forget that dirt and small objects dropping through the openings of the grating may be objectionable or even hazardous; furthermore, the passage of smoke, gases, and hot air through them may be disadvantageous. Closing the openings in gratings by filling them flush with concrete or mortar is seldom satisfactory because the latter may eventually drop out unless the grating provides a mechanical lock for the masonry.

Notes

hazard [ˈhæzəd] — *небезпека*
combustible [kəmˈbʌstəbl] — *горючий, займистий*
chloride [ˈklɔ:raɪd] — *хлорид*
steeple [ˈsti:pl] — *шпиль*
hatchway [ˈhætʃweɪ] — *люк*
to facilitate [fəˈsɪlɪteɪt] — *полегшувати, сприяти*
greasy [ˈgri:zɪ] — *жирний*
hazardous [ˈhæzədəs] — *рискований*
grating [ˈgreɪtɪŋ] — *грáти, решітка*

Text 7. Concrete Structures

Introduction. — Reinforced concrete is an excellent building material, adaptable to many uses. It is strong, fire-resistant, and durable when well made. On the other hand, it is a heavy material, and its use generally results in rather bulky members so that its greatest field of usefulness is in relatively low buildings and in structures where its mass, rigidity, and strength are advantageous. Tall buildings may be made of reinforced concrete but, when they are more than six or eight stories high, it is desirable to question the economy and advisability of such construction for industrial purposes.

Structures built of concrete should be planned upon the basis of the characteristics of the material itself, and upon the essential nature of the construction processes. Concrete is not a substitute for structural steel in terms of member for member. Architects and engineers, figuratively, should throw away many of their ideas derived from experience with steel-framed structures, then tackle the project at hand on the basis of utilizing the concrete to the best advantage. Many have done this and are now producing plans for concrete structures that are both attractive and practical.

Here, as elsewhere, the designer should make sure that concrete is the most desirable material for a structure and should give careful consideration to the general proportions of the structure and to the uses for which it is intended. Because of the nature of concrete construction, careful planning is needed in the first place because extensive alterations and radical changes of future use are likely to be both difficult and expensive.

Some General Principles. — The planning and the detail designing of concrete structures are so influenced and circumscribed by practical procedures and considerations that the engineer should attack such problems entirely upon the basis of the best use of this particular material. He should remember constantly that, except for possible precast members, he is creating a structure to be made of "artificial stone", of material placed in position in a plastic state so that it must be supported temporarily by something other than itself, and of a material that will and should conform to every detail of the surfaces with which it is in contact when the plastic concrete is deposited.

Not only does concrete improve with the use of good materials, but its quality depends largely upon the excellence of the workmanship used in its manufacture, the adequacy and thoroughness of its placement, and the care with which it is cured. The attainment of the intended high quality is almost completely in the hands of the artisans, who, in the field, convert heaps of aggregates, barrels of cement, and gallons of water into a structure for the use of man. Not only does its strength depend upon highly skilled labor, but the quality of its surface and the beauty of its appearance do likewise. It is foolish to forget these obvious truths. Yet occasionally such important operations are delegated to unskilled, inefficient workmen. Fortunately, this is the exception. Expert workmen produce surprisingly fine results.

When planning concrete work, an engineer should consider the following matters, along with many others:

1. Poured-concrete structures ordinarily try to act largely as continuous frames. This is inherent in their nature. In fact, if continuity is to be avoided without detrimental or objectionable cracking, special measures generally must be employed. Hence, the advantages of continuity can and should be utilized.

2. Since concrete is especially advantageous in resisting compression, its use is more desirable for columns and walls than for long-span beams. The arch, the dome, the cylindrical barrel, the rigid frame, the flat slab, and beam-and-girder construction are among the types most suitable for the use of concrete.

3. So-called "framed" connection are difficult to make in reinforced concrete. Junctions of beams to beams should be made by pouring the adjoining members monolithically if possible because, otherwise, it is difficult to provide for transverse shearing forces. When beams rest upon walls or columns, the construction joints should be located so that each beam has adequate bearing upon the supporting member.

4. Not only is simplicity of shape desirable in order to minimize the cost of formwork, but the duplication of parts permits the revise of forms. It is obvious that heavy forms high in the air are costly.

5. Architectural details should be planned with consideration not only for the fabrication of the forms but also for the removal or stripping of them without damage to the concrete, or undue harm to the forms themselves. The details should also be such that the concrete will conform completely and easily to all the contours, projections, and recesses of the forms without spalling, honeycombing, slumping, air-trapping, and surface imperfections.

6. As the desired surface texture of concrete structures is something to determine carefully in advance, the structure should be planned so that the desired effects will be attained. Good effects will not just happen of their own accord; the bad ones do that.

7. The sequence of pours and the location of construction joints should be determined during the general planning of a structure in order to ascertain that what is desired can be built practicably. The volume of concrete that can be placed in one continuous pour depends upon the capacity of the equipment and upon the nature and details of the structure. It is very important to avoid the incomplete placing of a pour by depositing a portion of the concrete at one time, then pouring additional concrete alongside or on top of the first part after the latter has only partly set. Settlement or displacement of forms, an attempt to vibrate or otherwise compact the concrete, and any other operations that disturb the original material after it has partially set but is not yet strong will generally damage the concrete. After the first part has hardened, there is likely to be an unexpected plane of weakness at the junction with that deposited later. Of course, a tall pier shaft may be poured almost continuously and over a period of many hours if the work is performed properly. However, this is seldom easy of accomplishment in the case of extensive foundations, walls, and floors.

Precast Concrete. — The use of precast-concrete members and parts of members is a matter that warrants careful study. The possible savings in formwork are obvious, but the handling of heavy pieces in the field may require special equipment. If portions of a structure are to be precast, the original planning should be based upon this fact, and

all details should be worked out accordingly. Precast parts can be incorporated in an otherwise poured-in-place structure, but provision should be made for the support of these heavy pieces during construction. Most poured-concrete structures gain much from the stiffness derived from the continuity secured at the junctions of parts, whereas a building made of heavy, loosely connected, precast parts may be inherently undesirable. It is possible, however, to connect precast parts by means of poured sections at the junctions if proper bonding of reinforcement is provided. Although such procedures have not been common in the past, their use should be investigated with an open mind. Because of the possibility of appreciable economies, the use of precast parts will undoubtedly increase in the future.

Notes

bulky [ˈbʌlkɪ] — *важкий*
to tackle [ˈtækl] — *енергійно братися за справу; схопити*
temporarily [ˈtempərərɪlɪ] — *тимчасово*
inefficient [ˌɪnɪˈfɪʃənt] — *нездатний, неефективний*
to traverse [ˈtrævə:s] — *лежати поперек*
duplication [ˌdju:plɪˈkeɪʃn] — *копіювання, копія*
undue [ˈʌnˈdju:] — *надмірний; невідповідний*
recess [rɪˈses] — *ніша*
to honeycomb [ˈhʌnɪkoum] — *робити дірки*
to slump [slʌmp] — *рідко падати*
to ascertain [ˌæsəˈteɪn] — *переконувати, з'ясовувати*
to warrant [ˈwɔrənt] — *виправдовувати, гарантувати*
to incorporate [ɪnˈkɔ:pəreɪt] — *об'єднувати; змішувати*

Text 8. Steel Mill Buildings

Adaptability of Steel for Industrial Buildings. — Structural steel rightfully holds an important position among the materials that are adapted to use in the construction of industrial buildings. Its prime function is that of constituting the skeleton framework which supports the roof and side coverings together with any other parts or equipment that must be attached to or supported by it. Steel is noncombustible, strong, yet relatively light in weight for its strength; it is ductile, reliable, and generally available; it can be fabricated in advance to form members of the desired strength and dimensions, which can be erected quickly in the field where strong connections are easily made. Thus, steel is well suited to use in large plants

having long spans, heavy loads, and large clear heights. It is also adapted to use in small structures.

As a material for the framework of industrial buildings, steel has two very important advantages:

1. Almost any structure within reason may be built of structural steel. This is a tremendous asset because of the great variety of shapes and sizes needed to house various industries.

2. A steel-frame structure may often be remodelled or extended to suit changed conditions, new processes, and even completely new uses. Sometimes this is exceedingly advantageous. By the use of burning, welding, and riveting, extensive alterations may be made in the field without prohibitive expense.

Another slight advantage, which may become important under special conditions, is the fact that the entire building may be dismantled and re-erected elsewhere when circumstances require it.

How can one tell whether to make a building out of steel or some other material? There may be simple but important matters that give the answer; e. g., personal preference, available materials, effect of weight on foundations if the soil is weak, suitability for the purpose, fire hazards, similarity to other buildings previously used and found to be satisfactory, similarity to adjacent buildings to be constructed, and speed and ease of construction. However, the required strength of the material and the relative economy may overrule these other factors when spans are long and loads are heavy.

The term "mill building" as used here denotes a single-story structure having one or more relatively wide aisles of considerable length and large clearance. The siding and roofing may be one or more of a wide variety of materials; generally, however, the whole construction is relatively light. Such a building generally houses large, heavy machinery supported directly on the ground; it may or may not have crane runways, trolley beams, or other overhead equipment for transporting materials. The manufacturing operations within it are usually those which require large areas on a single floor, and the handling of heavy or voluminous objects. Obviously, such buildings require long roof beams or trusses to span the aisles, slender but strong columns to carry heavy vertical loads, and substantial bracing to resist the wind forces against such large exposed wall areas. For all these, structural steel is admirably suited.

When planning the framework of a steel building, one should bear in mind the fact that commercial sections of steel are rolled in various sizes and shapes — but in these only. Unusual, complicated, and built-up members will naturally cost more per pound than will simple

rolled sections without large fabrication costs. When special members are needed, however, they can be made up by riveting and welding, but they should be so planned that they can be composed of parts that in themselves are standard shapes.

The variety of shapes, sizes, and details of industrial structures is about as extensive as the needs for which each individual building is designed.

Notes

ductile ['dʌktaɪl] — *пластичний, гнучкий*
asset ['æsət] — *якість*
to remodel ['ri:'mɔdl] — *переробляти*
to weld [weld] — *зварювати*
adjacent [ə'dʒeɪsənt] — *сусідній*
span [spæn] — *перекриття*
aisle ['aɪl] — *прохід*
mill — *фреза; завод; фабрика*
voluminous [və'lju:mɪnəs] — *великий*
truss [trʌs] — *укріплення*
to bear in mind — *пам'ятати*

Text 9. Planning the General Framing Scheme

The general plan for the framing of an industrial structure is worthy of careful study. It should be developed along with the layout of the equipment, planning of facilities for daylighting and ventilation, provisions for transportation and access, and the many other features that affect the size and shape of a building.

The following outline gives some of the procedure that may be followed in developing the framing scheme:

1. Locate the column rows so that the aisles (clear space between columns, in this sense) and crane runways accomodate the equipment and manufacturing processes. These automatically determine the spans of the trusses. If the building is high, it is generally economical to use moderately long trusses when planning the widths of the aisles, otherwise closely spaced rows of tall columns may use far more steel than would longer trusses. For example, a building requiring four aisles 40 ft. wide with clearances of 35 ft. for cranes would seem to be poorly proportioned; two 80-ft. aisles appear to be more suitable. Of course, there are very important reasons for using narrow aisles

in some cases. Try to equalize the widths of aisles or to have them reasonably proportioned in absolute dimensions and in relative size so that they will form the basis of a sensible layout and of a structure with a suitable architectural appearance.

2. Knowing what monitors or other provisions will be required in the roof for adequate daylighting and ventilation, make a diagrammatic cross section of the building and determine the general shape of the roof: sloping or flat; a series of peaks and valleys or a single ridge and long, side slopes; a flat main roof with rows of monitors or adjoining aisles of varying heights or whatever other shape best suits the requirements of clearances, lighting, etc. Architectural appearance, drainage in wet climates, snow in northern districts, or the kind of roof sheathing and covering to be used may determine whether a series of valleys, a large flat roof, or a long sloping one is best. These matters may also control the question whether it is better to place monitors and sawteeth crosswise of the aisles so that the low bays will drain easily, or whether they may be parallel to these aisles.

3. Choose a tentative width of bay, the distance center to center of columns in each row. For steel construction, it is seldom economical to use less than 17 or 18 ft. for this spacing because it requires a relatively large number of columns, and the purlins in the roof and the girts or wall framing become so light that minimum practicable sizes of members should be used anyway. If the bays exceed 25 ft., the roof and wall members, if stiff enough, are likely to be so heavy that the total tonnage of steel used in them becomes uneconomical. An ordinarily assumed dimension for the bays may be 20 ft.

4. If continuous operating sashes are to be used in the side windows, ascertain what the width of the individual sash units will be so that the bay width are multiples of this dimension, provided it is important or desirable to have it so. This may automatically change the spacing first selected. Such a change was actually made in planning the plant.

5. On the general layout, with the column rows and any critical columns shown thereon, experiment with the selected width of bay to see if the spaces between critical points can be divided evenly to suit the desired dimensions. To do this, it is often advisable to work on a piece of thin tracing paper placed over the general layout so that the latter does not become marked excessively. Perhaps some of the end columns can be shifted slightly — preferably adding rather than reducing floor area — to make the spacing fit. Perhaps the width of bays must be corrected to divide given total spaces into equal parts; perhaps any excess or deficit can be placed in some one bay, such as an end or central one. It will probably be unwise to use bays of one size in part of a building with different sizes used elsewhere.

6. When a seemingly good, uniform spacing of columns has been found, but before locating the columns on the plan, make sure that the columns can be lined up to form complete bents for the full width of the structure. When such an arrangement is impossible, try to line up as many of the bents as practicable, then adjust the special ones to harmonize with them as best they can. For example, assume that 20-ft. bays are the typical ones but that they cannot be used in one portion of an inner aisle because two 30-ft. spaces are required for equipment. It would be possible (perhaps) to use two 30-ft. bays clear across the building at this location. A better solution may be the scheme where the roof trusses are all at 20-ft. spacings but the ends of part of them are supported by jack trusses 30 ft. long placed between the columns, the central columns being tied in with bracing to the trusses and their lateral bracing system in order to steady the columns laterally. The interior row of columns at the right-hand side shows an opening more than 60 ft. wide over which a longitudinal double girder supports two intermediate roof trusses on stub columns.

7. Now check up provisions for the monitors, sawteeth, or other special features in the roof. If monitors run parallel to the trusses, the low bays may be carried by the bottom chords, which is an economical arrangement; they may be on top of the main roof. In either case, it is almost necessary to have the monitor widths based upon the truss spacing so that the framing of the monitors can be supported directly by the trusses. An uneven truss spacing is undesirable because it might cause unequal monitor sizes and thus produce an unsatisfactory appearance. Furthermore, the monitors must extend clear out to the side walls, no jack trusses can be used because they would project into the air unless they were placed under the bottom chords of the main trusses. Now see whether or not the number of bays will fit the monitor scheme so that there will be a low bay at each end because high end bays may cause unnecessarily high outer walls and provide extra windows where they do little good. A low bay at one end and a high bay at the other destroy the symmetry of a building.

8. Next, choose a spacing for the purlins which will be suitable for the strength of the roof sheathing and roofing — generally 5 to 7 or 8 ft. — and by which the truss length is divisible. This may result in different spacings over various aisles, but it is desirable to have a member at the column rows and at the outer walls. This spacing may affect the width of the monitors running across the trusses, or the spacing may be determined by the dimensions of the monitors. Draw a series of these purlins on the plan to see that they fit properly.

Notes

scheme ['ski:m] — *схема, проект*
layout ['leɪ'aut] — *проект; схема*
column ['kɔləm] — *колона*
crane ['kreɪn] — *підйомний кран*
to accommodate [ə'kɔmədeɪt] — *пристосовувати, розміщувати*
otherwise ['ʌðəwaɪz] — *інакше*
to equalize ['i:kwəlaɪz] — *зрівнювати, рівняти*
tentative ['tentətɪv] — *пробний, експериментальний*
to purl ['pə:l] — *прикрашати*
to girt [gə:t] — *оточувати*
sash [sæʃ] — *віконна рама*
excessively [ɪk'sesɪvlɪ] — *надмірно*
jack — *домкрат*
symmetry ['sɪmɪtrɪ] — *симетрія*

Text 10. Electric Lighting

Lighting Systems. — For convenience, lighting systems (or types of lighting) may be classified into four groups: direct, indirect, semi-direct, and semi-indirect. This grouping is arbitrary because, in practice, the last two may merge into each other or closely approach either of the first two systems.

Direct lighting may be defined as a system wherein practically all the light on a horizontal working plane — or at least that relied upon in the design — comes directly from the light sources, the lighting units. Generally the rays are at angles from vertically downward to practically horizontal, as pictured in Fig. 1 (a), reflectors being used to cut off upward rays and deflect them down to the working area. Such a system is efficient as far as the use of power is concerned, but it is likely to cause glare. The use of lenses, shields, and louvers helps to direct the light downward and to avoid annoyance from direct glare, but light reflected from parts being worked upon and from surrounding objects is another matter, and it may be a serious one. This system of lighting tends to cause high brightness and sharp dark shadows. It may be the best for the general lighting of high-ceilinged plants such as those with lights above cranes and over tall equipment.

Indirect lighting may be defined as a system in which practically all the light reaching a working plane is reflected from ceilings, walls, and other objects, none of the lighting units being visible to the workers' eyes. There are many ways of securing these effects

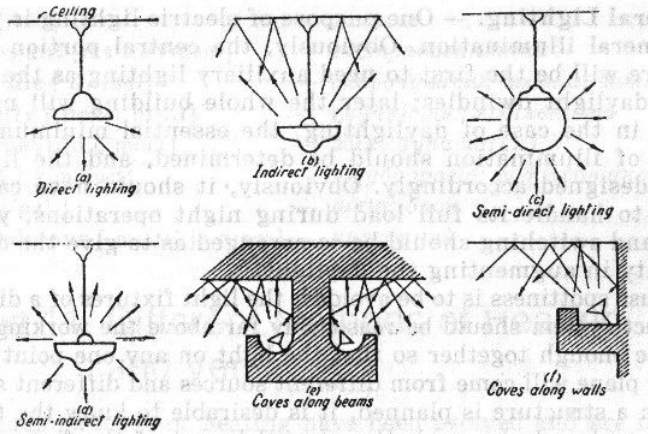


Fig. 1. Types of lighting

besides the two pictured in the sketch; e. g., coves may be installed along ceiling beams as well as side walls, shielded lights may be placed around the upper portions of columns similar to the home type of movable floor lamp, which throws the light upward, may be used. Such a system is especially adaptable for offices, drafting rooms, and plants for light manufacturing; and it is well suited for use in multistory buildings. It is obvious that the reflecting surfaces should be light in color and clean, and of a texture that will diffuse the light rather than reflect it as smooth glass and polished metal surfaces do. Such a system would be wasteful in a mill building with roofs supported by exposed trusses and having side walls with projecting columns and crane girders, because of the interference caused by these obstructions. Furthermore, it would be wasteful when the interior surfaces cannot be kept clean. Much of the light would also be lost through large windows.

A semidirect lighting system is one in which the greater part of the light on a horizontal working plane comes directly from the lighting units, but nevertheless a substantial part comes by reflection from the inner surfaces of the room or from other objects.

If the direct lighting is not more than approximately 25 percent of the total and if it is of moderate intensity, this system is well adapted to use in offices, drafting rooms, and multistory buildings. It secures most of the advantages of the diffused lighting produced by the completely indirect system without being quite so extravagant in the cost of construction and power.

General Lighting. — One purpose of electric lighting is to provide general illumination. Obviously, the central portion of the structure will be the first to need auxiliary lighting as the intensity of daylight dwindles; later the whole building will need it. Just as in the case of daylighting, the essential minimum foot-candles of illumination should be determined, and the lighting system designed accordingly. Obviously, it should have capacity enough to handle its full load during night operations, yet the wiring and switching should be so arranged as to give the desired flexibility in augmenting the daylight.

Because spottiness is to be avoided, the light fixtures of a direct or semidirect system should be reasonably far above the working plane and close enough together so that the light on any one point of the working plane will come from different sources and different angles.

When a structure is planned, it is desirable to know the type of lighting system to be used, the general layout of the fixtures, the location and size of the electrical control room or switchboards, and the approximate sizes and locations of conduits. The pattern made by the system should have some symmetry and uniformity, should be an obvious and harmonious part of the structure, and should fit in with the framing.

When these plans are in the making, it is important to consider maintenance problems — the cleaning of luminaires and the replacing of bulbs. The fixtures in offices and multistory factories should be located so that they may be reached by means of stepladders, specially designed movable platforms, or ladders mounted on wheels. This is not so easy to accomplish in the case of high, single-story mill buildings in which the lights are attached to or near the roof trusses. Sometimes a workman may reach them by riding the crane bridges, by going along catwalks, or by riding on wheeled towers pushed along the aisles between machines, provided the lights have been located with this in mind. It is foolish to waste power burning dirty lights in dusty fixtures, the combination perhaps being only 60 to 75 percent efficient. Yet, if cleaning them is dangerous and difficult, they will be poorly maintained. Although overhead lights might be suspended on pulley systems so that they could be lowered within reach of the floor, this is not usually practicable, and the multitudinous ropes and loops of wire are unattractive. Lights should be held firmly in a stationary position.

Notes

to deflect [dɪ'flekt] — *відхилятися*
glare ['glɛə] — *яскраве світло*
lens ['lenz] — *лінза*

shield [ʃi:ld] — *захист*
extravagant [ɪks'trævɪgənt] — *екстравагантний*
to dwindle ['dwɪndl] — *скорочувати; зменшувати(ся)*
flexibility [ˌfleksɪ'bɪlɪtɪ] — *гнучкість; мобільність*
to augment [ɔ:g'ment] — *збільшувати(ся)*
conduit ['kɔndjuɪt] — *трубопровід; водопровідна труба*
pulley ['pulɪ] — *шків; блок*
multitudinous [ˌmʌltɪ'tju:dɪnəs] — *численний*

Text 11. Different Methods of Heating and Ventilation

Various methods of heating have been evolved and are in use at the present day, and a knowledge of the characteristics and relative costs is necessary in making a selection of the most suitable type for any particular building.

There are two main divisions of heating systems: ***direct*** and ***indirect.***

Direct systems are those in which the fuel is consumed in the room to be heated.

Indirect systems are those in which the fuel is consumed outside the room, the heat being conveyed to the room by a medium such as steam or hot water.

Direct systems

Direct systems are chiefly used for intermittent heating, or for heating isolated rooms.

There are many forms of direct heating, such as gas and electric overhead radiant heaters, in which a metallic plate is heated to a high temperature so as to emit strong heat radiation; and gas and electric unit heaters in which air is delivered to the room by a fan and is warmed in its passage through the unit by heated elements. There are also low-temperature gas and electric radiant panels for fixing to walls, ceilings, etc., also electric tubular heaters for fixing near skirting level. These systems are generally more expensive in first cost than those enumerated above.

Indirect systems

Indirect systems are chiefly used for the continuous heating of a number of rooms or large buildings from one central source, hence the name "central heating". This does not necessarily imply that the

heating source is strictly central, indeed it may be at a considerable distance from the building.

This class of system finds its greatest application in large buildings of all types.

The advantages of the indirect system are —

(a) Fuel and ashes are kept outside the occupied spaces.

(b) Individual flues are not required.

(c) Cleanliness.

(d) Equable temperature maintained in all parts, easily controlled automatically.

The disadvantages are —

(a) Heat is lost from main piping where this is outside the occupied rooms. This loss can be minimized by proper insulation of the pipes.

(b) Labour is required for stoking and removal of ashes. This applies only with solid fuel and can be greatly reduced with automatic firing.

The medium employed for the transmission of heat is either steam, hot water, or heated air.

Steam. — In this system steam is generated in a boiler partly filled with water, and the steam is conveyed through pipes to radiators, unit heaters, etc., in the rooms to be heated. The steam is herein condensed into water which is preferably returned to the boiler through a system of return piping.

The advantages of steam are — low heat capacity, hence quick heating up and cooling down; low cost due to high temperature of heating surfaces.

The disadvantages are the burning effect on dust particles in the air due to the excessively hot surfaces, and the lack of regulation. To overcome the latter the vacuum system has been developed which permits of temperatures in the radiators being maintained below the boiling point of water.

The lack of regulation referred to means wastage of heat in mild weather, hence higher fuel consumption and running cost than with a carefully controlled hot water system.

Notes

to evolve [ɪ'vɔlv] — *розвивати(ся)*
to consume [kən'sju:m] — *споживати, витрачати*
to convey [kən'veɪ] — *передавати*
intermittent [ˌɪntə'mɪtənt] — *переривчастий*
to imply [ɪm'plaɪ] — *означати*
to stoke ['stouk] — *підкидати (паливо)*
wastage ['weɪstɪdʒ] — *витік*

Text 12. Ventilation and Water Heating

Adequate ventilation of buildings has received increased attention during the last few years. Low ceilings, small window areas, back-to-back houses, and excessive densities are things of the past, and now every endeavour is made to ensure a free circulation of air about buildings for the purpose of efficient ventilation.

Building byelaws prescribe the minimum heights of rooms and amount of open space to be provided in the front and rear of every building. The size of windows is controlled by the floor area of each room, and usually windows in habitable rooms should be equal to at least one-tenth of floor area. Rooms without fireplaces are to be ventilated to take the place of the chimney flue, which is usually regarded as a good ventilator. Another important clause controls the minimum heights of rooms.

It will be seen, however, that the building byelaws in this respect are useless unless some control is exercised over the grouping of building units. It is absurd to insist on suitable means of ventilation if it is permissible to construct buildings close to one another, thereby impeding the circulation of fresh air. It is now impossible to crowd dwellings together and consequently the byelaws with regard to ventilation have greater significance.

The constituents are mainly nitrogen and oxygen and suitable means have to be adopted to ensure a constant supply of air of this composition for the maintenance of life.

From experience it is found that approximately 3,000 cu. ft. of air per person per hour is required in enclosed spaces in order to maintain healthy conditions. This figure forms a basis for calculating the size of efficient mechanical ventilating schemes.

Take a room 10 ft. wide by 10 ft. broad and 10 ft. in height. The air we breathe is at first taken from common stock. When the air is breathed back it contains gaseous impurities which contaminate the remaining air until the time arrives when the air becomes so foul as to be dangerous to health. The carbon-dioxide content is increased and 0.06 percent is about the maximum allowance. Therefore a room of 1,000 cu. ft. capacity really requires three air changes per hour in order to maintain the percentage of CO_2 within reasonable limits.

Notes

endeavour [ɪn'devə] — *намагатися, докладати зусиль*
bye-law ['baɪlɔ:] — *постанова місцевої влади*
to prescribe [prɪs'kraɪb] — *приписувати*
rear ['rɪə] — *тильна сторона*

absurd [əb′sə:d] — *безглуздий*
to impede [ım′pi:d] — *затримувати, перешкоджати*
impurity [ım′pjuərıtı] — *нечистота, бруд*
foul [′faul] — *брудний, гидкий; забруднений*
reasonable [′ri:zənəbl] — *розумний; помірний*

Text 13. Natural Ventilation

Small domestic buildings, offices, hotels, and other places with small floor areas are ventilated by natural means depending largely upon the provision of suitable inlets and outlets. The fittings used are too well known to set down in detail, but briefly they comprise: windows, lantern lights with sides to open, fanlights, hopper sashes, revolving cowls, draught window boards, valves and air vents, "hit and miss" ventilators, tobin tube inlets, fireplaces, doors, electric fans, etc.

With regard to the tobin tube care should be taken to see that this fitting receives attention, otherwise after a number of years the receptacle may be found full of filth owing to misuse. It is not unusual for careless people to deposit cigarette-ends, waste paper, etc., into the open ends of the ventilator. The usual height of 5 ft. to 6 ft. is convenient for this misuse, particularly as few people realize their real purpose.

This type of ventilator is used mostly in public buildings, church halls, billiard halls, etc., and can be quite efficient if given periodic attention.

Natural ventilation has the advantage of being cheap to install, and provides healthy and stimulating conditions, provided the inlets and outlets have been designed with skill.

Artificial Ventilation. — In the case of large floor areas, such as we have in designs for theatres, factories, large public halls, and other similar buildings, it is necessary to resort to artificial ventilation, which may be as follows:

(1) Vacuum or exhaust ventilating schemes.
(2) Plenum or propulsion ventilating schemes.
(3) Some combination of the above systems.

These systems will be described in detail.

Vacuum Ventilation. — This is a system of ventilation whereby the internal air is extracted by suitable fans. The ingoing air is induced through windows and other similar inlets already described for natural ventilation, and a steady flow of air is maintained by means of the extraction fans.

Various types of fans may be used. They are generally made of metal of a rotary design and housed in a convenient part of the ductwork. Care must be taken to see that the ducts are fairly straight, and with easy bends if necessary. Avoid right-angled bends, which impair the efficiency of the system owing to friction.

Fans are usually driven by electric motors, but other power may be utilized where electricity is not available.

With the vacuum ventilating system there is no control of the incoming air; therefore this system can only be employed successfully where the surroundings are not noisy and windows can be opened to admit clean air.

Plenum Ventilation. — Control over the incoming air is an important feature of this type of ventilation. Where the conditions are such that the surroundings are noisy and the air is fouled by smoke and dust, the plenum system can be contemplated to provide clean air at the correct temperature and humidity. The air is drawn into the building by a fan, and is discharged through ductwork at suitable positions; conveniently placed outlets abstract the vitiated air through ducts controlled by an extraction fan or smaller power than the inlet fan. A slight pressure is created owing to a large rate of incoming air than that which is extracted, and consequently any leakage must be outwards.

The plenum system of ventilation is costly to install, owing to the necessity for expensive apparatus consisting of propulsion and extraction fans, air heaters, washers and filters (these vary according to circumstances), and distributing ductwork for the incoming air and outgoing air.

A typical arrangement of plenum heating suitable for a large auditorium is as follows: The air coming in is heated by a heater battery, fed from an independent boiler, feeding wrought-iron gilled tubes which have a good radiating surface. In summer, however, the air can be cooled by passing through the same battery fed by an ammonia refrigerating plant supplying cold water instead of hot water from the boiler. The ductwork is liable to convey sound unless special care is taken with the placing of the fans. These should be well away from the most important rooms, and even then the fan and motor should have an anti-vibration base of rubber or similar material to minimise noise. Another good precaution is to provide flexible connections of leather between the ductwork and the inlets and outlets of the fan casing.

The ductwork may be of light galvanized-iron sheeting, circular in section, or formed in brickwork or concrete. In new buildings it is possible to incorporate the various ducts in the general layout of the design, but where the ductwork has to be applied to an existing build-

ing, galvanized circular trunking is frequently used. Asbestos-cement conduits are also favoured. The main ductwork should have means of access for cleansing purposes.

In the cases of the inlet and outlet grilles, it is usual to make them decorative in character and detachable.

From the foregoing description it will be seen that the plenum system is rather complicated and needs skilled attention for maintenance. The system must be frequently examined, otherwise a breakdown has serious consequences. For this reason it is advisable to duplicate the fans.

Hot Water Supply to Buildings. — For domestic purposes the water is generally heated by means of a boiler at the back of a fireplace or by an independent boiler in the kitchen, burning coke or other suitable fuel.

Tank and Cylinder Systems. — A typical system installed in a small house with the well-known "boot boiler" is shown in Fig. 2. This type of range boiler is economical and thoroughly efficient. Sometimes two boilers are interconnected, one behind the kitchen range and the other in the living-room or elsewhere. This arrangement has the advantage of supplying hot water irrespective of which fire is in

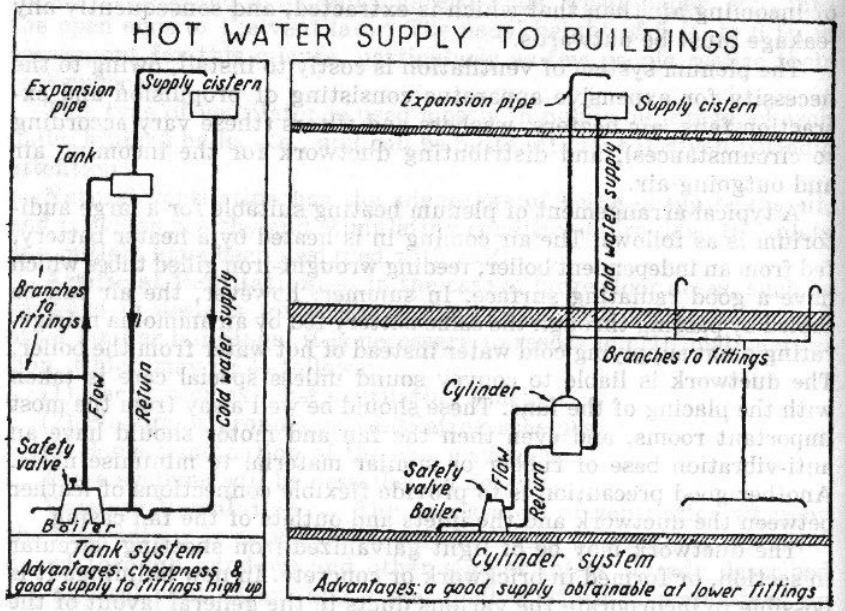


Fig. 2

use. An independent boiler is nowadays frequently specified in place of the kitchen-range type.

Distributing Mains. — The distributing mains generally extend along the streets, and are laid deep enough to avoid injury from frost and heavy traffic, usually at a depth of not less than 3 ft. 6 in. from the surface of the ground or pavement immediately above such pipe.

The mains vary in size. They are usually of an internal diameter of 4 in. and upwards, and made of cast iron with caulked-lead joints or flanged joints. The caulked-lead socket and spigot joint is still extensively used for cast-iron mains of all descriptions. Occasionally, however, it is advantageous to use flexible joints which permit movement between adjacent pipes sufficient to enable bends to be negotiated without the use of specials.

Asbestos-cement pressure pipes are also popular and are generally accepted for water mains and extensions. It is necessary in this case to bolt a saddle in position when tapping under pressure for the insertion of a ferrule.

Circulation of mains should be aimed at, otherwise dead ends will become troublesome owing to stagnation. Where it is impossible to avoid dead ends, frequent flushing out is necessary. The pipes, when laid, are generally tested to twice the working pressure.

Type of Supply. — The water supply may be intermittent or constant, usually the latter, whereby the mains are always full of water. By a constant system is meant a system whereby the mains are constantly under pressure. The drinking water is taken direct from the rising main, and consequently it is only necessary to provide a small storage system sufficient for the hot water supply. In cases where the water is turned off periodically, the system is known as the intermittent supply. In this system, large storage tanks are necessary for the water, which is supplied for a short period each day.

The constant system has the following advantages over the intermittent supply:

(a) The mains are always full and an adequate supply of water may be obtained at any time.

(b) The danger of drinking water becoming contaminated is lessened owing to a direct supply from the main and the avoidance of large storage cisterns.

(c) The pipes, constantly under pressure, are less liable to deteriorate. With the intermittent supply, a vacuum may be created causing a strain on the pipe joints which may lead to gradual leakage.

(d) In order to maintain a good fire-fighting service, a constant supply is necessary for the fire hydrants. An abundant supply of water can be obtained in the case of fire.

The chief advantage of the intermittent supply is the saving of water, but the constant system is usually preferred.

Service Pipes. — The service or supply pipe may be lead, copper, wrought iron, or steel. Lead pipes are extensively used, and the weight in proportion to the diameter will vary slightly in accordance with the regulations of the water authorities.

Notes

provision [prə'vɪʒn] — *забезпечення*
inlet ['ɪnlet] — *впуск; впускний отвір*
outlet ['autlet] — *випускний отвір*
to foul [faul] — *забруднювати*
to vitiate ['vɪʃɪeɪt] — *псувати*
propulsion [prə'pʌlʃn] — *просування, по́штовх*
ammonia [ə'mounjə] — *аміак; нашатир*
liable ['laɪəbl] — *схильний (до); зобов'язаний*
precaution [prɪ'kɔ:ʃn] — *обережність; застереження*
to detatch [dɪ'tætʃ] — *виділяти*
irrespective [ˌɪrɪs'pektɪv] **of** — *незалежно від*
main ['meɪn] — *магістраль (водопровідна, газова і т. ін.)*
to flange ['flændʒ] — *виступати за край*
saddle ['sædl] — *сідло*
stagnation [stæg'neɪʃn] — *застій*
cistern ['sɪstən] — *бак; цистерна*
hydrant ['haɪdrənt] — *водорозбірний кран (колонка)*

Text 14. Pipes

Copper **pipes** are permitted for use inside premises subject to the gauge complying with water company's regulations. Such pipes are simple to fix and have a neat appearance.

Galvanized wrought-iron pipes may or may not be permitted. Some authorities will only allow such pipes on the outlet side of a metered supply. Where the water is of a hard nature they may be safely used, owing to the formation of an insoluble coating of carbonate of lime. Galvanized wrought-iron pipes, though cheap, are little used for domestic supplies, as they are subject to corrosion at the joints and elsewhere where the galvanizing has been disturbed.

There are three grades of iron pipes, known as "gas", "water" and "steam" strengths, and for water supplies the steam quality should be specified.

Whatever type of service pipe is laid, it should be at a reasonable depth below the surface of the ground, usually not less than 2 ft. 6 in., to guard against the effects of frost. In addition, any part of the pipe which may be in an exposed situation should be properly protected.

Having excavated the ground to the required depth and exposed the water main, the next step is to apply to the water company, who will make the actual connection by supplying and fixing a ferrule for the connection.

Mains are tapped under pressure by a special machine consisting of a watertight box which is attached to the main by means of a chain. The hole is drilled and tapped, and by revolving the cover it is possible to bring the ferrule directly over the hole, into which it is screwed down.

This method allows the work of a connection to be made without shutting off the water in the main. In some cases, however, the connection may be such that a tee-piece has to be inserted for a large branch. Where this is so, it is necessary to isolate part of the main by shutting off the water by means of the valves in order to carry out the work. To cause a minimum of inconvenience, it is best to do the connection late at night.

Where it is intended to use wrought-iron galvanized pipe for the service connection, it is usual to lay the pipe from the stop valve to within approximately 2 ft. 6 in. of the water main. The tapping of the water main is then made by the water company's workmen and a ferrule inserted. Next, about 2 ft. 6 in. of lead pipe is fixed between the ferrule and the iron service pipe, by means of wiped joints and a plumber's union. The provision of the short length of lead piping is necessary to allow for the pipe to give a little without causing trouble. Where the service pipe is in lead, the connection is made direct to the ferrule with the usual wiped joint.

When laying the main service pipe from the main to the building, care should be taken to avoid laying the service pipe through any drain inspection chambers or through any place where, in the event of the pipe being or becoming unsound, the water would be liable to become fouled or to escape without observation.

The natural tendency is to utilize the same trench as the drain occupies to save excavation, but the best method is to lay the service pipe in a separate trench altogether. In any case, where it may be impracticable to do so, the water company should be consulted.

They may allow the pipe through foul soil, provided the pipe is sufficiently protected from contact with such soil, either by being carried through an exterior cast-iron tube or by some other approved means.

Notes

to permit [pə'mɪt] — *допускати*
premises ['premɪsɪz] — *будинок (з прилеглими будівлями)*
to gauge ['geɪdʒ] — *вимірювати*
to comply [kəm'plaɪ] — *виконувати*
lime ['laɪm] — *вапно*
to insert [ɪn'sə:t] — *вміщати*
trench ['trentʃ] — *рів*

Text 15. Drainage

General Principles Applicable to any Drainage Scheme

1. The diameter of the drains should be 4 in. for domestic buildings, and this size is usually proportionate to the volume of liquid expected through the pipes.

2. Where a number of houses are drained by a single pipe, or in cases of large buildings, then a 6-in. pipe is generally required for part of the drainage system.

3. Self-cleansing velocities are required, and this means that the drains should be laid to gradients of 1 in 40 for 4-in. and 1 in 60 for 6-in. pipes, where practicable. It is harmful to lay pipes to an excessive gradient or a flat gradient, and care should be exercised to obtain the right fall.

4. There should be means of inspection, usually obtained by the construction of inspection chambers suitably placed.

Separate, Partially Separate, and Combined Drainage Systems

The type of sewage in any given town determines the type of drainage required. If separate, two separate sets of drains are required — one to take off roof water and general paved drainage, usually known as surface water; the other to remove the sewage and wastes from sinks, baths, lavatory basins, etc., named foul water. Separate sewers increase the building costs a little, but the system is favoured, particularly where it is desirable to keep the volume of sewage at a minimum owing to the cost of pumping.

The public surface-water sewers discharge into streams. Consequently there may be quite a number of independent long lengths of surface-water sewers with outlets at convenient positions on the route of a stream or river passing through the district. The foul-water sewers cannot be treated in a similar manner. The sewage must be treated before disposal. The partially separate system still requires two separate

sets of drains, and is similar to the separate system, with the exception that part of the roof water may be drained to the foul sewer. Usually the rain from the rear of the roof is dealt with by the foul drain, while the rain from the front of the roof, pavements, and street surfaces is discharged to the nearest water course. If the system is combined, one set of drains must convey all soil and surface-water drainage.

Where separate drainage systems are called for, the authorities exercise special care with regard to the supervision of the connections to the public sewers. It is most important that no mistake should be made with the identification of the sewers; otherwise a wrong connection causes endless trouble and danger to public health.

If a foul-water drain is inadvertently connected to a surface-water sewer, the faulty discharge may be easily located at the outlet of the sewer to a stream; but the chief difficulty is locating the property wrongly connected once the work has been completed. The danger of wrong connections cannot be ignored; but there is little to fear if the builder makes an inspection before confirming the drain connection to the sewer.

Each system has advantages according to local conditions. Where two sewers are used, the foul-water sewer can be reduced in size. The volume of foul water to be treated is considerably less than the combined system, and where pumping is essential there is a saving in the outlay and annual expense of the pumping installation.

Natural water courses running through a district often effect a great saving on drainage costs, because it is quite reasonable to run surface-water drains to any convenient outlet on the course of stream and save excess piping.

A separate drainage system almost doubles the cost of drainage as compared with the combined system. There is, however, less likelihood of flooding during times of abnormal rainfall.

Drains

Drains and sewers must be formed of good sound pipes of glazed stoneware, heavy cast-iron, or other equally suitable material. The size will vary according to the volume of drainage, but it is essential that the pipes should be of adequate size and laid to a proper gradient, with suitable watertight joints. The minimum internal diameter for a sewage drain is 4 in., and it is the usual practice to use this size for most work of a domestic nature where the work consists of separate units with separate sewer connections. House drains should be laid in a similar manner, as already described for sewers. The work, however, is usually less involved, owing to small sizes and shallow depths. It is best to use the sight-rail method for gradients, although frequently a tapered board is used for setting out the fall of the drain.

This method, although not so accurate, is satisfactory for the construction of short lengths of drain. A suitable tapered board cut to the required fall is used with a spirit level for grading the trench bottom.

The following are some general principles:

(1) A good foundation is essential; therefore the best method is to lay a 6-in. bed of concrete, even if the soil is firm.

(2) Avoid, if possible, passing drains under a building. Where no other means are practicable, then surround the drain with 6 in. of concrete or lay in cast-iron pipes and provide suitable access at each end of any straight length which passes underneath a building. The access, of course, must be provided outside and convenient for rodding purposes.

(3) Keep the drain about 4 ft. away at least from the external walls. Where circumstances will not permit this and the drain is adjoining the wall, make sure that concrete is carried up to underneath the footings of the wall.

(4) Where a drain passes through a wall it must be protected against the weight of the wall by constructing a relieving arch or other similar support.

(5) If the levels are such that part of the drain is to be above ground, then use cast-iron pipes and construct suitable pier supports adjoining the joints.

Notes

drainage ['dreɪnɪdʒ] — *дренаж, осушення*
sewage ['sju:ɪdʒ] — *стічні води*
sewer ['sjuə] — *сточна труба, каналізаційна труба*
supervision [ˌsju:pə'vɪʒn] — *нагляд*
outlay ['autleɪ] **(outlaid)** — *витрати*
likelihood ['laɪklɪhud] — *ймовірність*
stoneware ['stounweə] — *глиняний*
gradient ['greɪdɪənt] — *нахил*
to taper ['teɪpə] — *звужувати(ся)*
pier ['pɪə] — *стовп; стояк*

8.
Section. Machine Elements

Text 1. Press, Shrink, and Friction Joints

A press joint, also called a *force joint*, is obtained by forcing a shaft into a hole that is slightly smaller than the shaft. This is possible because of the elasticity of the materials, which produces the grip that holds the hub and shaft together.

A *shrink joint* differs from a press joint chiefly by the method of assembling it. The hub is heated to expand its bore and to slip it on the shaft. When the hub cools down to the temperature of the shaft, the grip is produced in the same way as in the force joint. The shrink joint is also used to connect machine parts by means of special rings, anchors, and tie rods.

In a *friction joint* the holding grip is produced by the conical shape of the shaft end and the hub bore and by the pull of a nut, or by a slotted hub whose bore is smaller than the shaft and which is spread by a wedge when the joint is being assembled.

The assembling of a shaft and a hub by means of a press joint is simpler than that with a shrink joint, especially if a hydraulic press of a sufficient capacity is available. Shrink joints are used mainly in places where it is difficult or impossible to assemble a press joint, as in the case of rings or anchors. On the other hand, shrink joints assembled with the same interference as press joints give more than three times the holding power against both torsion and axial pull. This superior efectiveness is due to the absence of abrasion between the surfaces of the shaft and the hub during assembly.

Press and shrink joints are permanent connections, while the friction joint can be dismantled. All three joints are used when machine parts must be connected more securely than can be accomplished

with a key or screw joint, especially when they are subjected to shock or vibration.

Riveted Joints

Riveting has been the standard method of joining plates and structural parts before welding began to replace it with increasing rapidity.

A rivet is a round bar consisting of an-upset end called the *head*, and a long part called the *shank*. The rivet blank is heated to a red glow, inserted into one of the holes, and, while the head is held firmly against the plate by a heavy sledge, the projecting end is formed into a second head, called the *point*, by means of a hand hammer and a set or by a press.

Button heads are used for small rivets up to 5/16 in. in diameter, which are driven cold; pan heads are used chiefly in ship work; countersunk heads are used only in special cases, chiefly in structural work and below the water line in ships; the countersunk points weaken the plate so much that they should be used only when unavoidable; the others, including button heads, are used in boiler and structural work.

Rivet diameters in common use increase from 3/8 in. to 11/2 in. by eighths of an inch.

Rivets are made of tough and ductile low-carbon or nickel steel. The rivet materials must have a tensile strength between 45,000 and 55,000 psi. and a minimum yield point equal to one half the tensile strength.

Brass rivets are used only cold and in small sizes.

Rivet holes are either punched or drilled. Punching injures the metal around the holes, for which reason holes should be punched at least 1/8 in. smaller than the required size, and then reamed. Holes in plates thicker than 5/16 in. should be punched 1/4 in. smaller. Simultaneous reaming of the hole through the plates to be connected by a rivet straightens the hole and eliminates offsets, which weaken the rivet. Holes of a diameter smaller than the thickness of the plate cannot be punched, since the punch is apt to crush.

Notes

press — *тиск*
shrink ['ʃrɪŋk] — *стискування*
friction ['frɪkʃn] — *тертя*
joint ['dʒɔɪnt] — *з'єднання; стиск; шарнір; вузол*
shaft [ʃɑ:ft] — *ручка; вал; вісь*
grip — *лещата*
anchor ['æŋkə] — *якір*
hub [hʌb] — *втулка*

pull [pul] — *напруження; тяга*
nut [nʌt] — *гайка*
to slot — *робити щілину (проріз, паз)*
to bore [bɔ:] — *свердлити; бурити*
bore — *отвір*
to wedge [wedʒ] — *вбивати клин*
to assemble [ə'sembl] — *складати; монтувати*
abrasion [ə'breɪʒn] — *тертя; шліфування*
to dismantle [dɪ'mæntl] — *розбирати*
plate ['pleɪt] — *пластина*
bar [bɑ:] — *штáба; зáсув*
to upset [ʌp'set] — *перевертати, перекидати*
shank [ʃæŋk] — *стрижень*
sledge [sledʒ] — *кувалда*
point — *вістря, кінчик*
to punch [pʌntʃ] — *пробивати (отвори)*
to drill — *свердлити, бурити*
to ream [ri:m] — *розсвердлювати*
simultaneous [ˌsɪməl'teɪnjəs] — *одночасний*
to straighten ['streɪtn] — *випрямляти*
to eliminate [ɪ'lɪmɪneɪt] — *усувати; знищувати*
offset ['ɔ:fset] — *відвід (труби)*
to weaken ['wi:kən] — *ослабляти*
apt — *схильний*
to crush — *давити, дробити*

Text 2. Bearings

Bearings with Sliding Contact

General Considerations. — A bearing is a machine part which supports a moving part and confines its motion. That part of a shaft which rotates in a bearing is called a *journal*. Bearings in which one rubbing surface slides over another are called *plain bearings* and may be divided into two classes: Those with a continuous rotary motion and those with an intermittent motion. To the first class belong journal bearings, which carry a load acting at right angles to the shaft axis, and thrust bearings, which take a load acting in the direction of the shaft axis. To the second class belong bearings of parts having a rocking motion, as wrist pins, or a linear reciprocating motion, as cross-heads. The latter can be considered as rocking parts with an infinitely large radius of the bearing surface.

Bearings with a continuous rotary motion form the great majority of all bearings. They are also the only ones in which an oil film pressure adequate to support the journal can be created by the journal itself. Bearings with an intermittent motion must depend for proper operation either upon an outside source for obtaining the necessary oil pressure or upon an abundant oil supply and a low specific bearing pressure.

Bearing Failures. — The failure or need of replacement of a bearing with sliding contact may be due to:

(a) excessive wear of the bearing surfaces;

(b) overheating; or

(c) cracking of the bearing metal.

Excessive Wear. —Wear is caused by metal-to-metal contact. It cannot be entirely eliminated but can be appreciably reduced by providing a sufficient bearing area and by adequate lubrication.

Overheating, if not stopped in time, may result either in seizure of the journal if it runs in a hard-metal bearing, such as a copper-alloy bearing, or in melting the bearing surface, if the bearing is lined with a metal having a low melting temperature. Overheating is primarily caused by metal-to-metal contact. Lubrication decreases the danger of overheating. However, it may start even with proper lubrication, if the heat dissipation of the bearing is not adequate.

Cracking of the bearing metal is due to heavy shock loads, such as are taking place in the running gear of internal combustion engines when the compressive stresses in the bearing metal exceed its endurance limit. The remedies are to lower the specific bearing pressure or to use a bearing metal with a proportionately higher endurance limit. However, even in this case the presence of an oil film is useful as a shock-absorber.

Design Basis. —The object of lubricating a bearing is to interpose a liquid film between the rubbing surfaces and thus to reduce the frictional resistance between the surfaces of the journal and of the bearing material to that due to the fluid friction of the lubricant. From the discussion of causes of bearing failure it is evident that reducing friction by proper lubrication is one of the main problems of a bearing design. Other factors which must be considered in a bearing design are specific pressure, rubbing speed, viscosity of the lubricating oil, and heat dissipation.

Viscosity of Oil. — For perfect lubrication, the most important property of the lubricating oil is its internal friction or viscosity. Viscosity is expressed numerically by a coefficient which represents the resistance offered by a layer of the liquid of unit area to the

motion parallel to the area of another layer of the liquid, at unit distance, moving with unit velocity relatively to the first layer. In c.g.s. units, this coefficient is known as the *absolute viscosity* and is equal to the force in dynes per sq. cm. at a velocity of 1 cm. per sec. at a distance of 1 cm.

The unit of absolute viscosity is termed a *poise*. For practical purposes the unit is too big and one one-hundredth of it, the *centipoise*, is commonly used. It so happens that the viscosity of water at 68.4°F. is exactly one centipoise.

Notes

bearing ['bɛərɪŋ] — *підшипник*
to confine [kən'faɪn] — *обмежувати*
plain — *простий*
to rock — *колихати, гойдати(ся)*
pin — *штифт*
linear ['lɪnɪə] — *вузький і довгий; лінійний*
to reciprocate [rɪ'sɪprəkeɪt] — *рухатися вперед і назад (поршень)*
to lubricate ['lu:brɪkeɪt] — *мастити*
endurance [ɪn'djuərəns] — *міцність*
to interpose [ˌɪntə'pouz] — *вставляти; становити*
lubricant ['lu:brɪkent] — *мастило*
viscosity [vɪs'kɔsɪtɪ] — *зчеплення*
coefficient [ˌkouɪ'fɪʃnt] — *коефіцієнт*
poise ['pɔɪz] — *рівновага*

Text 3. Bearings with Rolling Contact

General Considerations. — In a bearing with rolling contact the shaft is supported on rollers or balls. A bearing of this type has the theoretical advantage of reduced friction, but to be practical it must fulfil the following conditions:

(a) unavoidable sliding should be reduced to a minimum;

(b) the rolling elements must be properly guided in their motion;

(c) all rolling elements should be of exactly the same size;

(d) the rolling elements and their guides or raceways must be extremely hard and be very smoothly polished;

(e) the pressure should be approximately normal to the surface of contact;

(f) in order to avoid distortion the rolling elements must not be overloaded.

Advantages.—Properly designed and well manufactured bearings with rolling contact have the following advantages over bearings with sliding contact:

(a) they will maintain a comparatively accurate alignment over long periods of time;

(b) they can carry heavy momentary overloads without failure or seizure;

(c) their power loss caused by friction is very small;

(d) they are particularly adapted to very low speeds since their friction coefficient is independent of speed;

(e) they have a very low starting friction;

(f) their lubrication is simple and requires but little attention.

Classification.—Bearings with rolling contact may be divided into two main classes according to the type of rolling elements used:

(a) *ball bearings* and

(b) *roller bearings* with cylindrical, conical, spherical, or concave rollers.

Each of the above classes may be subdivided into the following types:

(a) radial bearings;

(b) thrust bearings, and

(c) radial-thrust or angular bearings which can take both radial and axial forces.

Ball Bearings.—Each radial ball bearing consists of four elements:

(a) an *inner ring or race*, grooved on its outer surface;

(b) an *outer race* grooved on its inner surface;

(c) *steel balls* and

(d) a *ball retainer* or *cage* for spacing the balls so that they do not touch each other, thus reducing wear and noise.

Types. (Fig. 1) (a) a single-row radial bearing usually made with a deep groove;

(b) an angular-type bearing, which can take an axial load in addition to the radial load;

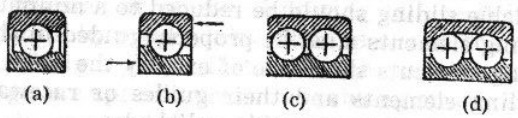


Fig. 1. Types of ball bearings.

(c) a double-row bearing;

(d) a self-aligning double-row bearing, the inner surface of the outer race of which is part of a sphere.

Notes

roller ['rəʊlə] — *ролик*
distortion [dɪs'tɔ:ʃn] — *викривлення*
accurate ['ækjurɪt] — *точний, правильний*
alignment [ə'laɪnmənt] — *вирівнювання*
momentary ['məʊməntrɪ] — *міттєвий; короткочасний*
friction ['frɪkʃn] — *тертя*
spherical ['sferɪkəl] — *кулястий; сферичний*
concave ['kɒn'keɪv] — *угнутий*
radial ['reɪdjəl] — *радіальний*
thrust [θrʌst] — *поштовх*
to groove [gru:v] — *робити виїмку*
to retain [rɪ'teɪn] — *утримувати*
inner ['ɪnə] — *внутрішній*

Text 4. Noise and Vibration in Ball Bearings

In rotating machines, noise and vibration are indications of faulty operation of ball bearings. More often than not trouble is traced to the design and assembly of the machine rather than to the bearings themselves. The technology of their manufacture is such that ball bearings in general are precise and reliable components. Therefore, the satisfactory performance of bearings in the assembled product is clearly the responsibility of design and production.

The balls in a bearing require an absolutely parallel track to roll upon, entirely free from eccentricity, wobble or other variations. Study of the bearing discloses what can happen to destroy this accurate mechanism if a lack of squareness of mounting the bearing exists in any perceptible degree. Should the inner ring be cocked to a tilt position, the balls are forced to climb one side of the raceway during part of a revolution, with resulting drag on the bearing retainer. Then, the balls accelerate down the raceway to climb the opposite side in the other part of the revolution, reversing the strains on the bearing retainer. The balls instead of rotating about a true horizontal axis tend to spin from contact with the sides of the raceway and to reverse their direction of spin during the second half of the revolution.

Some degree of lack of parallelism or squareness of the rings or associated parts is permissible before bearing performance is considered unacceptable under commercial standards.

Misalignment is, of course, not the only cause of improper bearing operation. However, it is a fault that is clearly related to factors of design. Some constructions are more liable or sensitive to misalignment than others. Internal looseness, excessive end play and improper shaft fit also lead to bearing troubles, which usually are indicated by noise and vibration.

Noise is probably the most common cause of rejection, simply because it covers the most ground and its existence is so noticeable. By noise is meant those sounds objectionable to an inspector's standards of operation. Since the human factor is involved, such noise evaluation is not an absolute test. The level at which sounds become annoying is not the same for all persons. Except for borderline cases, however, inspectors agree consistently on whether or not the noise in a bearing under test is objectionable. A more positive evaluation of bearing noise can be obtained by use of sound meters, with or without benefit of "quiet room" test conditions.

Once it is decided that a bearing is noisy, the cause can often be determined immediately from the nature of the sound. Most bearing faults can be associated with definite types of noise.

Notes

to trace — *стежити*
assembly [ə'sembli] — *монтаж*
precise [prɪ'saɪs] — *точний*
reliable [rɪ'laɪəbl] — *надійний*
track ['træk] — *слід*
eccentricity [ˌeksen'trɪsɪtɪ] — *дивацтво; ексцентричність*
wobble ['wɔbl] — *хиткий*
variation [ˌvɛərɪ'eɪʃn] — *зміна; коливання*
mounting ['mauntɪŋ] — *монтаж*
perceptible [pə'septəbl] — *помітний, відчутний*
to cock [kɔk] — *піднімати*
tilt — *похилий*
to reverse [rɪ'vəːs] — *змінювати*
to spin — *крутитися*
revolution — *обертання*

Text 5. Loose Clearance of Balls

Internal bearing looseness is usually identifed by a high, even tone or rattle. It may be quickly checked by pressing axially against the end of the shaft with a pointed wood stick. If looseness is the

only trouble, this action will immediately lessen the noise. Heavy duty small motors and other rotating machines for everyday service, at moderate speeds are often supplied with bearings of a medium fit to permit some latitude in the assembly of the inner ring on the shaft. When mounted, the axial play range is normally between 0.0025 and 0.0045 in. Applications for high speeds or requiring above average quietness, have bearings of a tight fit with an axial play range in small units of. 0.0010 to 0.0025 in. This is strictly axial play and not radial play, which has a value of about one-seventh to one-eleventh of these figures.

Where only one of the two ball bearings is relatively loose in internal fit, any trouble in either bearing usually adds to the noise in the loose bearing, regardless of whether or not it originates there. Factors such as unbalance, bent shaft or wobble stand out in this respect by greatly increasing the magnitude of noise, even though the trouble may be at the opposite end of the unit. If noise control is essential, care should be taken to have" both bearings in about the same internal lateral fit range.

High, singing noise in a bearing may signify one of three common things: dirt in a high speed bearing, rust at any speed, or radial preload from a too tight shaft mounting. More rarely, windage noises from slight pressure differential currents in a fan or blower unit are of this character. The trouble may be localized by removing the shaft from the housing. The outer ring of one of the bearings should be held so that the shaft is vertical. When the shaft is spun, the fingers will detect roughness if rust or dirt is present. Dirt tends to cause a drag in the slow-turning bearing so held, but rust does not. The bearing at the opposite end should be checked also, as noise sometimes is generated from an entirely different place than is initially supposed when the unit is running.

A high radial preload, produced by forcing a bearing on a shaft too large for normal practical fit, will expand the ring until no internal play remains. This condition is easily checked by trying to move the bearing outer ring sideways. An excessively preloaded bearing has no sideways freedom and appears to produce a decided drag on the slowly turning shaft when the bearing outer ring is held in the hand. Any windage sing can be identified by covering ventilation openings in the housing. This should result in changing the noise tone or stopping it altogether. Noise from this condition will change more rapidly with varying speed than will noise from the three other conditions and it will completely disappear at lower speeds. Although windage noises are not related to bearing troubles, bearings are usually suspect until the troubleshooter proves otherwise.

Notes

loose [lu:s] — *недбалий*
clearance ['klɪərəns] — *чистка*
internal [ɪn'tə:nl] — *внутрішній*
rattle ['rætl] — *тріск, гуркіт*
application [ˌæplɪ'keɪn] — *вживання, використання*
sideways ['saɪdweɪz] — *убік; збоку*
otherwise ['ʌðəwaɪz] — *інакше*

Text 6. Shrill Noises and Chatter

An extremely shrill noise arises from raceways, end shields or ball retainers that were damaged or imprinted from light hammer blows. In these cases, the tone changes with the speed of the unit, but does not die out at low speeds. A feeling of roughness will be evident when the shaft is turned slowly by hand.

Chatter indicates too large a bore in the housing so that the bearing outer ring creeps and chatters from its own or other vibration in the unit. Chatter of this sort may be difficult to locate where a rough housing bore exists. The minute peaks and valleys in the bore surface provide a fit which may seem on first assembly to be tight. But, with the vibration encountered in use, the bearing becomes loose as these peaks wear down. This fault is one of the common and recurring troubles found on production lines where tone quality control is rigidly required by the acceptance standards of the product. Cure for this trouble is to provide a smooth surface bore in the housing, held strictly within tolerances. Chatter may also be controlled by painting the housing bores just before bearing assembly with a very heavy viscosity oil above 3,000 saybolt. The thin film on the broad surface of the circumference prevents chatter effectively, and appears to hold its initial qualities upon examination after two years of continuous service. It is also somewhat effective in dampening noise from other causes.

Smooth tone quality or lack of objectionable noise is a common objective in design of high speed motors or similar units. The conventional unit often has a flat spring washer to take up axial or lateral play. This tends to lessen variations of tone, which sometimes reaches the chatter stage from outer bearing ring creep. Noise from "looseness" is at its loudest in those units that, by chance, have been assembled of components, all or most of which are at the extremes of their dimensional tolerances. The cumulative play in these components is considerable.

The spring is intended to take up all of these variations and is required to keep a nearly constant pressure on the bearing outer ring. Any major increase in pressure will cause preload troubles, with resulting heating and loss of speed or performance efficiency. Another function of the spring is to grip the bearing outer ring to stop turning, which otherwise might cause creep and chatter. Use of long springs, of double flat spring washers or other compressible elements, such as synthetic rubber washers, effectively provides uniform tone quality over the range of production tolerance variables.

One noise may be overlooked in trying for tone quality. This is grease slap, an intermittent click or slap noise coming from a double-shielded bearing when the unit is first started on run-in test. This is simply a part of the channeling process, does no harm and disappears in a short time. The duration of the noise depends on the quantity of grease in the bearing and the speed of the unit.

Notes

shrill [ʃrɪl] — *різкий*
chatter ['tʃætə] — *клацання*
to imprint [ɪm'prɪnt] — *штемпелювати; залишити слід*
to encounter [ɪn'kauntə] — *стикати(ся)*
to recur [rɪ'kə:] — *повторюватися*
within [wɪ'ðɪn] — *в, у межах*
bore [bɔ:] — *отвір*
circumference [sə'kʌmfərəns] — *коло*
conventional [kən'venʃənl] — *звичайний, традиційний*
spring [sprɪŋ] — *ресора, пружина*
cumulative ['kju:mjulətɪv] — *накопичений*
compressible [kəm'presəbl] — *компресорний*

Text 7. Vibration

In this case, vibration is considered only for its relation to noise; not for fatigue or other effects. To be objectionable from this standpoint, the vibration is above moderate amplitudes and can be measured by hand feel of the unit being tested.

Lack of dynamic balance is a frequent source of trouble. It is recognized by an extremely strong and sharp vibration, which prevails on rundown test until the unit is well below the critical speed. Static balance will not provide dynamic balance.

Bent shafts, double bent shafts, or whipping shafts produce sharp vibrations that feel almost the same to the hand. However, vibra-

tions from the first two causes retain their intensity on rundown until the unit is almost stopped, far longer than is the case for pure dynamic unbalance vibration. Shaft whip disappears at certain critical speeds and may be most easily located by use of a stroboscopic tachometer. Bent shafts may be of simple bend or compound bend, depending upon the handling. The bends vary as to location over the length of similar shafts. Long, thin shafts are, of course, the most susceptible to bends. Rejections commonly mount from one to twenty percent and back again in a single day from this cause. The magnitude of the shaft bends that bring trouble run in the order of other off-square variables. While soft, thin shafts may be strong enough for a given application, experience shows that more rigid shafts pay dividends in attaining uniformity in tone quality.

Wobble of mounted bearings represents a major cause of trouble where provision is not made for the proper proportion of the shaft shoulders. This trouble is recognized in a running unit from the magnitude of vibration, which is heavy like that from dynamic unbalance.

In units having long, thin shafts, vibration can be caused by parts mounted on the shaft extension if these parts are only statically balanced before assembly with the shaft. The possible result is heavy vibration, which is sharpest at the back end of the unit, away from the shaft extension. Where the back bearing has more internal lateral play than the front bearing, this condition will be accompanied by considerable noise in the rear bearing. In high speed units of this type, shaft whip also enters the problem and increases the possibilities of rejection. Short stocky shafts and extensions are the cure for rejection from these causes, along with a proper degree of dynamic balance for the parts mounted on the short extension.

Noise and vibration often develop in units where end caps inclose and clamp the bearing outer rings. The trouble arises when the caps are machined improperly so that the face against the bearing outer ring is not parallel to the cap flange face against the housing. Designs using die castings are particularly liable to this trouble unless the surfaces of the casting are finished.

Vibration of a similar nature arises from clamp nuts and threads cut on the shaft. If the threads of both are not cut in the proper relationship with the axis of the shaft, the bearing and clamp surfaces may be in misalignment and wobble may result. This is especially true of tight fitting threads. The clamp nut should be free-turning with a slight amount of play between the shaft and nut threads. Such play effectively absorbs out-of-squareness and prevents cocking of the ball bearing inner ring. In some cases, a cocked bearing may result in bending of thin shafts, causing unbalance in running tests.

Heating from axial preload may be caused by expansion of the rotating parts, with the result that all of the end play available at the floating bearing location is taken up. Or the axial preload may arise from the chance assembly of housing parts at the lower end of the allowable tolerances with rotating parts that are at the higher end of the tolerances. Such a combination would take up all end play and cause bending. Heavy preloads may be placed on the bearing by either of these causes. Yet it is difficult to determine the magnitude of these loads during test because turning the shaft by hand slowly discloses only a slight drag or tight " feeling".

Axial preload may also occur where housing fits are too tight to allow the floating position bearing to function. This can be checked by loosening of the housing bolts, which should immediately free the preload and improve the tone quality and speed of the unit.

Heating from radial preload is caused by insufficient internal play in the bearings and is rare. A false condition paralleling this is sometimes created by mounting a close-fitting bearing on an oversize shaft.

Notes

fatigue [fə'ti:g] — *втома*
standpoint ['stændpɔint] — *точка зору, погляд*
amplitude ['æmplɪtju:d] — *амплітуда*
to rundown — *зупинятися*
to whip [wɪp] — *підганяти*
to vary ['vɛərɪ] — *змінювати(ся)*
susceptible [sə'septəbl] — *вразливий*
rejection [rɪ'dʒekʃn] — *відхилення*
magnitude ['mægnɪtju:d] — *величина*
variable ['vɛərɪəbl] — *непостійний*
rigid ['rɪdʒɪd] — *жорстокий; негнучкий*
extension [ɪks'tenʃn] — *поширення, розширення*
cap — *капсуль*
to clamp [klæmp] — *затискувати, скріпляти*
to machine [mə'ʃi:n] — *піддавати механічній обробці*
flange ['flændʒ] — *край, кромка*
housing — *футляр; коробка; ніша*
die casting ['kɑ:stɪŋ] — *процес лиття (металу)*
nut — *гайка*
thread [θred] — *нарізка*
(mis) alignment [ə'laɪnmənt] — *вирівнювання, неправильне вирівнювання*
drag [dræg] — *гальмо*

fitting — *устаткування; складання; монтаж; підходящий, придатний*
bearing ['bɛəriŋ] — *підшипник*

Text 8. Gearing

Friction Gearing

General Considerations. — Friction gears depend for their driving action upon the friction of the driving wheel, or driver, against its mate, or follower. The friction surface of a driver should be of a comparatively soft material, such as wood, fiber, leather, paper, or rubber, while that of the follower is usually made of cast iron. This arrangement insures the maintenance of the correct shape of the friction surfaces; whereas if the follower is of the softer material its surface might be injured and eventually ruined when starting under load or when an excessive load has brought it to a standstill.

Friction gears are used for light and medium powers in machinery which is frequently started and stopped, also where provision for a change of speed of the driven shaft or a reversed motion is necessary. Their advantages are flexibility and noiselessness.

The disadvantages of friction gears are the thrust on the bearings and slippage, resulting in a comparatively low efficiency. However, by using metal-to-metal contact surfaces and ball or roller bearings, these objections are partially eliminated in some recent designs.

The driving capacity of friction gears is a function of the coefficient of friction between the surfaces in contact and of the pressure which holds them in contact. This pressure is limited by the ability of the softer surface to endure it without injury.

Toothed Bevel Gearing

General Considerations. — Bevel gears are used to connect two shafts whose axes intersect each other. Two types of bevel gearing are in general use, straight-tooth gears and spiral-tooth gears. In the straight-tooth bevel gears called straight bevel gears, the elements of the teeth converge to a common point, called the apex, which is the point of intersection of the gear axes. The form of tooth used for bevel gears is the involute. Spiral bevel gears are made either with curved teeth, or with straight teeth. Spiral bevel gears compare with straight bevel gears much as helical gears on parallel shafts compare with straight-tooth spur gears. Their advantages are smoother tooth engagement, quiet operation, greater strength, and higher permissible velocities.

Bevel gears are not interchangeable and are designed in pairs. In the majority of cases the axes of the shafts form a right angle, but they may intersect at any desired angle.

Toothed Spur Gearing

General Considerations. — Toothed gears may be considered as friction gears in which the contact surfaces are provided with grooves and projections which prevent slip and insure positive means of transmitting rotation. Toothed gears are used when a constant speed ratio is desired and the distance between the shafts is relatively small. Toothed spur gears are used to connect parallel shafts and are suitable for transmission up to the largest power.

Classification. — Spur gearing may be classified as external, internal, and rack and pinion. If the tooth elements are parallel to the shaft axis, the gears are termed straight-tooth spur gears; if the elements are helices, the gears are called helical gears. If the words spur gears are used without a modifying adjective, the more commonly used straight-tooth gears are signified.

Requirements. — (a) The teeth must have a profile which insures a constant velocity ratio.

(b) The relative motion of one tooth upon the other should be more of a rolling than of a sliding nature.

(c) The arc of engagement should be so long that at all times more than one pair of teeth is in mesh. In practice this requirement is not always fulfilled.

(d) The tooth profile should approach a cantilever beam of uniform strength.

Worm Gearing

General Considerations. — Worm gearing is a type of screw gearing used for transmitting power between non-intersecting shafts which are at right angles to each other. By this means higher speed reductions may be obtained in a minimum space. There are two classes of worm gearing in common use, each of which has its advantages: one is a straight or cylindrical worm and the other a worm with a hollow shape similar to that of an hour glass. Due to its nature worm gearing is used mostly as a speed reducer, the worm being the driving member.

Straight Worm Gears. — The threads of a straight or cylindrical worm have an axial pitch that is constant for all points between the top and the root of the threads. The gear teeth are of the involute form. There exist two methods of cutting the worm-gear teeth. By the first method, used for ordinary worm gearing, the cutting hob has a constant diameter and is fed radially to the proper depth into

the gear blank, both hob and blank being rotated in the required relation to each other.

The teeth produced by this method are not theoretically correct but are sufficiently accurate for single-thread worm gears with a great number of teeth.

When a higher efficiency and better service are desired, the teeth are cut with a tapered hob fed into the gear blank longitudinally at right angles to the axis of the blank.

Screw Gearing

General Considerations. — Screw or helical gears, often miscalled spiral gears, are used to connect shafts which are not intersecting. Their axes may be: (a) parallel, (b) at right angles, or (c) inclined at any angle to each other. Type (a) gears are always called helical gears.

Worm gears form a special type (b). In order to preclude confusion with helical spur gears having parallel axes, a better name for those with non-parallel axes, is screw gears. Screw gears resemble helical spur gears by the shape of teeth, but their action is different. The engaging teeth slide over each other instead of moving in the same direction at the pitch point. Such gears are suitable only for the transmission of light power at moderate speeds. They are used to convert rapid rotary motion into slow rotary or, when using a rack, into slow linear motion. When used as a speed increaser they are subject to rapid wear.

Notes

gearing ['gɪərɪŋ] — *передача*
driver ['draɪvə] — *двигун, передача*
cast iron ['kɑ:st'aɪən] — *чавун*
maintenance ['meɪntɪnəns] — *підтримання; утримання*
to start [stɑ:t] — *пускати (машину)*
standstill — *зупинка*
medium ['mi:djəm] — *засіб; середній, помірний*
power — *сила*
machinery — *машини*
flexibility — *гнучкість*
slippage ['slɪpɪdʒ] — *ковзання*
efficiency [ɔɪ'fɪʃnsɪ] — *дієвість; коефіцієнт корисної дії*
objection [əb'dʒekʃn] — *несхвалення, неприязне ставлення*
to eliminate [ɪ'lɪmɪneɪt] — *усувати*
capacity [kə'pæsɪtɪ] — *потужність*
to endure [ɪn'djuə] — *терпіти, зносити; тривати*
injury ['ɪndʒərɪ] — *пошкодження*

bevel ['bevəl] — *нахил*
tooth ['tu:θ] — *зубець*
to converge [kən'və:dʒ] — *сходитися (лінії)*
apex ['eɪpeks] — *верхівка*
to intersect [ˌɪntə'sekt] — *перетинати(ся)*
spur [spə:] — *стимул, поштовх*
engagement — *зчеплення*
groove [gru:v] — *виїмка, жолобок*
projection [prə'dʒekʃn] — *виступ; проектування*
mesh [meʃ] — *петля*
pitch [pɪtʃ] — *рівень, ступінь*
spiral ['spaɪərəl] — *спіраль; спіральний, гвинтовий*

Text 9. Clutches

Coupling and Positive Clutches

General Considerations. — A coupling is used to connect two shafts permanently; it is disconnected only for repairs or to make a change in the installation. A clutch permits easy and quick connection and disconnection of two shafts. A clutch is also used instead of a key to connect the shaft with a revolving part, such as a pulley or a gear. Couplings are made in two main types: rigid and flexible.

Clutch constructions are based on the positive-action and friction principles.

Friction Clutches

General Considerations. — The object of a friction clutch is to connect a stationary machine part to a rotating part, to bring it up to speed and to transmit the required power with a minimum of slippage. In certain cases a friction clutch serves as a safety device by slipping when the torque transmitted through it exceeds a safe value, thus preventing the breakage of parts in the transmission train.

Design Requirements. — The following considerations must be observed in the design of a clutch:

(a) Selection of a type suitable for given operating conditions.
(b) Selection of materials forming the contact surfaces.
(c) A sufficient torque capacity.
(d) Transmission of the motion without shock.
(e) Quick disengagement without drag.
(f) Provision for holding the contact surfaces together by the clutch itself.

(g) Low weight in order to keep down the inertia, especially in high-speed service.

(h) Balancing of all moving parts, especially in high-speed service.

(i) Provision for taking up wear of the contact surfaces.

(j) Accessibility and provisions facilitating repairs.

(k) In an industrial clutch absence of or protection of projecting parts.

(l) In a clutch frequently or continuously operated, provision for carrying away the heat generated at the contact surfaces.

Classification. — Friction clutches may be divided into two main groups, according to the direction of the acting force: axial clutches and radial or rim clutches.

Axial clutches are those which have the contact pressure applied in a direction parallel to the axis of rotation. Axial clutches, in turn, can be subdivided into: (a) cone clutches, (b) disk clutches, and (c) combined cone and disk clutches.

In rim clutches the contact pressure is applied upon a rim in a radial direction. These clutches, like brakes, may be subdivided into band clutches and block clutches, also into external, internal, and combined internal-and-external clutches.

Magnetic clutches are usually of the disk type.

Clutch Coupling. — A friction clutch used to connect two shafts is often termed a clutch coupling or friction coupling. Only a few examples of the more representative clutch types will be discussed. These examples and the field of their application by their torque capacity and speed may serve as a guide for the analysis and design of other arrangements.

Selection of Type. — The factors which must be taken into consideration in deciding what type of clutch is to be used are: torque, rotative speed, available space, and frequency of operation.

Torque. — To transmit a heavy or a fluctuating torque a clutch must have sufficient gripping power. This condition is fulfilled in general by multi-disk clutches and for low-speed service by cone and rim clutches of large diameter. The use of special materials may increase the torque capacity of a clutch.

Speed. — Light, compact, and internally balanced clutches, such as the multi-disc type, are best suited for high rotative speeds.

Space Limitations. — Multi-disc, twin-cone, and double-cone clutches are more compact than other types.

Frequency of Operation. — Clutches which are in frequent or continuous operation should have a small travel, a simple engaging mechanism, and large cooling areas to dissipate the heat generated during the engaging of a clutch under load. In this case single-disc clutches with metal contact surfaces and cone clutches are the most suitable.

Notes

clutch [clʌtʃ] — *зчеплення, муфта*
permanently [ˈpə:mənəntlɪ] — *постійно*
pulley [ˈpulɪ] — *шків, блок*
disengagement [ˌdɪsɪnˈgeɪdʒmənt] — *звільнення*
inertia [ɪˈnə:ʃɪə] — *інерція*
accessible [ækˈsesəbl] — *зручний*
to facilitate [fəˈsɪlɪteɪt] — *полегшувати; сприяти*
rim [rim] — *край*
to fluctuate [ˈflʌktjueɪt] — *вагатися; бути нестійким*
cone [ˈkoun] — *конус*

Text 10. Why Parts Fail

Mechanical failures of metals can be broadly classified as those in which the part is: a) deformed to such an extent that it was no longer serviceable; or b) fractured. Since the fracture of a part is often more disastrous than excessive deformation, emphasis is placed upon failures by fracture. But rarely does a structure or machine fail in normal service simply because loads are greater than the strength of the parts. Occasionally this will happen if service requirements are underestimated. Much more common, however, are failures where factors other than static loading of the parts are involved, such as fluctuating stress, corrosion, and rubbing between supposedly fixed members.

The nature of the stresses, and other factors, have a marked influence on the nature of a fracture, so a knowledge of the several types of fractures provides a powerful tool in determining the causes of failures in service.

Static or Overload Fracture. — When a metal member fails because of a single application of a load greater than the strength of the member, there is usually considerable plastic deformation prior to fracture. This deformation is apparent on inspection of the fractured parts. This ability of a member to withstand plastic deformation is a function not only of the properties of the material but also of the geometry of the member, the type of stress to which it is subjected, the rate of loading, and, in many materials, the temperature.

Although there are very few applications of metals in which it is necessary for the part to deform appreciably in service some ductility is essential to permit yielding of the metal at sharp notches. Such notches are almost universally present in commercial metals due to inclusions, bolt holes, welding defects, scratches, corrosion pits and

other reasons. The stress at the bottom of a severe notch may be several times as large as the average stress on the section; a ductile material will deform plastically in the small highly stressed region and so redistribute the stress that its peak value will be reduced. If conditions are such that the material behaves in a brittle manner, a crack will be formed before plastic deformation can take place. Frequently, this crack will propagate at high velocity through the rest of the section. This type of fracture is characterized by very little deformation adjacent to the fracture and often by markings known as "herringbone" or "chevron" patterns on the fracture surface.

The strength of metals generally decreases as the temperature increases. Consequently, parts that have adequate strength at room temperature may fail if operating temperature becomes high, and the fracture can occur after is high enough, the strength of the grain boundaries in the metal will be reduced to such an extent that intergranular cracking will occur, and the resulting fracture will show very little ductility.

Fatigue Fractures. — When a metal is subjected to repeated or fluctuating loads it may eventually fracture at stresses much lower than those which would be required to cause fracture under static conditions. This phenomenon is known as fatigue and is the most common cause of primary failures of metals in service. Laboratory tests have established the fact that a fatigue fracture is progressive in nature; after a number (often many million) of cycles of stress, a small crack forms in the region where the stress is highest. Under continued stressing, this crack grows in a direction generally perpendicular to the tensile stress untill the cross section of the member is reduced to such an extent that the remaining area fractures from overload. Because of this mechanism, the surface of such a fracture shows two characteristic regions that are usually quite different in appearance.

Because the stress required to initiate a fatigue crack is usually less than that needed to cause plastic deformation of the metal, a fatigue fracture is characterized by its brittle nature. In most fatigue fractures that occur in service the fatigue crack extends only part way across the section, and there is a considerable area broken by over-stress. This part will show some ductility, so fractures of this type will not fit together well when the parts are replaced in approximately their original relationship (the fatigue crack portion will be held apart by the deformed overstress portion).

The surfaces of fatigue fractures frequently show characteristic markings which represent the outline of the fatigue crack at various points in its growth. When these markings are present, they provide a means of locating the origin of the fracture accurately.

It is generally agreed that the primary factor responsible for the fatigue failure of a part is much more often its geometry than the material of which it is made. A large percentage of the failures investigated could have been avoided by more careful design to eliminate points of stress concentration. The stress necessary to cause fatigue failure is usually less than that required for plastic deformation of the metal, so there is no opportunity for redistribution of the load in the neighborhood of the notch.

Fretting caused by rubbing between closely fitting members is a frequent source of fatigue fractures which does not seem to be properly appreciated. When fretting is severe between steel members it can often be detected by the presence of a fine brown powder. This should always be regarded as a danger sign and corrective action should be taken if the parts are subjected to fluctuating stress. A powder, usually black, is formed by fretting between aluminium members.

As most fatigue fractures start on the surface, the condition of the surface is of primary importance if fatigue failures are to be avoided.

Notes

to fail ['feɪl] — *зазнавати невдачі; не вистачати; бракувати*
failure ['feɪljə] — *відсутність; брак; аварія; пошкодження*
serviceable ['sə:vɪsəbl] — *придатний, корисний*
to fracture ['fræktʃə] — *ламати, розбивати*
fixed ['fɪkst] — *нерухомий, постійний*
apparent [ə'pærnt] — *явний; очевидний*
appreciably [ə'pri:ʃəblɪ] — *значно, помітно*
notch [nɔtʃ] — *виїмка*
inclusion [ɪn'klu:ʒn] — *включення*
scratch [skrætʃ] — *подряпина*
granular ['grænjulə] — *гранульований*
to fret [fret] — *роздратовувати(ся)*

Text 11. Stress Corrosion Cracking

When a metal is exposed to a corrosive media and is subjected to a load, fracture may occur even though the stress is less than that required to cause fracture in the absence of corrosion. The corrosion necessary to initiate stress corrosion cracking need not be severe, and frequently will not cause noticeable corrosion on the surface. In many instances this type of fracture can occur in parts that are sub-

jected to no external load whatsoever, due to the internal stress developed in the part during fabrication.

This is also a progressive type of fracture, beginning with a small crack and progressing across the section perpendicular to the tensile stress. The resulting fracture is brittle, as stress corrosion cracking can occur under stresses less than those required to cause plastic deformation. It differs from a fatigue fracture in that there are usually numerous cracks that tend to "wander" through the metal, giving a coarse appearance to the fracture surface. A polished section through the metal damaged by stress corrosion cracking usually shows a network of fine cracks.

Corrosion is frequently a contributing factor to mechanical failures. A small corrosion pit can concentrate the stress in the surface of a part and be dangerous if the part is subjected to fluctuating loads. Even corrosive agents that do not appreciably corrode the metal can effect its fatigue strength. Some light metals and copper alloys are found to give trouble under mildly corrosive conditions and care should be taken to avoid the possibility of stress corrosion in the use of these materials. Preventive measures in the selection of materials will minimize these effects.

The precautions which must be observed by everyone concerned with the design, fabrication or use of metal parts in order to avoid failure in service, are:

1. **Design:** Elimination of sharp reentrant angles at fillets, keyways and other changes of section. Accurate stress analysis at points of stress concentration and verification of the analysis by experiment or by fatigue testing of sample parts. Careful selection of material and fabricating methods to produce parts of adequate transverse strength if significant stresses are to be applied in that direction. Proper combination of material and static design stress to eliminate the possibility of stress corrosion cracking in the environments to be met. Specification of materials that will provide adequate resistance to brittle fracture, particularly under shock loading and low ambient temperatures.

2. **Fabrication:** Careful workmanship to avoid points of stress concentration caused by welding defects, tool marks, improperly formed fillets, grinding cracks, quenching cracks and others. Control of forging practice to avoid folds, seams, and internal fissures. Protective atmospheres during heat treatment to avoid decarburization. Proper control or elimination of residual stress caused by pressfits or cold working in parts subject to corrosive environments. Rigid inspection of highly stressed parts to eliminate surface imperfections.

3. **Use:** Control of operations to restrict the loads to those for which the machine or structure is designed. Protection of parts from corrosion that can cause damage. Periodic inspection of highly stressed members by personnel acquainted with the nature of fatigue failures. Prompt repair or replacement of parts damaged by unusual conditions, such as fire, collision, overloading or unusual corrosion. Periodic disassembly of clamped members to inspect for evidence of fretting.

Notes

corrosion [kə'rouʒn] — *корозія; ржавіння*
medium ['mi:djəm] — *засіб, спосіб*
media ['mi:djə] — *засоби*
whatsoever [ˌwɔtsou'evə] — *який би не; будь-який*
brittle ['brɪtl] — *крихкий, ламкий*
to corrode [kə'roud] — *роз'їдати; іржавіти*
fabrication [ˌfæbrɪ'keɪʃn] — *випуск; виробництво*
to forge [fɔ:dʒ] — *кувати*
to quench [kwentʃ] — *гасити*

Text 12. Friction Fundamentals

All of the effects of friction involve force. The same force which keeps stationary objects in place tends to retard objects in motion. Basic concepts of the two corresponding types of friction are static and dynamic. The first is simply a tangential force associated with a normal force and no work is done. The second involves both force and speed, and energy is expended. A friction element is on a rotating drum; mechanical energy is converted directly to heat at the rubbing surfaces by virtue of friction, giving the immediate effect of increasing the temperature of the rubbing materials.

In the study of commercial friction elements and mechanisms, it is not possible to determine the coefficient of friction in the classical manner, nor does it have the same meaning as in the classical sense. Under dynamic friction conditions the weight of the friction element is replaced by the pressure with which two surfaces are applied to each other. The inclined plane, which appears to be boundless in the classical analogy, is replaced by a drum in the automobile brake and an opposing disc in the clutch. Classically, the static breakaway friction is measured. From a practical standpoint, however, dynamic engagement and breakaway friction conditions are important in a clutch, while kinetic friction of slipping surfaces and static break-

away friction at rest are important in a brake. In a classical example there is no temperature problem; the temperature of the two rubbing surfaces is assumed to be the ambient temperature, and no heat is generated by the rubbing surfaces.

But in practical application, the purpose of a friction element is to absorb energy. In fact, the energy to be absorbed in the friction mechanism of an airplane brake is often quite large.

In view of the discrepancy between the classical and practical interpretations of friction, it is necessary to re-evaluate the concepts. The phenomena observed by the early French physicist, Amontons, on the effect of pressure and by Coulomb on the effect of velocity were of scientific value but the friction element of today requires evaluation under much more severe conditions.

Mechanism of Friction.—Several factors contribute to the phenomenon of friction. These are adhesion, cohesion, abrasion and elastic deformation.

The *friction of adhesion* is similar to that involving a fluid or a viscous mass. The friction of one's hand on glass or on a varnished table top is high, but it is friction which increases with the time the hand is allowed to rest on the surface. Here, the pores of the skin adhere to the table top like suction cups, if a very small amount of moisture is present to complete the seal. The adhesion can be broken by spreading a little powder on the hand.

Cohesion, the second factor, is the phenomenon by which surfaces of compatible metals become welded together. Fusion welding causes cohesion over large areas, but the welding resulting from friction occurs over extremely small contact areas. Thus, metal may cohere with metal, but it is difficult to conceive of the coherence of cloth with metal. Nor is it generally conceivable that the resin in a molded brake lining will cohere with the metal brake drum, but resin will cohere with resin. Copper will cohere with copper, and iron or steel will cohere with the same. Most mutually soluble metals, in fact, will cohere.

The third factor contributing to friction is *mechanical abrasion*. It is the same effect as that required by a cutting tool which plows through an object, displacing or removing a quantity of metal. In such a manner, a diamond point embedded in a tough material and dragged across a soft surface will score the surface, leaving a trough from which material has been removed or a trench banked by displaced metal. This effect involves a measurable force, and even though the scratch may be minute, the sum of the forces necessary to make many scratches in a surface is considerable. Friction material manufacturers sometimes find it necessary to include in their composition

small amounts of abrasive material which tend to mark the opposing surface and may contribute to the friction.

The fourth factor is the *elastic* and *plastic deformation* induced by a load moving over a surface. The friction force resulting from deformation is not very important in the case of two discs engaging each other. It is a well known fact that in the two-shoe internal-expanding brake there is a definite tendency for the brake drum to go out of round, becoming elliptical in shape during braking. The force necessary to maintain the ellipticity of the drum during rapid rotation is considerable, and contributes to the friction force.

Notes

fundamentals [ˌfʌndəˈmentlz] — *основи; основні принципи*
basic [ˈbeɪsɪk] — *основний*
concept [ˈkɔnsept] — *поняття; загальне уявлення*
dynamic [daɪˈnæmɪk] — *динамічний*
to extend — *поширювати(ся)*
drum — *барабан*
commercial [kəˈmɜːʃl] — *торговельний, комерційний*
to incline [ɪnˈklaɪn] — *схилятися*
boundless [ˈbaundlɪs] — *безмежний*
analogy [əˈnælədʒɪ] — *аналогія, подібність*
brake [ˈbreɪk] — *гальмо*
ambient [ˈæmbɪənt] — *оточуючий*
discrepancy [dɪsˈkrepnəsɪ] — *невідповідність, розбіжність*
interpretation [ɪnˌtɜːprɪˈteɪʃn] — *тлумачення*
severe [sɪˈvɪə] — *тяжкий, суворий*
Amontons [ˈæməntənz]
Coulomb [ˈkuːlɔm, kuːˈlɔŋ]
abrasion [əˈbreɪʒn] — *тертя, шліфування*
elastic [ɪˈlæstɪk] — *еластичний; гнучкий*
adhesion [ədˈhiːʒn] — *прилипання; причепність*
viscous [ˈvɪskəs] — *в'язкий; липкий*
to varnish [ˈvɑːnɪʃ] — *лакувати; прикрашати*
suction [ˈsʌkʃn] — *поглинання*
cohesion [kouˈhiːʒn] — *зчеплення, зв'язок*
compatible [kəmˈpætəbl] — *сполучний, сумісний*
to cohere [kouˈhɪə] — *бути зчепленим, зв'язаним*
to conceive [kənˈsiːv] — *збагнути, розуміти*
to embed [ɪmˈbed] — *вставляти, впроваджувати*
trough [trɔf] — *жóлоб; запáдина*

Text 13. Contributing Factors

With the realization that the modern friction mechanism is essentially an engine in which mechanical energy is converted to heat, it is well to survey the interrelation of friction and wear rate of the friction materials. There are several basic factors affecting friction and wear which must be analyzed and considered. The most important of these is pressure. Many of the organic or molded friction materials exhibit no change in friction with pressure, but some of the sintered-metal materials suffer a decrease in friction as the pressure on the lining increases. The coefficient of friction of one material decreases from about 0.3 at 20-psi plate pressure to about 0.22 at 200 psi.

For metallic materials to have friction decreasing with increasing speed is common. The effect of speed on friction is not limited to sintered metal, but is noticeably evident in the cast-iron railroad brake shoe where it is not only a fact that the average friction from a 100-mph stop is much less than from a 40-mph stop, but it is very desirable and necessary. In the case of the railroad wheel the curve of the retarding force of the brake should be parallel to the curve of the adhesion of the wheel to the rail. For railroad applications, adhesion is expressed as Fa/L where Fa is the force required to cause the wheel to slip on the rail and L is the wheel load.

Adhesion becomes very much lower as the speed of the wheel increases, mainly because high speed causes the pressure of the wheel against the rail to be increasingly variable. If, during a "bounce" of the wheel when the normal pressure is relatively light, the brake shoe should have sufficient friction to grab the wheel, then a slide which would continue until the brake pressure was released would be initiated. This action is fully explained by the great difference between static and dynamic friction of the metal brake shoe against the wheel, and the wheel against the rail. If the wheel is in rolling, not sliding, contact with the rail, the friction is high and the lower sliding friction of the brake shoe against the wheel may continue. As soon as the brake shoe is able to grab the wheel and force it into sliding contact with the rail, the system tends to remain in this condition until the brake is released. Therefore, it is advantageous to have the coefficient of friction of brake and wheel dropping with increased speed, as does the adhesion.

There is a parallel to this situation in the case of the automobile, but the treatment is different. Whereas the railroad brake is applied with a mechanical pressure which is not sensitive to the results obtained, automobile brakes are controlled by human beings who gage the pressure to be applied by its effects. If the tires lose their adhesion, the operator releases the brake pressure enough to restore the ground-to-tire adhesion and then increases the pressure to obtain the full effect of rolling braking.

Beyond the effects of speed and pressure, temperature seems to have an independent effect on the coefficient of friction. The magnitude of the effect of temperature varies with the material and may be greater than that of either pressure or speed. Thus, it is possible for one material to show a moderate increase in friction as temperature increases, while another may do just the reverse. To separate completely the effect of pressure and speed changes from the effects of temperature changes is probably impossible, because if pressure is constant and speed is increased, the surface temperature will increase. Similarly, if the speed is kept constant and the pressure is increased, there will be a corresponding increase in the amount of power, resulting in higher temperature.

Notes

contributing [kən'trɪbju:tɪŋ] — *сприяючий*
convert [kən'və:t] — *перетворювати*
to survey [sə:'veɪ] — *оглядати; досліджувати*
wear ['wɛə] — *зношування*
to consider [kən'sɪdə] — *розглядати; вважати*
pressure ['preʃə] — *тиск*
to decrease [di:'kri:s] — *зменшувати*
sinter ['sɪntə] — *шлак*
to gage ['geɪdʒ] — *заставляти, закладати; ручитися*
treatment ['tri:tmənt] — *поводження, ставлення; обробка*
magnitude ['mægnɪtju:d] — *величина; значущість*
to vary ['vɛərɪ] — *змінювати(ся)*
reverse [rɪ'və:s] — *зворотний*
constant ['kɔnstənt] — *постійний*

Text 14. Wear Rate and Surface Temperature

Wear Rate. — The subject of wear is abroad one, since it is affected by many complex interrelated factors. There appears, however, to be a very close relation between the wear of a particular material and the amount of work done in the braking or clutch application. Under conditions which are not extreme, the rate of wear of a constantly dragging friction element will increase in nearly a straight

line with increasing speed. Similarly, the work done by a friction element dragging at a constant speed and variable pressure will increase in direct relation with pressure.

If, on the other hand, a braking stop is considered in which a vehicle of given weight is decelerated to rest from a given speed, the energy converted to heat during the stop varies with the square of the initial speed. Thus, the energy, and the wear on friction elements, in a stop from 100 mph are four times as much as when the same vehicle is stopped from 50 mph. If, in the same example, the deceleration rate is increased by increasing the pressure, the energy of the stop remains the same, and the wear would at first be expected to be the same. Because energy is absorbed at a faster rate, however, the surface temperature will be higher and the wear for the stop will be greater.

Higher temperature of the rubbing surfaces causes higher wear rate. With organic materials such as paper, cloth, cork, and leather, the permissible temperature rise is limited by the possibility of chemical deterioration, which destroys the friction element. Resin-bonded, molded asbestos friction elements are capable of higher operating temperatures and because their thermal insulating capacity is great, they deteriorate slowly. In the case of metallic friction materials there are no internal chemical changes before the melting point, and deterioration can only come from oxidation or physical changes. At the same time, however, other characteristics of these materials may have a compensating influence on selection for a particular application.

Surface Temperature.—While it is reasonably easy to measure the speed of rubbing surfaces and to estimate the pressure, the temperature of a pair of rubbing surfaces is difficult to determine. Specialists in friction analysis have never come to agreement as to where or how temperature should be measured, nor have they agreed as to what it means if it is measured. It may be said with reasonable assurance of acceptance that there is no such thing as the temperature of the rubbing surfaces. There is, without doubt, a range of temperature.

The lowest temperature of the surface may be the extrapolated value of a curve which may be determined experimentally by measuring with thermocouples the temperature at a series of points successively closer to the surface. The maximum temperature of the rubbing surfaces will be the melting temperature of the lowest-melting-point major metal. Thus, if the brake lining is pure copper and the drum material pure iron, the maximum temperature of the interface will be the melting temperature of copper. The degree of approach of the minimum temperature to the maximum will depend upon the amount of energy to be absorbed by the friction mechanism and upon the time involved.

A cautious and reasonable approach to the temperature question will help in correctly appraising the effects of heavy duty braking under extreme energy absorption service. The immediate effect of high temperature in a brake is wear, either on the brake lining or the drum.

High-temperature resistance to wear is increased in molded linings by increasing the amount of inorganic material, such as metals, graphite, oxides, and ceramics, in the lining. Near the surface, if the organic binder is destroyed by heat, the ceramic fillers remain and continue to have body and friction properties. The melting temperature of the remaining ceramics is relatively high, and may be higher than that of the steel. If the latter is true, then scoring and general damage to the drum may ensue, because the maximum temperature reached at the surface will be the melting temperature of the drum, instead of the lining. If sintered-metal linings are employed, and the melting point of the matrix metal is substantially lower than that of the drum, it is not likely that the metal lining will damage the drum for reason of high melting point.

Notes

amount [ə'maunt] — *кількість*
similarly ['sɪmɪləlɪ] — *подібно*
on the other hand — *з другого боку*
to decelerate [di:'seləreɪt] — *зменшувати швидкість*
permissible [pə'mɪsəbl] — *дозволений, допустимий*
deterioration [dɪ,tɪərɪə'reɪʃn] — *погіршення, псування*
resin ['rezɪn] — *смола*
a curve [kə:v] — *крива (лінія)*
cautious ['kɔ:ʃəs] — *обережний, обачний*
reasonable ['ri:zənəbl] — *помірний, прийнятний*
approach [ə'proutʃ] — *підхід*
to appraise [ə'peɪz] — *оцінювати*
lining [laɪnɪŋ] — *облицювання, обкладка*
ceramic [sɪ'ræmɪk] — *керамічний; гончарний*
property ['prɔpətɪ] — *властивість*
to ensue [ɪn'sju:] — *виникати; випливати, виходити*

Text 15. Metal Adhesives

Properties and Advantages

Although metal adhesives have only existed for some 12 years, they have already justified their existence by the contribution which they have made to the more outstanding products of the aircraft

industry. Other industries are now utilizing the advantages conferred by using adhesives, notably the electrical industry, which for the first time is able to join together similar or dissimilar materials with a high-strength adhesive which is also an insulating film.

The conventional methods for joining metals are bolting, riveting, soldering, brazing and welding, all of which are well-tried processes with which every engineer is familiar. There are, however, many applications where none of these really meet the demands of the situation and in such cases adhesives with their rather different properties may be more suitable. The properties and advantages bestowed by the use of adhesives may be summarized as follows:

(1) Simplification of design.

(2) Possible reduction of production time and consequently production cost.

(3) Ability to join together dissimilar materials.

(4) Increased strength over comparable riveted or spot-welded joints, particularly in light alloys.

(5) The ability to join together high-strength aluminium alloys without lowering the physical properties of the alloy.

(6) Absence of distortion in a bonded structure, due to the avoidance of local heating and the lower temperatures used when compared with welding or brazing.

(7) Even stress distribution over the whole of the bonded area and consequent avoidance of areas of high stress concentration, such as occur around rivet holes, spot welds or bolt holes.

Notes

adhesive [əd'hi:sɪv] — *липкий*
to justify ['dʒʌstɪfaɪ] — *виправдовувати*
to confer [kən'fə:] — *надавати; вести переговори*
dissimilar ['dɪ'sɪmɪlə] — *несхожий, відмінний*
bolt ['boult] — *болт; засув*
to rivet ['rɪvɪt] — *клепати*
to solder ['sɔldə] — *паяти, запаяти*
to braze ['breɪz] — *паяти*
to weld — *зварювати*
alloy ['ælɔɪ] — *сплав*
distortion [dɪs'tɔ:ʃn] — *викривлення*
to occur [ə'kə:] — *траплятися*
spot — *місце*

9.

Section. Power and Mechanical Engineering

Text 1. Internal Combustion Engines

The engines of practically all mechanically propelled road vehicles, motorcycles, airplanes, tractors, motor boats, and mobile industrial units belong to that class of prime movers known as heat engines, and to the subdivision thereof which has been generally referred to as "internal-combustion" engines.

Combustion engines may be divided into types according to the duration of the cycle on which they operate, in terms of piston strokes. By a cycle is meant the succession of operations in the engine cylinder which constantly repeats itself. The great majority of modern automotive engines operate on the four-stroke cycle, usually referred to as the Otto cycle, which is completed in four strokes of the piston, or during two revolutions of the crankshaft. Engines are also being built to operate on a cycle which is completed in two piston strokes. In this cycle a combustible gaseous mixture is compressed in the cylinder during the outward stroke of the piston, and burned and allowed to expand during the following inward stroke. Evacuation of the products of combustion and admission of a new charge take place during the latter part of the expansion, and the early part of the compression stroke. Since there is no separate exhaust stroke, the burnt gases cannot be expelled from the cylinder by a pumping action of the piston therein; they must be blown out, by either fresh air or combustible mixture, under pressure, a process known as scavenging. Two-stroke engines with scavenging by combustible mixture are used only in small units (outboard engines, for example), and generally only in applications where the operation is quite intermittent. Their chief advantage is low first cost; their disadvantages are low fuel economy

and lack of flexibility. A few engines have been built to operate on a six-stroke cycle, which has certain advantages where fuel of low volatility is to be used. Four of the six strokes of this cycle are used for the same operations as in the four-stroke cycle (to be described in detail further on); during the remaining two strokes the combustible mixture is retained in the cylinder without being ignited, to give the fuel a better chance to vaporize and to diffuse uniformly throughout the air charge. Six-cycle engines have never reached a practical stage, and of all of the high-speed combustion engines in use today that operate on volatile fuels, more than 99 percent of the total horse power undoubtedly work on the four-stroke cycle.

The four-stroke cycle comprises the following four phases or operations, which succeed one another in the order in which they are given:

Admission of the charge to the cylinder.

Compression of the charge.

Combustion of the charge (which includes its ignition and expansion).

Expulsion of the products of combustion.

Notes

piston ['pɪstən] — *поршень*
stroke ['strouk] — *удар; хід*
cycle ['saɪkl] — *оберт, такт*
crankshaft ['kræŋk ʃɑ:ft] — *колінчатий вал*
outward ['autwəd] — *зовні*
to scavenge ['skævɪndʒ] — *прибирати сміття*
volatile ['vɔlətaɪl] — *непостійний, змінний*
to ignite [ɪg'naɪt] — *запалювати; загорятися*
charge [tʃɑ:dʒ] — *навантаження, заряд*
expulsion [ɪks'pʌlʃn] — *виключення*

Text 2. What a Diesel Engine Is

A diesel engine is a machine which produces power by burning oil in a body of air which has been squeezed to a high pressure by a moving piston. Since it is a machine that produces power, it is called an engine, and since the burning or combustion takes place within the engine itself, it is called an internal-combustion engine. A steam engine uses steam made by burning fuel outside the engine. That is external combustion.

To compress the air, put in the oil, and produce power, every diesel engine must have certain basic parts. It must have a round *sleeve*, or

cylinder, in the bore of which a close-fitting *plug* or *piston* can slide in and out to make strokes. The piston must be connected to a mechanism which controls its sliding. For this purpose ordinary engines use a *crank mechanism*. This consists of, first, a round bar or *shaft* which can turn or revolve in circular guides called *bearings* and which has an offset or *crank* (which turns in a circle when the shaft revolves), and, second, a *connecting rod* which, as the name implies, connects the crank to the piston. The connecting rod is a straight rod with a bearing at each end. The crank mechanism (which is also used in many other kinds of machinery) is a device for converting the in-and-out motion of the piston to rotating motion of the crankshaft. The power produced by the engine is taken off the crankshaft.

Other basic parts are necessary. *Valves* or *ports* are needed to let the air into the cylinder, and also to let out the burned or spent gases after they have done their work. Also a *spray nozzle*, or *fuel injector*, is needed to deliver the oil for burning in the form of a finely divided spray. (It works something like the nozzle on a garden hose.) To do this the oil must be put under pressure. This is accomplished by a pump which is called a *fuel-injection pump*.

Notes

to squeeze [skwi:z] — *стискувати; прошитовхувати*
sleeve — *муфта*
bore [bɔ:] — *отвір*
plug [plʌg] — *втулка; пробка*
crank ['kræŋk] — *кривошип, коліно*
shaft [ʃɑ:ft] — *вісь, держак*
valve ['vælv] — *клапан, вентиль*
nozzle ['nɔzl] — *сопло́, форсунка*
to accomplish [ə'kɔmplɪʃ] — *виконувати, здійснювати*

Text 3. What Happens Inside the Engine

To begin learning how a diesel engine works, let's see what happens inside the engine, step by step.

Basic Actions.— First, air must be gotten into the cylinder because no fuel will burn without air.

Burning or combustion is the process of uniting a fuel or *combustible* with the oxygen in the air. The process is a chemical one, which means that the fuel and oxygen, in uniting, change into new substances.

Second, the air must be squeezed or *compressed* to a high pressure.

There are two reasons for compressing the air. One reason is that if the combustible mixture has been compressed to a high pressure before it starts to burn, it will produce more power than if it had not been compressed. The other reason is that when air (or any gas, for that matter) is compressed, its temperature goes up — the higher the pressure, the higher the temperature. In a diesel engine, the air is compressed so much that it becomes as hot as red-hot iron, in fact, so hot that it will *ignite* oil that is sprayed into it.

This is a fundamental difference between a diesel engine and a gasoline engine such as the one in an automobile. In a gasoline engine, a spark is used to ignite the combustible mixture, while in a diesel engine the fuel ignites by itself just from contact with air — air that is very hot because it has been highly compressed.

Third, the fuel must be squirted into the cylinder in the form of a fine spray. The oil squirted in *after* the air has been compressed and thus heated to a high temperature. It must be in the form of a fine spray so that a cloud of oil droplets will spread throughout all of the air. This produces a thorough or "homogeneous" mixture of oil and air, which is needed for quick and complete combustion. (It all must happen so fast in an engine that there's no time to waste.)

Fourth, combustion takes place immediately after the oil is sprayed into the cylinder; this generates a large amount of heat. The gaseous mixture gets hotter and tries to grow larger or *expand*. It pushes on the piston, which in turn transmits the force through the connecting rod to the crank on the crankshaft. This makes the crankshaft revolve and thus deliver *power* to whatever machine the engine is driving.

Fifth and last, when the piston has finished its preceding power stroke, and the gases in the cylinder have lost their pressure, the spent gases must be gotten rid of or *exhausted*.

Meaning of a "Cycle". — When the cylinder is rid of the spent gases, it is ready to receive a fresh charge of air and start the *cycle* all over again. A cycle, in other words, is a full series of the separate steps or *events* which follow each other.

This is a good place to learn what is meant by the common terms of *two-cycle* engines and *four-cycle* engines. These terms are *really* abbreviations for *two-stroke cycle* and *four-stroke cycle*, which make more sense, but almost everyone now uses the shorter terms. In a two-cycle engine, it takes two strokes of the piston (that is, one up-stroke and one down-stroke) to go through one complete cycle of *events*. In a four-cycle engine, a complete cycle requires four strokes of the piston (one up, one down, one up and one down). These terms apply to all kinds of internal-combustion engines, not merely to diesels.

Notes

spark [spɑ:k] — *іскра, спалах*
to squirt ['skwə:t] — *пускати струмінь*
homogeneous [hɔmə'dʒi:njəs] — *однорідний*
to generate ['dʒenəreɪt] — *породжувати; викликати*
exhaust [ɪg'zɔ:st] — *випуск, вихлоп*
merely ['mɪəlɪ] — *тільки, лише; просто*

Text 4. How Diesel Engines Differ from Gasoline Engines

If you know something about ordinary **gasoline engines**, such as those in automobiles, you will have noticed that diesel engines, in many respects, work in the same way. Before we see how they differ, let's see how they are alike.

Both types of engines run on *liquid* fuels. In certain special cases they even use exactly the same fuel. Gasoline engines have been made to run on kerosene, and so have diesel engines. Gasoline, kerosene, and diesel oil are all produced from natural petroleum (crude oil), and are distinguished mainly by their *volatility*, that is, the ease with which they can be changed from a liquid to a vapor. Gasoline is quite volatile, that is, it evaporates or vaporizes at a low temperature. Kerosene needs more heat to make it vaporize, while diesel oil requires still more heat.

Both types of engines are *internal-combustion* engines, that is, they burn the fuel inside their cylinders. Most gasoline engines and many diesel engines work on the four-stroke cycle, that is, the piston makes a suction stroke (down), a compression stroke (up), a power stroke (down), and an exhaust stroke (up).

What, then, are the main *differences* between diesel engines and gasoline engines?

First, a diesel engine has no ignition system — it has no spark plug fed with high-tension electricity from a distributor, spark-coil, timer, and battery, or from a magneto. None of this is needed on a diesel engine because the fuel is ignited simply by contact with very hot air which has been highly compressed in the cylinder.

Second, a diesel engine draws into its cylinder air alone, and it compresses this air on its compression stroke *before* any fuel enters the cylinder. On the other hand, a gasoline engine mixes air with fuel in a carburettor *outside* the cylinder before it enters the engine through the inlet valve during the suction stroke.

Third, diesel engines use greater compression than gasoline engines. In a gasoline engine, the amount of compression or *compression ratio* that can be used is strictly limited because *fuel*, as well as air is being compressed. If the combustible fuel-air mixture is compressed too much, it gets so hot that it will ignite by itself. In other words, the mixture will *pre-ignite* before the piston has completed its compression stroke, and will try to stop the piston. Even a little more compression than the right amount will cause *detonation* or *knocks* because some of the mixture burns all at once before the flame from the spark gets to it. A mixture of a certain amount of fuel and air will produce more power the more it has been compressed. Therefore, the *efficiency* of a gasoline engine, that is, the amount of power produced from a certain amount of fuel, is limited by the permissible compression ratio, which is about 7 to 1 (or a little more if highly leaded premium gasoline* is used.).

The compression in a diesel engine is not limited by the possibility of pre-ignition because a diesel engine compresses air only. Therefore, diesel engines use compression ratios of about 16 to 1, and so achieve greater efficiency in the use of fuel.

Fourth, diesel engines use less volatile, heavier liquid fuels than gasoline engines. These heavier fuels are generally cheaper than gasoline. Gasoline engines must use this highly volatile fuel because only a fuel which evaporates at low temperature will form a uniform mixture with the rapid current of air flowing through the carburettor.

Fifth, diesel engines use fuel pumps and injection nozzles to inject the oil into the cylinder in the form of a fine spray. Gasoline engines, on the other hand, mix the fuel and air in a carburettor.

Sixth, diesel engines are heavier than gasoline engines of the same size because they work against greater pressures, and consequently their parts must be stronger. The greater strength is obtained (for the same materials) by making the parts thicker and therefore heavier.

Notes

volatility [ˌvɔləˈtɪlɪtɪ] — *мінливість*
volatile [ˈvɔlətaɪl] — *непостійний*
suction [sʌkʃn] — *впускний*
carburettor [ˈkɑ:bjuretə] — *карбюратор*
detonation [ˌdetouˈneɪʃn] — *вибух*

* highly leaded premium gasoline [ˈhaɪlɪ ˈledɪd ˈpri:mjəm ˈgæsoli:n]

Text 5. Diesel Engines Compared to other Prime Movers

Why are **diesel engines** used so much? Not merely because they can produce power — there are many other ways of producing power. Besides diesel engines, there are gasoline engines, steam engines, steam turbines, and water wheels (also known as hydraulic turbines), to name some though not all such examples. These machines are known as prime movers. Also, you can often buy power in the form of electricity which has come over wires; this is power which first has been produced by a prime mover and then converted into electricity. So it is a fair question — why, with all these different sources of power are diesel engines often preferred to the others? Sometimes the question is easily answered; sometimes it demands professional engineering study.

Advantages of Diesel Engines. — It's not the purpose of this chapter to explain the work of professional engineers, so let's just list the main advantages that diesel engines have over other forms of power for certain kinds of uses.

1. Small Consumption of Fuel. The diesel engine is one of the most highly efficient heat-engines; that is, it gets more power out of the fuel it burns than any other ordinary prime mover, except the largest and most efficient steam turbines. Its fuel consumption is much less than that of a gasoline engine. It is an engine of high *economy*.

2. Cheap Fuel. The diesel engine uses fuels costing less than half as much as gasoline.

3. Economy at Light Loads. The diesel engine is not only efficient when it is fully loaded, but also when it is only partly loaded (which is the way engines run most of the time). When running at half load, the diesel engine consumes only about 10 percent more fuel *per unit of power produced* than it does at full load. The efficiency of other engines drops off greatly when the load is reduced.

4. Greater Safety. Diesel fuel is nonexplosive and is far less inflammable than gasoline. In fact, it requires special effort to make it start to burn, much like hard coal does. This feature, alone, makes the diesel attractive in the motorboat field. Also, diesel exhaust gases are less poisonous than those from gasoline engines, because they contain little carbon monoxide.

5. Economy in Small Sizes. In great contrast to a steam- power plant, a small diesel engine has nearly as good an economy as a large one. This makes it possible to build an efficient power plant just large enough to meet present needs, and to enlarge it with additional

units as the load grows. At all stages of growth, the efficiency is high.

6. Sustained Economy in Service. Again in contrast to a steam-power plant, diesel efficiency falls off little during thousands of hours of use between overhauls. Steam-plant efficiency depends on continuous control of the furnace conditions and gradually falls off as boiler tubes become fouled. These factors are not present with diesel engines — as long as the exhaust gases are clear, the fuel economy must be good.

7. Independence of Water Supply. An efficient steam plant requires great quantities of condensing water, and must generally be located near a large body of water. A diesel engine requires little water, and can be successfully used in the most arid regions.

8. Lightness and Compactness. The diesel engine is a complete power plant in itself; it can be made light in weight and takes up a small amount of space. It is therefore well suited to portable and mobile installations.

9. Quick Starting. A cold diesel engine can be started instantly and made to carry its full load in a few minutes. It is therefore ideal for supplying emergency power.

10. Easily Reversible. By adding an extra set of cams, a diesel engine can be made to run at full power in either direction. This is important in marine applications.

11. Economy in Labor. No fireroom force is needed.

12. Freedom from Nuisance. There are no ashes to be disposed of, no noisy and dusty coal-handling and pulverizing equipment to maintain, no smoke, and noise can be easily eliminated.

Disadvantages of Diesel Engines.—We have just learned the main advantages that diesel engines have over other forms of power producers. But diesel engines also have certain disadvantages, and you might as well learn right now what they are, so that you will understand why such engines do not fit into many applications.

1. Cost. Diesel engines, because of the higher pressures at which they work, require sturdier construction, better materials, and closer fits than gasoline engines. Therefore, they cost more to build.

2. Weight. Because of the sturdier construction, mentioned above, diesel engines weigh more than gasoline engines of the same power.

3. Attendance. A diesel engine requires more attention than an electric motor running on purchased current. It also requires more attention per unit of power produced than a large steam turbine or water wheel.

4. Fuel Cost. The type of oil which most diesel engines use for fuel is often more costly than coal when compared on a heat-value basis. A dollar's worth of coal contains more heat units than a dollar's worth of diesel oil. Ordinarily, this difference in fuel price is more than offset by the small amount of oil consumed by the diesel compared with the amount of coal burned in a steam-power plant of the same power. But if coal is unusually cheap compared to oil, a steam-power plant may produce power at a lower cost for fuel than a diesel could.

A steam-power plant may also be able to cut its fuel cost below that of a diesel if its exhaust steam (which contains most of the heat) can be fully utilized for some heating process (as in a laundry).

Of course, no fuel at all is needed to drive a water wheel in a water-power plant. (The main items of cost in a water-power plant are the charges on the investment.)

5. Space. For large power outputs, diesel engines occupy much more space than steam turbines.

You can now see why, for one or more of the above reasons, other forms of power are preferred for such uses as:

a) Airplanes. Gasoline engines are lighter.

b) Ordinary automobiles. Gasoline engines are cheaper to build.

c) Electric-power plants in large cities. Large steam turbines occupy less space, require less attendance, and can use cheap coal efficiently.

Notes

hydraulic [haɪ'drɔ:lɪk] — *гідравлічний*
to sustain [səs'teɪn] — *підтримувати, витримувати*
to foul ['faul] — *забруднювати*
arid ['ærɪd] — *посушливий*
portable ['pɔ:təbl] — *складний; розбірний*
instantly ['ɪnstəntlɪ] — *відразу, негайно*
emergency [ɪ'mə:dʒnsɪ] — *крайність; непередбачений випадок*
nuisance ['nju:sns] — *прикрість, неприємність*
to dispose [dɪs'pouz] — *розміщати; використовувати*
sturdy [s'tə:dɪ] — *стійкий; сильний*
attendance [ə'tendəns] — *обслуговування; догляд*
to consume [kən'sju:m] — *споживати, марнувати*
offset ['ɔ:fset] — *відвід (труби)*
to utilize ['ju:tɪlaɪz] — *використовувати*
output ['autput] — *продуктивність; випуск; результати*

Text 6. Distinguishing Features of Diesel Engines

How to Recognize a Diesel Engine. — Whenever you see an engine you should be able to tell quickly whether or not it is a diesel. Many diesels, at first glance, look like gasoline engines, but it's easy to distinguish them if you keep in mind three essential differences in the way they work. These are: (1) the diesel ignites its fuel solely by the heat of compression, and therefore has no external ignition system; (2) the diesel draws in air alone when it fills its cylinders, and therefore uses no carburettor; (3) the diesel injects its fuel into the cylinder in the form of a spray at high pressure, and therefore uses a fuel-injection pump.

Table 1, which shows these essential differences between diesel and gasoline engine, will help you recognize a diesel.

Table I. Differences between a Diesel and a Gasoline Engine

Features	Diesel Engine	Gasoline Engine
Ignition system	Has no visible ignition system.	Has spark plugs. Has spark coil or magneto.
Carburetion	Cylinders are filled with air alone. Has no carburettor.	Has carburettor to mix gasoline and air before they enter cylinders.
Fuel injection	Has fuel-injection pump to spray oil into cylinders under high pressure. Has spray nozzle in each cylinder.	Has no fuel-injection pump or spray nozzles in cylinders.

There's another important difference between diesel and gasoline engines — the diesel is built heavier because it must withstand higher pressures, but you can hardly see this from the outside.

Some vertical steam engines of late design look remarkably like diesels, which is not surprising because the designers of these steam engines deliberately copied some of the mechanical features of diesel construction. But the large steam supply pipe gives them away, as does the absence of a fuel-injection pump.

Where passenger traffic is light, and only one or two cars are needed, diesel electric railcars are used. They work like the locomotives, but each car carries its own diesel-electric power plant as well as the electric motors to drive the wheels.

The reason why the railroads have almost universally adopted the diesel engine is to save money. Compared to steam locomotives diesels save money by using much less fuel and by being available for service for much more of the time. Compared to straight electric locomotives, diesels save the heavy investment required for overhead wires or third rails. Passengers prefer diesel electric locomotives to steam because trains start more smoothly, travel more comfortably at higher speeds, and give off little smoke.

Trucks, Buses, Tractors, Power Shovels, Construction Machinery, Logging Equipment. — Diesel engines have come into general use for all these applications. The principal reason is the saving in cost of fuel — the diesel engine uses fewer gallons of less costly fuel than the gasoline engine. True, the diesel costs more to begin with, but if it is used in a class of service which keeps it busy enough, the saving in cost of fuel soon pays back the extra investment.

Another advantage of the diesel is its greater pulling or "lugging" power when it slows down under a heavy load. In other words, the diesel loses less power at reduced speed than the gasoline engine.

Stationary Power Plants. — Diesel engines are employed in a great many kinds of stationary power plants. The reasons are many: the chief ones are saving in cost of fuel compared to small steam or gasoline power plants, and lower total cost than that of bought electric power. Additional advantages enter into certain special applications such as isolated service stations, railway water stations, vacation resorts, lumber camps, mine power plants, oil-well drilling, and emergency power plants. Here the following advantages of the diesel are important: independence of water supply, lightness and compactness, freedom from fire hazard, and ability to start quickly.

Marine Uses. — Diesels are now widely used in marine service of many kinds, such as sea-going vessels (both passenger and freight), motorboats, ferryboats, tugs, naval vessels, and icebreakers. The main reason for these uses of diesels is, again, lower cost of fuel compared to steam. Submarines used to be powered with gasoline engines; now they invariably use diesels, not only because of the greater range of travel due to their consuming less fuel, but also because of the reduced fire hazard. The latter is also an impelling reason for the use of diesels on motorboats.

Mines and Tunnels. — Diesel locomotives are now preferred to electric locomotives for mine haulage and for tunnel construction

because they are less expensive in both first cost and operating cost. Their exhaust gases contain little poisonous monoxide gas, which is an important objection to gasoline engines.

Notes

deliberately [dɪ'lɪbərɪtlɪ] — *навмисно*
universal [ˌju:nɪ'və:sl] — *загальний, універсальний*
smoothly ['smu:ðlɪ] — *рівно, спокійно*
stationary ['steɪʃnərɪ] — *стаціонарний, постійний*
lumber ['lʌmbə] — *лісоматеріал; мотлох*
ferryboat ['ferɪbout] — *судно для перевозу через річку*
submarine ['sʌbməri:n] — *підводний човен*
invariably ['ɪvɛərɪəblɪ] — *незмінно, постійно*
to impel [ɪm'pel] — *спонукати, примушувати*
haulage ['hɔ:lɪdʒ] — *тяга; доставка*

Text 7. Gasoline Engines

Fundamentals of the Automobile

Basically, the automobile consists of four components. These are:

1. The engine.
2. The framework, or support for the engine and wheels.
3. The power train, or mechanism that transmits the power from the engine to the wheels.
4. The body.

To these may be added a fifth component, the car-body accessories: the heater, lights, radio, and other devices that contribute to the convenience and comfort of the driver.

The Engine. — The engine is the source of power that makes the wheels go around and the car move. It is usually referred to as an internal-combustion engine because gasoline is burned within its cylinders or combustion chambers. This burning, or combustion, takes place at such high speed as to be termed an "explosion"; the high pressure thus created causes a shaft to turn or rotate. This rotary motion is transmitted to the car wheels by the power train so that the wheels rotate and the car moves.

Most automobile engines have six or eight cylinders, although some four-, twelve-, and sixteen-cylinder engines are in use.

Engine Operation. — The activities that take place in the engine cylinder can be divided into four stages, or strokes. "Stroke" refers to the piston movement. The upper limit of piston movement is called

top dead center, or T. D. C. The lower limit of piston movement is called bottom dead centre or B. D. C. A stroke constitutes piston movement from TDC to BDC, or from BDC to TDC. In other words, the piston completes a stroke each time it changes direction of motion. Where the entire cycle of events in the cylinder requires four strokes (two crankshaft revolutions), the engine is called a four-stroke-cycle engine or a four-cycle engine. The four strokes are: intake, compression, power and exhaust.

a. Intake. — On the intake stroke the intake valve is opened. The piston is moving down, and a mixture of air and vaporized gasoline is being drawn into the cylinder through the valve opening. The mixture of gasoline and air is delivered to the cylinder by the fuel system.

b. Compression. — After the piston reaches BDC or the lower limit of its travel, it begins to move upward and at this instant the intake valve closes. The other valve is also closed so that the cylinder is sealed. The piston moves upward, compressing the mixture to as little as onesixth of its original volume or less. This creates a fairly high pressure within the cylinder.

c. Power. — As the piston reaches TDC or the upper limit of its travel, an electric spark is generated at the cylinder spark plug. The spark plug consists of two wire electrodes, which are electrically insulated from each other. At the proper instant the ignition system delivers a high-voltage surge of electricity to the spark plug. This causes an electric spark to jump across the gap between the spark plug electrodes. The spark ignites or sets fire to the highly explosive mixture of gasoline vapor and air. Rapid combustion takes place, and the already high pressure within the cylinder increases to as much as 400 pounds per square inch. At this instant a piston 3 inches in diameter would have a pressure of nearly $1^1/_2$ tons pushing against it. This terrific pressure against the top of the piston forces it downward, and a power impulse is transmitted to the engine crankshaft through the connecting rod and crank. As the piston moves downward on the power stroke, it continues to transmit turning effort to the shaft.

d. Exhaust. — As the piston reaches the lower limit of its travel again, the exhaust valve opens. The piston moves upward on the exhaust stroke, forcing the burned gases out of the cylinder through the exhaust-valve opening. At the instant that the piston once more reaches top dead center, the exhaust valve closes and the intake valve opens so that, when the piston begins to move downward on the intake stroke, a fresh charge of gasoline vapor and air can be drawn into the cylinder. The above four strokes are continually repeated during the operation of the engine.

Fuel System. — The fuel system is designed to store liquid gasoline and to deliver it to the engine cylinders on the intake strokes in the form of vapor mixed with air. The fuel system must vary the proportions of air and gasoline vapor to meet the requirements of the various operating conditions. Thus for initial starting with a cold engine a very rich mixture of about 9 pounds of air to 1 pound of gasoline is needed. After the engine has warmed up, it will run satisfactorily on a leaner mixture of about 15 pounds of air for each pound of gasoline. For acceleration and full-load or high speed operation, the mixture must again be enriched.

The fuel system consists of a tank in which the liquid gasoline is stored, a fuel line, or tube, through which the gasoline can be brought from the tank to the engine, a pump, which pulls the gasoline through the fuel line, and a carburettor, which mixes the gasoline with air. The carburettor is designed to mix each pound of gasoline with 9 to 15 pounds of air under various operating conditions. The richer mixtures of about 9 pounds of air per pound of gasoline are for starting, initial warm-up, and acceleration, while the leaner mixtures of about 15 pounds of air per pound of gasoline are for normal over-the-road operation.

Fuel Pump. — The fuel pump consists of a rocker arm, a flexible diaphragm, and two valves. The rocker arm rests against a cam on the camshaft so that rotation of the shaft makes the arm rock. This rocking motion causes the diaphragm to fluctuate up and down, alternately creating pressure and vacuum in the pump chamber. When vacuum is created, the inlet valve is lifted off its seat, allowing gasoline to be drawn from the fuel tank, through the fuel line, and into the pump chamber. On the return stroke the diaphragm creates pressure in the pump chamber. This causes the inlet valve to close and the outlet valve to open, forcing gasoline from the pump chamber through a fuel line to the carburettor.

Fuel Tank. — The fuel tank, normally located at the rear of the vehicle and attached to the frame, is merely a storage tank made of sheet metal. It often contains a number of baffles or metal plates, which are attached to the inner surface of the tank parallel to the ends. These have openings through which the gasoline can pass, and their main purpose is to prevent sudden surging of the gasoline from one to the other end of the tank, when the car rounds a corner. The filler opening of the tank is closed by a cap, and the tank end of the fuel line is attached at or near the bottom of the tank. Usually, this line enters the tank at some point slightly above the bottom so that dirt or water that has settled to the bottom of the tank will not enter the fuel line.

Engine Fuels. — The automobile engine uses gasoline as a fuel.

Notes

framework — *каркас, конструкція*
to transmit [trænz'mɪt] — *передавати*
accessory [æk'sesərɪ] — *додатковий, допоміжний*
to contribute [kən'trɪbju:t] — *вносити, сприяти*
convenience [kən'vi:njəns] — *вигода, користь*
intake ['ɪnteɪk] — *впуск*
to seal [si:l] — *герметизувати, закривати*
plug — *запальна свічка (в моторі)*
to insulate ['ɪnsjuleɪt] — *ізолювати*
to store [stɔ:] — *робити запас, відкладати*
to attach [ə'tætʃ] — *прикріплювати*
storage ['stɔrɪdʒ] — *зберігання*
to baffle ['bæfl] — *спантеличувати; перешкоджати*
to surge ['sə:dʒ] — *хвилюватися*
tank ['tæŋk] — *резервуар; цистерна, бак*
slightly ['slaɪtlɪ] — *легко; злегка*
to settle ['setl] — *осідати*

Text 8. The Electric System

The electric current, as it moves through various wires, conductors, and electrically operated devices, performs several jobs on the car. It cranks the engine, furnishes electric sparks at the spark plugs that ignite the compressed mixture in the cylinders, operates the radio and heater motor, supplies lights for night driving, and operates gauges on the dash of the car that indicate charging rate in amperes, oil pressure, engine temperature, and the amount of fuel in the tank.

Components of Electric System. — The electric system consists of the storage battery, cranking motor, generator, regulator, ignition distributor, coil, and spark plugs as well as the wires and switches that connect these various units. Lights, radio, heater, indicating gauges, and other electrically operated devices, while a part of the electric system, are usually considered as accessory devices, since they are not absolutely necessary to the operation of the car.

a. Storage Battery. — The storage battery is an electrochemical device, which means that its operation depends on both chemical and electrical actions. The battery is a source of electric current when the engine is being cranked with the electric cranking motor and also during the times when the generator is not supplying enough current

for connected electric units. When current is withdrawn from the battery, chemical actions take place that produce the flow of current. The chemicals in the battery are, in a sense, used up by this chemical action. Thus, after a certain amount of current has been withdrawn, the battery becomes "discharged." To "recharge" the battery, current from some external source, such as a generator, must be forced through it in the opposite direction.

b. Cranking Motor. — The cranking motor is a special direct-current electric motor that starts the engine by rotating the crankshaft when the cranking-motor switch is closed. Closing the switch connects the motor to the battery. There is a special gearing arrangement between the cranking-motor drive pinion and the engine flywheel that will be discussed below.

c. Generator. — The generator is a device that converts mechanical energy (from the automobile engine) into a flow of electric current. This current restores the battery to a charged condition when it has become discharged and also operates electrical devices, such as the ignition system, lights, radio, etc. The generator is usually mounted to the side of the engine block and is driven by the engine fan belt.

d. Regulator. — Under some conditions, the generator could produce too much current, and this would damage the various electrical devices turned on. To prevent such damage a generator-output regulator is used. The regulator controls the amount of current the generator produces, allowing the generator to produce a high current when the battery is in a discharged condition and electric units are turned on. When the battery becomes charged and electric units are turned off, the regulator cuts down the current produced to the amount needed to meet the operating requirement of the system.

e. Ignition System. — The ignition system provides the electric sparks that ignite or set fire to the compressed fuel air mixture in the engine cylinders. Each spark is timed by the ignition system to appear at the correct instant with respect to the piston as it approaches the end of the compression stroke.

f. Lights, Heater, Radio, Indicating Devices. — The lights, radio, and heater add to the flexibility, comfort, and convenience of the car, while indicating devices keep the driver informed as to engine temperature, oil pressure, amount of fuel, and battery charging rate.

g. Wiring and Switches. — The wiring that connects the various electric units serves as paths or circuits through which the current can flow from one to another unit. Switches, placed in these circuits, are forms of valves that can close or open the circuits to permit or prevent the flow of current. The wires are made up of conducting materials, such as copper, that freely conduct the current between

the electric units. Some materials, such as rubber or glass, are non-conductors or insulators that will not allow current to flow through them. Such substances are used to cover and insulate the wires so that the current will be kept within the proper circuits or paths.

Notes

to furnish ['fə:nɪʃ] — *постачати*
gauge ['geɪdʒ] — *розмір, масштаб*
battery ['bætərɪ] — *акумулятор; батарея*
generator ['dʒenəreɪtə] — *генератор*
coil ['kɔɪl] — *змійовик*
switch — *вимикач*
pinion ['pɪnjən] — *шестерня*
flywheel ['flaɪwi:l] — *махове колесо*

Text 9. Power Train

The power that the engine develops must be transmitted to the car wheels, so that the wheels will rotate and cause the car to move. The **power train** performs this job, providing in the process several different gear ratios between the engine crankshaft and wheels, so that the engine crankshaft may rotate approximately four, eight, or twelve times to cause the wheels to rotate once. The power train consists of a series of gears and shafts, which mechanically connect the engine shaft with the car wheels, and contains a clutch, a transmission or change gears, a propeller shaft, and the final drive.

a. Clutch.— The clutch permits the driver to connect the crankshaft to or disconnect it from the power train. A clutch is necessary since the automobile engine must be started without load, that is without being required to deliver any power. In order for the engine to deliver power, the crankshaft must be rotating at a reasonable speed of several hundred revolutions per minute or more. The engine will start at speeds below 100 r.p.m. (revolutions per minute), but it would not continue to operate at this low speed if a load were immediately thrown on it. Consequently, a clutch is placed in the power train between the crankshaft and transmission. The clutch permits the engine to run freely without delivering power to the power train. It also permits operation of the transmission so that the various gear ratios between the engine crankshaft and wheels may be obtained.

The clutch consists essentially of a double-faced friction disk about a foot in diameter, which is splined to the clutch shaft, and a spring arrangement for forcing this disk tightly against the smooth face of

the engine flywheel. The splines are internal teeth on the friction-disk hub and external teeth on the clutch shaft that permit relative axial movement but cause the disk and shaft to rotate together. The flywheel is attached to the end of the engine crankshaft, and when the clutch is engaged, the friction disk is held against the flywheel so that it revolves with the flywheel. This rotary motion is transmitted through the clutch and clutch shaft to the transmission and from there to the car wheels.

When the clutch foot pedal is depressed, the clutch fork lever moves against the clutch throw out bearing, forcing the bearing inward. This operates release levels that take up the spring pressure so that pressure against the friction disk is relieved and it can move away from the flywheel face. When this happens, the friction disk and shaft stop revolving. When the foot pressure on the clutch pedal is removed, the springs again force the friction disk against the flywheel face, so that it once more rotates with the flywheel.

b. Transmission. — The transmission or change gears provide a means of varying the gear ratios of the engine crankshaft and the wheels. Thus the engine crankshaft may turn four, eight, or twelve times for each wheel revolution (approximately). In addition, a reverse gear is provided that permits backing the car.

The varying gear ratios are necessary since the gasoline engine does not develop much power at low engine speeds: it must be turning at a fairly high speed in order to deliver enough power to start the car moving. Thus, on first starting, the gears are placed in low-speed so that the engine crankshaft will turn approximately 12 times for each wheel revolution. The clutch is then engaged, so that power is applied to the wheels. Car speed increases with engine speed until the car is moving 5 or 10 miles per hour, at which time the engine crankshaft may be turning as many as 2,000 r.p.m. The clutch is then disengaged and the engine crankshaft speed reduced to permit gear changing; the gears are shifted into second, and the clutch is again engaged. Since the ratio is now about 8:1, a higher car speed is obtained as engine speed is again increased. The gears are then shifted into high, the clutch being disengaged and engaged for this operation, so that the ratio between the engine and wheels will be approximately 4:1. In other words, the engine crankshaft will turn four times to cause the wheels to turn once.

c. Gears. — Before we further consider the transmission and the final drive, it is well to take a look at gear construction. The relative rotation between two meshing gears (or the gear ratio) is determined by the number of teeth in the gears. When two meshing gears have the same number of teeth, they will both turn at the same speed.

When one gear has more teeth than the other, however, the smaller gear will turn more rapidly than the larger one. Thus a gear with 24 teeth will turn half as fast as a gear with only 12 teeth, and the gear ratio between the two gears is 2:1. If the 12-tooth gear were meshed with a 36-tooth gear, the 12-tooth gear would turn three times for every revolution of the larger gear. The gear ratio between these gears would be 3:1.

d. Operation of Transmission. — Essentially, the transmission consists of three shafts, and eight gears of various sizes. Four of the gears are rigidly connected to the countershaft. One of the countershaft gears is permanently meshed with the driving gear on the end of the clutch shaft. When the engine is running and the clutch is engaged, the countershaft is rotating in a direction opposite or counter to the rotation of the driving gear. With the gears in neutral and the car stationary, the transmission main shaft is not turning. The transmission main shaft is mechanically connected by shafts and gears in the final drive to the car wheels. The two gears on the transmission main shaft may be shifted back and forth along the splines on the shaft by operation of the gearshift lever in the driving compartment. The splines are matching internal and external teeth that permit axial movement of the gears but cause the gears and shaft to rotate together.

Low Gear.— When the gearshift lever is operated to place the gears in low, the large gear on the transmission main shaft is moved along the shaft until it meshes with the small gear on the countershaft. The clutch is disengaged for this operation so that the clutch shaft and countershaft stop rotating. When the clutch is again engaged, the transmission main shaft is caused to rotate as the driving gear on the clutch shaft drives it through the countershaft. Since the countershaft is turning more slowly than the clutch shaft, and since the small countershaft gear is engaged with the large transmission main shaft gear, a gear reduction of approximately 3:1 is achieved; that is, the clutch shaft turns three times for each revolution of the transmission main shaft. Further gear reduction in the final drive at the rear wheels produces a still higher gear ratio (approximately 12:1) between the engine crankshaft and the wheels.

Second Gear.— When the clutch is operated and the gearshift lever moved to second, the large gear on the transmission main shaft demeshes from the small countershaft gear. The smaller transmission main shaft gear is slid into mesh with the large countershaft gear. This provides a somewhat reduced gear ratio, so that the engine crankshaft turns only about twice to the transmission main shafts once. The final drive-gear reduction increases this gear ratio to approximately 8:1.

High Gear.— When the gears are shifted into high, the two gears on the transmission main shaft are demeshed from the countershaft gears, and the smaller transmission-shaft gear is forced axially against the driving gear. Teeth on the ends of the two gears mesh so that the transmission main shaft turns with the clutch shaft, and a ratio of 1:1 is obtained. The final drive-gear reduction produces a gear ratio of about 4:1 between engine crankshaft and wheels.

Notes

consequently ['kɔnsɪkwəntlɪ] — *отже, тому*
hub [hʌb] — *втулка*
to revolve [rɪ'vɔlv] — *обертати(ся)*
to depress [dɪ'pres] — *понижувати, ослаблювати*
to throw out — *виключати*
lever ['li:və] — *ричаг*
transmission [trænz'mɪʃn] — *передача*
to shift — *переміщати(ся)*
to disengage [ˌdɪsɪn'geɪdʒ] — *звільнятися(ся)*
gear ['gɪə] — *шестерня*
rotation [rou'teɪʃn] — *обертання*
to match — *підходити, відповідати*
to clutch [klʌtʃ] — *затискувати*
clutch — *муфта; зчеплення, зубець*
to mesh — *ловити*

Text 10. Steam Turbines

Types and Characteristics

Turbines have developed to their present forms along various lines according to steam conditions, condensing water available, types of service, and requirements as to cost and economy; and this process is still going on, with all builders continually changing, experimenting with and improving their product. There has been a growing amount of standardization of the smaller sizes of machines, but not until the urgent requirements of the Second World War forced it was there a serious attempt to standardize the operating conditions and certain physical characteristics of the units in the range from 11,500 to 60,000-kw rating. However, this standardization is not so rigid but that further development is continually taking place, with the use of higher temperatures and pressures and improvements in heat rates, paralleling the continued improvements in improvement of the elec-

tric generator, condenser, and steam-generating equipment associated with the steam turbine in power plant use.

Definitions. — A steam turbine may be defined as a form of heat engine in which the energy of the steam is transformed into kinetic energy by means of expansion through nozzles, and the kinetic energy of the resulting jet is in turn converted into force doing work on rings of blading mounted on a rotating part. **(Fig. 1.)**

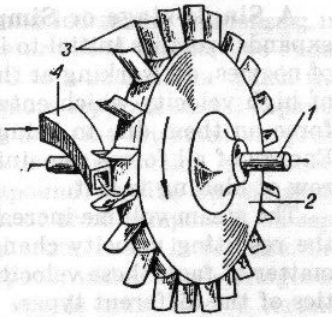


Fig.1. Outline diagram of a steam turbine

1. Shaft 2. Rotor. 3. Blades or buckets. 4. Nazzles or flow passages.

The usual turbine consists of four fundamental parts: the rotor which carries the blades or buckets; the stator consisting of cylinder and casing, which are often combined and within which the rotor turns; the nozzles or flow passages for the steam, which are generally fixed to the inside of the cylinder; and the frame or base for supporting both the stator and the rotor, the latter being carried in bearings. Cylinder, casing, and frame are often combined, particularly in small turbines.

Accessories necessary for the successful continuous commercial operation are a controlling or governing system for adjusting the energy supply to the turbine to suit the load to be carried and for maintaining constant speed, a lubricating system, piping for steam supply and exhaust, and (for economical power generation in large quantities) a condensing system.

Notes

urgent ['ə:dʒnt] — *терміновий*
improvement [ɪm'pru:vmənt] — *поліпшення, удосконалення*
condenser [kən'densə] — *конденсатор*
bucket — *ківш*
stator ['steɪtə] — *статор*
rotor ['routə] — *ротор*

Text 11. Turbine Characteristics

A. With Respect to Form of Blade Passages

Impulse Turbine. — It may be defined as a system in which all steam expansion takes place in fixed nozzles and none occurs in passages among moving blades.

A Single-stage or Simple-impulse Turbine. — Here the steam expands from its initial to its final pressure in one nozzle (or one set of nozzles, all working at the same pressure), resulting in a steam jet of high velocity which enters the blade passages and, by exerting a force on them due to being deflected in direction, turns the rotor. Energy of all forms remaining in the steam after it leaves the single row of blading is lost.

The steam volume increases whenever the pressure decreases, but the resulting velocity changes depend on the type of turbine. As a matter of fact, these velocity changes are distinguishing characteristics of the different types.

A Velocity-stage Impulse Turbine has one set of nozzles, with several rows of blades following it. In passing from the nozzle exit through one set of blades, the velocity of the steam is lowered by virtue of the work done on the blades but is still high. It then passes through a row of fixed guide blades which change the direction of the steam until it flows approximately parallel to the original nozzle direction, discharging it into a second row of blading fixed to the same wheel. This second row again lowers the steam velocity by virtue of the work delivered to the wheel. A second set of guide blades and a third row of moving blades are sometimes used.

The steam enters through a steam strainer and governor valve into a steam chest supplying the various nozzles spaced around a portion of the periphery. Individual nozzles may be opened or closed by a hand wheel on the stem of the nozzle-control valve. The turbine wheel is mounted on a shaft which passes through the casing to bearings outside, carbon packing being used in the shaft glands of this turbine to maintain steam tightness. The governor is mounted on the right-hand end of the shaft and operates the balanced-piston governor valve through a lever and link. On the left end of the shaft goes the coupling for attaching the driven machinery.

B. With Respect to General Arrangement of Flow

In **single-flow** turbines the steam enters at one end, flows once through the blading in a direction approximately parallel to the axis, emerges at the other end, and enters the condenser. This is the most common arrangement in small and moderately large turbines.

In **double-flow** turbines, which are generally low-pressure machines, the steam enters at the center and divides the two portions passing axially away from each other through separate sets of blading on the same rotor. This type of unit is completely balanced against end thrust and gives large area for flow through two sets of low-pressure blading. In these turbines the two low-pressure exhausts

are brought together within the casing and led to the condenser; in some cases, separate exhaust connections are used for the two ends.

Compound turbine is the term applied to a machine in which the steam passes in sequence through two or more separate units, expanding in each. Most often the high-pressure and the intermediate pressure portions are in one casing and the low-pressure portion in another. Two units may be arranged tandem compound, in line on the same shaft and driving the same electrical unit, or cross compound, on separate shafts and driving separate electrical units. In the latter case, the low-pressure unit may rotate at a lower speed, which is advantageous for handling large steam flows, but the speeds must have a certain definite relation dictated by generator frequency requirements. The two units of the cross-compound turbine are operated as one, being held rigidly in step by the electrical phase relation. Tandem-cross compound arrangements are also possible, where the high-pressure unit and its generator are on one shaft and the intermediate and low-pressure units are arranged tandem and drive two generators.

The two units of a cross-compound turbine may be gear-connected to a single generator or to a single propeller shaft. In some marine installations, separate high, intermediate, and low-pressure units have been gear-connected to a single propeller shaft.

Various divided-flow arrangements have been used in the past, with splitting of the flow of partially expanded steam from the high or intermediate sections between two other units. These are now little used in stationary practice, but in marine installations, where two propeller shafts must be driven independently but at approximately equal speeds, except when manoeuvering, they find application.

C. With Respect to Direction of Steam Flow Relative to Plane of Rotation

Axial flow signifies steam flow substantially parallel to the axis of rotation, among blades which are set radially. This is the only arrangement used in medium and large turbines and is generally used in small turbines also. It provides opportunity for almost any desired degree of expansion of the steam by increase in the length of the blades and the diameter at which they rotate, coupled with increase in the number of rows of blades.

Attention may be called here to the fact that in no turbine does the steam whirl around with the rotating part, except to a limited degree, it is also important to realize that the length of time required for a given particle of steam to pass through the turbine is exceedingly brief, being only a few hundredths of a second. Finally, steam turbines cannot be reversed in direction of rotation as can reciprocat-

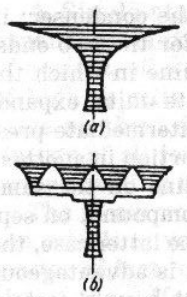


Fig.2.

ing engines. In locomotive and marine propulsion with mechanical drive, separate backing or astern turbines must be provided if a shaft is to be capable of reversed rotation.

Radial flow is obtained when the steam enters at or near the shaft and flows substantially radially outward among blades which are placed parallel to the axis of rotation. In one turbine of this type successive rings of blades are attached alternately to two discs mounted on separate rotors, these rotors turning in opposite directions on the same axis and driving separate generators.

In another turbine of the same type steam enters through openings near the axis in the two discs and passes radially outward over the whole 360 deg. through the successive blade rings. At first the increase of flow area naturally provided by the increasing circumference of the blade rings is too great, and the blade lengths have to be diminished; then the steam begins to expand at a greater rate, requiring longer blades.

Owing to the high relative velocity of the alternate rows of blades rotating in opposite directions, only a moderate number of rows is required for complete expansion with high efficiency. The principle is attractive, and the mechanical problems have been ingeniously solved, but the elaborated packing required to limit leakage, the high cost of construction, and the limitation on the size which can be built, however, have all hindered development, and therefore few of these machines are in use in America.

Tangential flow is the term applied when the steam enters through a nozzle placed approximately tangent to the periphery and directed into semicircular buckets milled obliquely into the edge of the wheel. Coupled with this is the action of a reversing chamber fitted closely to, but not touching, the periphery of the wheel, which has similar buckets milled into it. These latter receive the steam disharged from the wheel buckets and return it again a number of times to the wheel buckets in the proper direction to produce additional work, the steam following an approximately helical path. Any number of nozzles may be used, each with its reversing chamber, up to that number which will completely fill the periphery. This type of flow is also called helical.

Notes

in virtue ['vɜ:tju:] **of** — *завдяки*
strainer ['streɪnə] — *фільтр*
tandem ['tændəm] — *один за одним*

installation [ˌɪnstə'leɪʃn] — *установка, монтаж*
to manoeuvre [mə'nu:və] — *маневрувати*
flow ['flou] — *потік*
to signify ['sɪgnɪfaɪ] — *значити, означати*
substantially [səb'stænʃəlɪ] — *істотно*
arrangement [ə'reɪndʒmənt] — *врегулювання*
alternatively [ɔ:l'tɜ:nətɪvlɪ] — *вибірково*
circumference [sə'kʌmfərəns] — *коло*
ingeniously [ɪn'dʒi:njəslɪ] — *дотепно, винахідливо*
to elaborate [ɪ'læbəreɪt] — *детально розробляти*
periphery [pə'rɪfərɪ] — *периферія*

Text 12. Steam-Turbine Operation and Maintenance

The operator is usually as much interested in reliability as he is in economy, and the removals of turbines from service are due more to "rubs" or their effects than to any other cause lying in the turbines themselves. The speed of wheel rims relative to the adjacent stationary parts varies from 400 to 1,500 or more feet per second; if contact does occur, so much heat is generated almost instantaneously that the deflection which caused the initial rub is apt to be increased owing to warping of the unevenly heated metal, sometimes resulting in the complete destruction of the unit. These rubs may result from one of several causes, even in a turbine which is properly designed in the first place: (a) improper adjustment of the rotor in its axial position; (b) unbalance of the rotor, producing excessive vibration and deflection; (c) sudden wear of the thrust bearing which holds the rotor in axial location or of the bearings supporting the rotor, caused by failure of the lubricating system; and (d) rapid changes in temperature produced by sudden changes in load conditions, causing unequal expansion.

In improperly designed or constructed turbines, the relative expansion of the rotor and casing may be so much that with the clearance originally provided, it is impossible to have any adjustment that will surely prevent rubbing under all operating conditions. Also the discs or diaphragms may be mechanically weak and may deflect under centrifugal force or steam pressure, respectively. The wheels particularly will also vibrate under certain conditions which must be avoided.

Corrosion and erosion of the blades and nozzles will usually necessitate their replacement after a period of service whose length depends on the conditions of operation. In some cases, this has not

happened within the commercial life of the machine; i. e., the machine has become obsolete. The economy of units seems to hold up fairly well through years of service, corrosion and erosion causing a small reduction with age as does the increased leakage due to increased clearance.

Mechanical losses are small; hence the mechanical efficiency is high; and while perfection of the lubricating system is practically essential for successful turbine operation, when once it is attained, bearing troubles and adjustments are infrequent. Care of the unit resolves itself largely into careful watching of the oil temperatures and proper care in cleaning and renewing the oil.

With the steady increase of the initial pressure and temperature of the steam supplied to turbines have come difficulties due to clogging of blade and nozzle passages by solids carried over from the steam generators. More or less effective remedies have been found, but reliable preventatives are still being sought.

Notes

maintenance [ˈmeɪntɪnəns] — *технічне обслуговування, ремонт*
instantaneously [ˌɪnstənˈteɪnjəslɪ] — *миттєво, негайно*
to warp [wɔ:p] — *викривляти(ся)*
deflection [dɪˈflekʃn] — *відхилення*
to lubricate [ˈlu:brɪkeɪt] — *мастити*
improperly [ɪmˈprɔpəlɪ] — *неправильно*
erosion [ɪˈrouʒn] — *ерозія*
obsolete [ˈɔbsəli:t] — *застарілий*
steady [ˈstedɪ] — *міцний, постійний*
remedy [ˈremɪdɪ] — *ліки; засіб*

Text 13. Gas Turbine

The turbine is a major component common to the gas turbine-propeller engine, and to the thermal jet engine. In the gas turbine-propeller engine the turbine must develop the shaft power for driving the air compressor, propeller, and the auxiliaries. In the thermal jet engine, however, it is required to furnish only sufficient power to drive the air compressor and the auxiliaries. It should be noted that, in general, gas turbine-propeller engines are designed to deliver auxiliary jet thrust from the exhaust gases in addition to the propeller thrust, the usual proportions being 80 percent propeller thrust and 20 percent auxiliary jet thrust.

The general characteristics of turbines are well understood, and a wealth of information concerning them has been gathered during the past decades. Particularly helpful to the development of turbines which operate with highly heated gases are the experiences gathered in the development of turbo-superchargers and also steam turbines for high pressure and high-temperature applications. In many respects the turbine for gas turbine-propeller engines or turbo-jet engines is quite similar to the conventional steam turbine, the major difference being in the metallurgy, the means provided for cooling the bearings and highly stressed parts, and in the constructional features to safeguard against thermal distortion. The basic theory underlying their design and the evaluation of their operating characteristics is identical with that for steam turbines.

The **turbine blades** may be either solid or hollow, the type of construction being influenced by the material selected for their manufacture. The hollow blade offers the advantages of being adapted to cooling by flowing cold air through its interior and of reducing weight. The walls of the blade are usually tapered so that the outer extremity, where the stress vanishes, is quite thin. The greatest benefit derived from cooling is at the root of the blade where the stresses are high; the outer edge, because of its small stress, may be allowed to run hot.

In most designs the blades are twisted to maintain a favorable angle of attack for the fluid throughout its length. In the early development of the turbo jet, blading failures did occur, but they are now a rarity. The difficulties were overcome by increased accuracy in the manufacture of the blades, avoidance of small radii at root junctions, better analysis of vibration problems, and improved metallurgy.

Since improving turbine efficiency and output are related to ability to operate with higher temperatures, developments aimed at raising the permissible operating temperature of the turbine are of great importance. One promising approach is the application of ceramic coatings on the turbine blades to take the impact of the hot gases. The problem here is to develop a ceramic coating of high melting point which will bond to the metal and will have a coefficient of expansion close enough to that of the metal to prevent the coating from cracking or flaking off. Another approach proposes to let cooling liquid flow through a passage in the root of the blades.

A general thermodynamic treatment can be applied to both impulse and reaction stages by considering an intermediate stage of a multistage reaction turbine; the intermediate stage typifies the general case of a turbine stage. In such a stage the stationary blade row is the counterpart of the nozzle of an impulse stage.

Notes

major ['meɪdʒə] — *головний*
auxiliary [ɔ:g'zɪljərɪ] — *помічник, допоміжний*
similar ['sɪmɪlə] — *схожий, подібний*
metallurgy [me'tælədʒɪ] — *металургія*
distortion [dɪs'tɔ:ʃn] — *викривлення*
hollow ['hɔlou] — *пустий, порожній*
permissible [pə'mɪsəbl] — *дозволений, допустимий*
to flake ['fleɪk] — *сипатися*
counterpart ['kauntəpɑ:t] — *копія, дублікат*
impulse ['ɪmpʌls] — *поштовх; удар; імпульс*

Text 14. Hydraulic Turbines

Introduction. — Power may be developed from water by three fundamental processes: by action of its weight, of its pressure, or of its velocity; or by a combination of any or all three. In modern practice the Pelton or impulse wheel is the only type which obtains power by a single process, the action of one or more high-velocity jets. This type of wheel is usually found in high-head developments.

Types of Hydraulic Turbines. — Hydraulic turbines may be grouped in two general classes: the impulse type which utilizes the kinetic energy of a high-velocity jet which acts upon only a small part of the circumference at any instant, and the reaction type which develops power from the combined action of pressure and velocity of the water that completely fills the runner and water passages. The reaction group is divided into two general types: the Francis, sometimes called the reaction type, and the propeller type. The propeller class is also further subdivided into the fixed-blade or propeller type, and the adjustable-blade type of which the Kaplan is representative.

Impulse Wheels. With the impulse wheel the potential energy of the water in the penstock is transformed into kinetic energy in a jet issuing from the orifice of a nozzle. This jet discharges freely into the atmosphere inside the wheel housing and strikes against the bowl-shaped buckets of the runner.

Impulse wheels are used at heads of 800 ft. or more, although they may be used at lower heads, depending on the horsepower capacity involved. Usually not more than one or two jets are applied to the circumference of the runner or bucket wheel. The specific speed suitable for a given head and capacity of unit is much lower than that for the Francis or for the propeller type.

Steam issuing from the nozzles passes through the blading on one wheel and on exit immediately enters the blading on the second wheel, which turns in the opposite direction. The arrangement allows large power to be produced by a light and compact machine and has been used for propelling naval torpedoes, the working fluid being highly compressed and heated air. The two propellers turn in opposite directions, one being mounted on the hollow shaft and placed slightly ahead of the other.

G. With Respect to Steam and Exhaust Conditions

High-pressure condensing turbines, built in the largest sizes for power-plant use, and of the highest efficiency, are supplied with steam of high pressure and temperature and small volume and exhaust it at very low pressure and large volume. This great increase in steam volume calls for short blades at the high-pressure end and very long ones at the low-pressure end.

High-pressure noncondensing turbines are used where water for condensing purposes is unavailable or where all the exhaust steam at atmospheric pressure can be used for factory processing or for heating.

The steam volume at exhaust is moderate. These turbines are built in small or moderate sizes only.

Back-pressure turbines are used to furnish large quantities of steam at a fixed pressure for industrial purposes, generating as a by-product power which is dependent in amount on the demand for heating steam. They must operate in parallel with another power source which will make up the total amount needed.

Superposed or Topping Turbines.—Another use of high-pressure noncondensing turbines is for superposition on turbine installations of moderate pressure. For example, an existing plant using steam at 400 lb. and 750° F. and having a 29-in. vacuum might be furnished with a new boiler equipment supplying steam at 1,250 lb. and 950° F. The new high back-pressure unit would exhaust steam into the old turbines at a back pressure which would vary with the load but would be kept safe for the old units.

Mixed-pressure turbines are supplied with steam not only from a high-pressure source but also with low-pressure or exhaust steam, generally from another engine or turbine. The low-pressure steam enters and joins with the high-pressure steam after the latter has passed a number of rows of blades and has expanded down to the pressure at which the low-pressure steam is ordinarily received. Generally the low-pressure steam is expected to furnish most of the energy, the controlling system supplying steam from the high-pressure source to the high-pressure end only when the load requirements are greater than can be met by the low-pressure steam alone.

Regenerative turbines, practically always condensing, are in one sense the reverse of the above; all the steam is received from a high-pressure source, but at one or more points before the steam has expanded to the lowest pressure it is withdrawn or bled at intermediate pressures. Thus several supplies of steam at different temperatures are provided which are used for heating feed water by stages, the feed water going first through a heater supplied with bled steam at the lowest temperature, then progressively through heaters that are supplied with steam from bleed points at higher and higher temperatures. This is called regenerative feed heating, and use of the term should be restricted to the cases where all of the bled steam is used for heating, none being withdrawn for industrial purposes. Practically all large multistage turbines operate on the regenerative cycle.

Extraction turbines are utilized in manufacturing plants where steam is required for manufacturing purposes in addition to power production. A plain or nonautomatic-extraction turbine has a bleed or extraction opening part way down in the expansion, from which some of the steam flow can be drawn, the remainder passing on to the turbine exhaust. The pressure of the extracted steam will, however, vary with the load. To control the pressure, an automatic valve inside the turbine just below the extraction opening controls the flow from that point to the exhaust. When much steam is being extracted, the pressure tends to fall; the extraction valve automatically moves toward the closed position until the reduction of flow past it raises the pressure to the desired point, supplying more steam to the extraction line. If less extraction steam is used, the pressure rises, and the opening of the automatic valve allows more steam to flow to the turbine exhaust. If no steam is extracted, the valve is opened wide and the turbine operates as a straight high-pressure condensing unit. A second extraction may be provided, from which steam at a different pressure may be drawn.

The demands on these units are so different from those made on central-station turbine generators that they are sometimes called industrial turbines in distinction. Their variety is enormous, owing to differences in initial and exhaust conditions, differences in the relative quantity of power and process steam needed, and differences in the requirements as to constancy of turbine speed and of process steam pressure. Their governing systems in particular become complicated.

Reheating turbines have been provided to meet the demand for more economical power-plant operation. High-pressure steam is expanded in a turbine to an intermediate pressure, then is withdrawn and sent back to the boiler room for reheating (re-superheating),

thus increasing its enthalpy at the lower pressure, and is then returned to the turbine to complete its expansion. This results in a turbine divided into two parts. The two parts are in one casing; sometimes there are two casings; and sometimes three units, high-pressure, intermediate-pressure, and low-pressure, are used, the steam being reheated between the high-pressure and the intermediate-pressure units. Provision may be made for a second or a third reheating, but at the lower pressures the steam volume is so large that the piping and control valves become large and expensive and the economic advantage doubtful.

Low-pressure or exhaust turbines have come into use in several ways. First, when very large powers are required from a single machine, it is sometimes advisable to divide the total expansion of the steam into two stages in separate casings, resulting in a high-pressure and a low-pressure unit. In some cases, two low-pressure units divide between them the steam from one high-pressure turbine. There are cases where the total expansion is carried out in three units, a high, an intermediate, and a low-pressure. Second, in the stage of transition from reciprocating engines to turbines, low-pressure units were installed to receive the exhaust from reciprocating engines at about atmospheric pressure and, through their ability to utilize vacua were able to generate a large amount of additional power at high economy. Third, certain power requirements, as in steel-rolling mills, are best served by a reversing unit, and, as turbines cannot be reversed, a reversing reciprocating engine is used, operating noncondensing. This periodically furnishes large quantities of atmospheric exhaust steam which, passed through a heat-storage device called an accumulator, can efficiently operate a low-pressure or exhaust turbine.

Low-pressure turbines are generally, though not necessarily, made double flow.

Notes

to issue [ˈɪsju:] — *випускати*
orifice [ˈɔrɪfɪs] — *отвір*
torpedo [tɔ:ˈpi:dou] — *торпеда*
to mount [ˈmaunt] — *установлювати*
to regenerate [rɪˈdʒenəreɪt] — *відроджуватися*
to expand [ɪksˈpænd] — *поширювати(ся)*
to reciprocate [rɪˈsɪprəkeɪt] — *обмінюватися*
vacuum [ˈvækjuəm] — *вакуум; порожнеча*
vacua [ˈvækjuə] — *множ.*

10.
Section. Electrical Engineering

Text 1. Electrical Units

Practical Units

The three practical units, the **ohm**, **ampere**, and **volt**, provide standards for comparison. They are defined as follows —

The ohm is the first primary unit, and the international ohm is defined as the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 gm. in mass, of uniform cross-sectional area and of length 106.300 cm.

The ampere is the second primary unit. The international ampere is the unvarying electric current which, when passed through a solution of nitrate of silver in water, in accordance with a specification, deposits silver at the rate of 0.00111800 gm. per second.

The volt is the third primary unit and is the electric pressure which, when applied steadily to a conductor whose resistance is one international ohm, will produce a current of one international ampere. Further, the international watt is the energy expended per second by an unvarying electric current of one international ampere under an electric pressure of one international volt.

In addition to the practical construction of the ohm as defined above it may be derived in absolute measure as it has the dimensions of a velocity.

The original c.g.s. ampere was based on the magnetic effect of a current instead of the present electro-chemical effect.

M.K.S. Units

An alternative absolute system is based on the dimensions metre, kilogramme, and second. This is only one of many possible alternatives

containing any multiple or sub-multiple of the metre and the gramme. It has the advantage over the c.g.s. system of simpler identity between the absolute and the practical units in that it removes the powers of 10.

For the practical applications of the m.k.s. units a fourth unit is required in order to define all the practical units. This has been taken to be the unit of resistance, leading to the expression M.K.S. Ω units. But the present agreed fourth unit is the term μ_0, the permeability of free space, this being more fundamental. This applies of course to the m.k.s. system of electromagnetic units, providing M.K.S. μ units. Electrostatic units are not used with the m.k.s. system.

If μ_0 is taken to be unity in the c.g.s. system it becomes 10^{-7} in the m.k.s. system (but if rationalized it is $4\pi \times 10^{-7}$).

Notes

engineering [ˌendʒɪˈnɪərɪŋ] — *техніка*
c.g.s. = centimeter-grum-second
m.k.s. = meter-kilogram-second
ohm ['oum] — *ом*
ampere ['æmpɛə] — *ампер*
volt ['voult] — *вольт*

Text 2. Theory of Alternating Currents

Types of Electric Current

An **electric current** may be produced in a variety of ways, and from a number of different types of apparatus, e.g. an accumulator, a d.c. or an a.c. generator, or a thermionic valve. Whatever the source of origin, the electric current is fundamentally the same in all cases, but the manner in which it varies with time may be very different. This is shown by the graph of the current plotted against time as a base, and a number of examples are illustrated in **Fig. 1.**

(a) represents a steady direct current (D.C.) of unvarying magnitude, such as is obtained from an accumulator.

(b) represents a D.C. obtained from a d.c. generator, and consists of a steady D.C. superimposed on which is a uniform ripple of relatively high frequency, due to the commutator of the d.c. generator. As the armature rotates the commutator segments come under the brush in rapid succession and produce a ripple in the voltage which is reproduced in the current.

(c) represents a pulsating current varying periodically between maximum and minimum limits. It may be produced by adding a D.C. to an

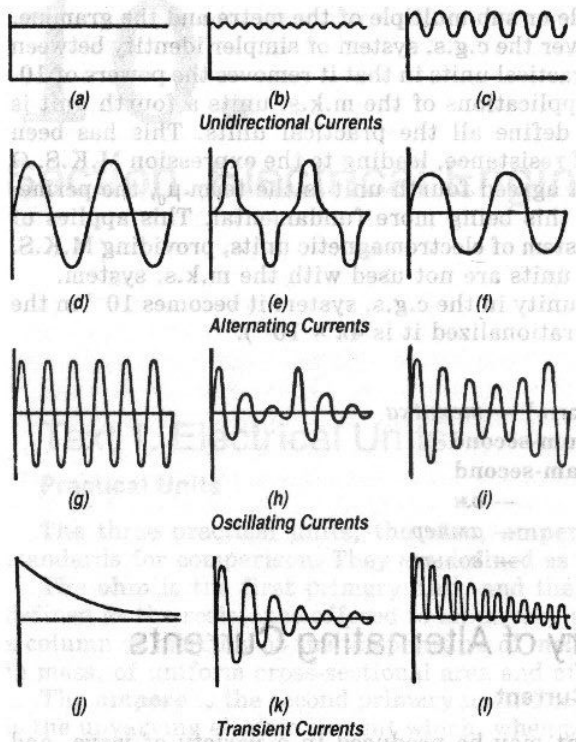


Fig. 1. Types of Electric Current

A.C. or vice versa. The d.c. component must be the larger if the current is to remain unidirectional. All the first three types of current are unidirectional, i.e. they flow in one direction only.

(d) represents a pure alternating current (A.C.). The current flows first in one direction and then in the other in a periodic manner, the time of each alternation being constant. In the ideal case the current varies with time according to a sine law, when it is said to be sinusoidal. Considering the time of a complete cycle of current (a positive half-wave plus a negative half-wave) as equal to 360°, the instantaneous values of the current are proportional to the sine of the angle measured from the zero point where the current is about to rise in the positive direction.

(e) represents a type of A.C. with a different wave form. Such an A.C. is said to have a peaked wave form, the term being self explanatory.

(f) represents an A.C. with yet another different wave form. Such an A.C. is said to have a flat-topped wave form.

Notes

alternating [ˈɔ:ltə:neɪtɪŋ] — *змінний*
current [ˈkʌrənt] — *струм*
apparatus [ˌæpəˈreɪtəs] — *прилад*
accumulator [əˈkju:mjuleɪtə] — *акумулятор*
graph [græf] — *графік*

to plot — *наносити на карту*
armature [ˈɑ:mətjuə] — *арматура*
ripple [ˈrɪpl] — *дзюрчання*
voltage [ˈvoultɪdʒ] — *напруга*

Text 3. Difference between A.C. and D.C.

A direct current (D.C.) flows continuously through a conducting circuit in one direction only, although it may not be steady so far as magnitude is concerned. It is unidirectional in character. An alternating current (A.C.), on the other hand, continually reverses in direction, as its name implies. Starting from zero, it grows in one direction, reaches a maximum, dies down to zero again, after which it rises in the opposite direction, reaches a maximum, again dying down to zero. It is thus continually changing in magnitude as well as direction, and this continual change causes certain effects of far-reaching importance.

It can be shown that high voltages are desirable for the economic transmission of a given amount of electric power. Take, for example, the transmission of 1000 kW. If the transmission voltage is 100 volts the current must be 10,000 amperes, but if the transmission voltage is 10,000 volts the current is only 100 amperes. The cross-section of the cables transmitting the power is determined by the current to be carried, and so in the former case the cables would need to be very much larger than in the latter case. It is true that the high-voltage cable would need to have more insulation, but even so, it would be very much cheaper than the larger low-voltage cable. A high voltage is therefore essential for the economic transmission of electric power.

Again, a.c. generators can be designed and built for much higher voltages than can d.c. generators, the voltage of the latter being limited by the problem of sparking at the commutator, a component which is absent in the a.c. generator. Then there is the most important factor that it is easy to transform a.c. power from one voltage to another by means of the transformer, an operation that is denied to the d.c. system. The transformer also enables the voltage to be stepped down at the receiving end of the transmission line to values which can readily be used by the various consumers. If necessary, it can be converted to the d.c. form for actual use, although this is not often necessary. There are certain processes for which D.C. is either essential or at any rate desirable but the utilization of electric power in the a.c. form is growing steadily. At the present day, by far the

greater part of the generation, transmission, and utilization of electric power is carried out by means of A.C.

Notes

cable ['keɪbl] — *кабель*
insulation [ˌɪnsju'leɪʃn] — *відособленість*
utilization [ˌju:tɪlaɪ'zeɪʃn] — *використання*
component [kəm'pounənt] — *складова частина*

Text 4. Terms and Definitions

In the following paragraphs the terms commonly used to distinguish between the various properties, or ways measuring the properties of alternating current are described.

Cycle and Period. — The complete series of changes consisting of the growth and decay of the voltage or current in one direction, together with its growth and decay in the reverse direction, is called one cycle. A voltage or current that is reproduced at equal intervals is said to be periodic, and the minimum time interval elapsing before the same instantaneous value recurs is called the periodic time or the period.

Frequency. — The number of complete cycles per second through which a voltage or current passes is called the frequency. It is always expressed in cycles per second, the reciprocal of this number being the periodic time.

Frequencies are now standardized for power purposes in the principal countries of the world, the standard for Great Britain being 50 cycles per second, while the U.S.A. has adopted 60 cycles per second.

Wave Form. — The shape of the graph of the voltage or current, when plotted against time as a base, is called the wave form or wave shape. The ideal aimed at is that of the sine wave, i.e. the graph has the same shape as the graph of a sine function in mathematics. The sine goes through 360^0 in a complete cycle, and so the time scale on the wave form of a voltage or current is usually represented in degrees, 360^0 being considered the equivalent of the time corresponding to 1 cycle, or the periodic time. Since these degrees may not always coincide with the geometrical degrees through which the rotating member of a machine has been rotated, they are called electrical degrees, in order to distinguish them from geometrical degrees.

One cycle is thus regarded as the equivalent of 360^0, and 180^0 is considered as a half-cycle, i.e. the duration of the voltage or current in one direction only.

Notes

cycle ['saɪkl] — *оберт, такт*
decay [dɪ'keɪ] — *розпад; руйнування*
to elapse [ɪ'læps] — *минати (про час)*
instantaneous [ˌɪnstən'teɪnjəs] — *миттєвий, моментальний*
to recur [rɪ'kə:] — *повторюватися*
frequency ['fri:kwənsɪ] — *частота; частотність*
reciprocal [rɪ'sɪprəkəl] — *взаємний*
periodic [ˌpɪərɪ'ɔdɪk] — *періодичний*
to coincide [ˌkouɪn'said] — *збігатися*

Text 5. Phase and Phase Difference

During the interval of time necessary for a current to pass through one complete cycle, it passes through many phases. In fact it has a different phase for each different interval of time. Consider the analogous case of the phases of the moon. Starting from the time of new moon the moon passes through its various phases, measured by its age from the time of the new moon, up to full moon, and then onwards through the various stages of the waning moon. Similarly an alternating current goes through various phases, starting from zero, rising up to maximum, and dying down again to zero. In the A.C. case, however, this comprises only half a cycle, for the whole series of values are then repeated in the opposite (negative) direction. Other electrical quantities, such as voltage, power, etc., in addition to current go through various phases from 0^0 to 360^0; indeed all quantities which vary in a periodic manner do so.

When two voltages or two currents are considered together, however, or when a voltage and current are considered simultaneously, the frequency being the same, they may not pass through the same phase at the same instant of time. For example, two currents may be such that, although their frequency may be the same, their phase at a particular instant of time may be different. One may pass through its maximum value at the instant when the other has a zero value, or some other value not its maximum value; the two currents, etc., are then said to have a phase difference, this being quoted in degrees. If one current has its maximum value at the same time that the other is zero, the two currents are said to be in quadrature; they have a phase difference of 90^0. Phase difference, because it is constant in a circuit where steady conditions obtain, is much more important in a.c. work than the actual phase which varies from instant to instant.

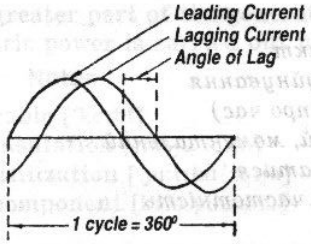


Fig. 2. Illustrating Phase Difference

Phase difference is illustrated in **Fig. 2**, where two currents are shown not in phase. The phase difference is measured by the distance between the points where the two graphs cross the base line in the same direction. This distance is measured in electrical degrees, the scale being obtained by considering the distance corresponding to one complete cycle as 360°. The current that is ahead in phase is said to lead the other current, while this current is said to lag behind the first current. Similarly, when considering two voltages, one is said to lead and the other to lag. Again, a voltage may lead the current that it produces, the current lagging behind the voltage.

Notes

analogous [ə'næləgəs] — *аналогічний, подібний*
onward ['ɔnwəd] — *що рухається вперед*
similarly ['sɪmɪləlɪ] — *подібно*
to wane [weɪn] — *зменшувати(ся)*
simultaneously [ˌsɪməl'teɪnjəslɪ] — *одночасно*
to quote ['kwəut] — *цитувати; брати в лапки*
quadrature ['kwɔdrətʃə] — *квадратура*
circuit ['sə:kɪt] — *цикл, кругообіг*
scale ['skeɪl] — *розмір*
to lag ['læg] — *відставати*
to lag behind — *запізнюватися*

Text 6. Inductance

When a current flows through a conductor it sets up a magnetic field in the neighbourhood of the conductor. This is negligible in its effects in a number of cases, but there are also many cases where this magnetic field exerts a profound effect upon the circuit. The magnetic field created by the current is representend by lines of magnetic flux, these lines consisting of closed loops which are interlinked with the electric circuit, itself necessarily a closed circuit. If the current is steady, the magnetic flux is constant and produces no effect upon the circuit, but if the current changes then the strength of the magnetic field also changes. If the current increases, the total

number of lines of magnetic flux is increased, so that the total number of flux-linkages is also increased. It is, however, a fundamental law that whenever the number of flux-linkages changes, an e.m.f. is induced in the circuit linked with the flux. This e.m.f. is proportional to the rate of change of linkages, and one volt is induced when the linkages change at the rate of 10^8 linkages per second.

Unit of Inductance. — The unit of inductance is the henry, and a circuit is said to possess an inductance of 1 henry if 1 volt is induced when the current changes at the rate of 1 ampere per second. The symbol for inductance is L, so that a circuit possesses an inductance of L henries if L volts are induced due to a rate of change of current of 1 ampere per second.

This induced e.m.f. always acts in such a direction as to oppose the change of current in the circuit, and also the magnetic flux linked with it. Thus, if the current is rising, inductance tends to oppose its growth, and if the current is falling inductance tends to oppose its decay. Examples of this effect are found in the field circuit of an ordinary generator or motor, the field circuit being highly inductive. When switched into circuit the current does not immediately rise to its full value, but grows relatively slowly, while when the switch is opened, the current tends to continue as evinced by the spark at the opening contacts.

Mutual Inductance. — When inductance is due to flux linking with the same circuit that carries the current, it is called self-inductance, in order to distinguish it from inductance due to flux linking with the circuit due to current in a neighbouring circuit, which is called mutual inductance. In the latter case, two circuits are said to possess mutual inductance if a change of current in one circuit causes an e.m.f. to be induced in the other circuit.

Two circuits are said to possess a mutual inductance of L henries if L volts are induced in one circuit due to a rate of change of current of 1 ampere per second in the other circuit. The circuit in which the current is changing is called the primary circuit, while the circuit in which the e.m.f. is induced is called the secondary circuit. When two circuits possess mutual inductance, either circuit can be employed as the primary, the value of the mutual inductance being the same, no matter which circuit is the primary and which is the secondary.

Importance of Inductance in A. C. Circuits. — Inductance is a property of a circuit, just as is resistance, and is therefore possessed by d.c. as well as a.c. circuits. In d.c. circuits, however, its effects are not apparent when the current is steady, and are only noticeable when the current is started or stopped, or when it changes in value. The reason for this is that the induced e.m.f. resulting from induc-

tance is due to the rate at which the current, and therefore the flux, is changing. If the current does not change, there is no induced e.m.f. In a.c. circuits, on the other hand, the current is always changing, and therefore the e.m.f. of self-induction is always present. This modifies the value of the current and has far-reaching effects.

Notes

negligible ['neglɪdʒəbl] — *незначний*
to exert [ɪg'zə:t] — *напружувати (силу)*
flux ['flʌks] — *постійний рух*
e.m.f. = electromotive force
to evince [ɪ'vɪns] — *виявляти, показувати*
far-reaching — *далекосяжний*

Text 7. Hysteresis

When a specimen of iron is carried round a magnetic cycle, a certain dissipation of energy takes place. To build up a magnetic field requires the expenditure of a certain amount of energy, and this energy is not all returned when the magnetic field is destroyed, if iron is the medium. This lost energy is dissipated in the iron in the form of heat. If the iron be now magnetized in the reverse direction, the same process is repeated, with the result that when the iron is brought back to its initial state of magnetization, an amount of energy has been expended in taking the iron round its magnetic cycle. The relation between the various values of B and H (in both positive and negative directions) is shown in **Fig. 3**. This effect of the dissipation of energy, due to the lagging of the flux behind the magnetizing force, is called **hysteresis**, and the closed curve shown in Fig. 3 is called a hysteresis loop. It should be noted that as the value of H is raised and lowered, the curve progresses in the direction indicated by the arrows.

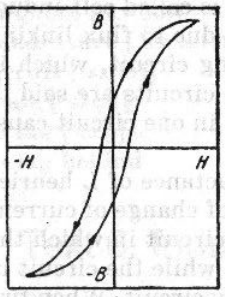


Fig.3. Hysteresis Loop
B — flux density;
H — magnetizing force in ampereturns per cm.

It can be proved that the energy dissipated in taking the iron round a magnetic cycle is proportional to the area of the **hysteresis loop**, so that it is desirable to employ iron having a narrow hysteresis loop. When subjected to alternating magnetization, the loop is traversed once for every cycle of the current, and so the energy wasted per second is proportional to the frequency. This energy wasted per second constitutes a loss, measured in watts, and is known as the hysteresis loss. In addition to being proportional to the frequency it also depends, in a somewhat complicated manner, upon the maximum flux density attained. This is usually expressed by saying that the hysteresis loss is proportional to B^x where x has a value approximately equal to 1.6 at moderate flux densities, but which may reach a value as high as 4 for extremely high flux densities.

Notes

specimen ['spesɪmɪn] — *зразок*
dissipation [ˌdɪsɪ'peɪʃn] — *розсіювання; руйнування*
medium ['mi:djəm] — *засіб, спосіб; середовище; середній*
loop [lu:p] — *петля*
to constitute ['kɔnstɪtju:t] — *складати; встановлювати*
watt [wɔt] — *ват*
to attain [ə'teɪn] — *досягати, добиватися*
moderate ['mɔdərɪt] — *помірний*
extremely [ɪks'tri:mlɪ] — *надзвичайно*

Text 8. Electrical Measurements

The measurement of any physical quantity applies a determination of its magnitude in terms of some appropriate unit. It follows, therefore, that before we can measure we must decide upon a system of units which will be convenient for the purpose. In the case of simple fundamental quantities such as length, mass, or time, the units themselves are simple.

Electrical and magnetic quantities are, however, much less simple than length, mass, or time, and cannot be measured directly by comparison with a material standard. The units in which we express these quantities have to be defined in terms of their observable effects obtained in experimental work, e. g. the weight of silver deposited in one second by a current when it is passed through a solution of silver nitrate is a measure of the magnitude of this current.

Electrical measurements can be classified broadly as either absolute measurements, or secondary measurements, but we need concern ourselves very little with the first class because such measurements are rarely undertaken and, generally speaking, are used only for periodic checks upon the accuracy of primary standards. They are of interest only to the specialist, the very large majority of the measurements made in practice being secondary, or comparison, measurements.

Electrical measuring instruments can be divided into three classes: *indicating instruments, recording instruments and integrating instruments.*

Indicating instruments, such as ammeters, voltmeters and wattmeters, constitute the largest of the three classes. These are fitted with a pointer which moves over a fixed scale and their characteristic is that they give an immediate indication of the value of the current, voltage or other quantity being measured. Such an instrument might therefore be compared with, say, a weighing machine or a barometer, giving an immediate reading of the weight or pressure existing at any instant, but making no permanent record of such a measurement.

Recording instruments, or graphers, as they are sometimes called, instead of being fitted with a pointer and scale, carry a pencil or pen, which presses on to a travelling ribbon of paper, and thus makes a continuous chart or record of the values measured. Such an instrument could be compared with the recording barometer often exhibited in an instrument maker's window. It will be noted that these two types do not differ in principle, since they are both used to measure the same kinds of things; but in the one case the indication is momentary and must be read by an observer on the spot, whilst in the other case the values are recorded on a chart for future observation and reference.

The third group, consisting of **integrating instruments** or electricity supply meters, differs fundamentally from the other two groups, since instead of indicating or recording, these instruments add up the total amount consumed over any given period. Thus, instead of reading, say, the current or the power flowing at any instant, they measure the product of current and time (in ampere-hours) or of power and time (in watt-hours), and so add up the electrical quantity or energy consumed.

An integrating instrument is, therefore, like the gas meter, which registers the quantity of gas consumed. Instead of a pointer and scale with a limited arc of movement, they are usually made to revolve and carry a train of gearing and a register which counts the number of revolutions made. In such instruments, the rate of revolution being proportional to the current (in an ampere-hour meter) or to the power (in a watt-hour meter), the total number of revolutions is proportional to the ampere-hours or watt-hours respectively.

All indicating instruments have three essential features: an operating force or mechanism, a controlling force or mechanism, and a damping force or mechanism. It must be realized that all measurement is comparison, and just as a length can be measured by putting a foot rule against it, or a weight can be measured by balancing it against

another weight, so an electrical effect can only be measured by allowing it to act against some known force or control. Thus, the process of electrical measurement can be said to consist of a "tug of war" between two opposing forces — the operating force, or torque, generated by the electricity which is being measured, and the controlling force, or torque, which opposes it. When the instrument comes to rest the pointer indicates the position of stability reached by these two opposite pulls. Although it does not enter into the actual measurement by influencing this position of stability, damping is essential to bring the moving system of the instrument to rest in a reasonably short time.

When an electric current flows, it gives rise to various effects — heating, electrostatic, electro-magnetic and chemical, and any one of these effects can be utilized to furnish the operating force of a measuring instrument.

Notes

appropriate [ə'prouprɪeɪt] — *придатний, властивий*
nitrate ['naɪtreɪt] — *нітрат*
to integrate ['ɪntɪgreɪt] — *інтегрувати*
ammeter ['æmɪtə] — *амперметр*
to gear ['gɪə] — *приводити в рух (механізм)*
revolution [ˌrevə'lu:ʃn] — *обертання; цикл*
to damp ['dæmp] — *послаблювати; приглушувати*
to indicate ['ɪndɪkeɪt] — *вказувати; свідчити*

Text 9. Ammeters and Voltmeters

Instrument Connections

The difference between an ammeter and a voltmeter seems to be fundamental, since the former is connected in series with the circuit and reads the current, whilst the latter is connected across the circuit and reads the voltage. In practice, however, it will be found that practically every voltmeter except the electrostatic type is operated by a flow of current through the instrument, so that the voltmeter is really a form of ammeter, but reading a very small current at a relatively high voltage.

As an example, take the moving iron type of mechanism which consists of a fixed coil of wire magnetizing a small piece of iron on the spindle of the instrument. In order to obtain full deflection it may be necessary for the coil to have an excitation of 300 ampere-turns, and if the instrument is to be an ammeter to read up to 10

amperes, this could be obtained by winding the bobbin with thirty turns of a fairly stout wire. The same mechanism could, however, be employed as a voltmeter by winding it with a very large number of turns of fine wire, so designed that the maximum voltage to be measured when applied to the coil sends sufficient current through it to provide the correct number of ampere-turns.

Types of Ammeters and Voltmeters

In order to produce the necessary deflecting torque for the operation of ammeters and voltmeters the various effects of electric current and of potential — the heating effect, electrostatic effect, magnetic effect, and electro-magnetic induction effect — are used leading to a number of different types of instrument. The resulting instruments are called: (a) hot wire, (b) electrostatic, (c) moving iron, (d) moving coil, and (e) induction. They are dealt with in some detail in succeeding pages where their advantages, disadvantages, and specialized characteristics are given. By way of introduction, however, it may be well to point out that the various types are usable on both d. c. and a. c. circuits with two exceptions, namely, the permanent-magnet, moving-coil instrument which can be used only with d. c., and the induction instruments which are limited to a. c. operation. For general purposes the moving-iron instruments are by far the most commonly used, while for d. c. work the permanent-magnet, moving-coil instrument is the best, being specially suitable for use with shunts and multipliers for multirange purposes. The other types are uncommon for general work, although each has advantages under certain conditions. Thus the order in which the instruments are described below is not that of relative importance, but merely such as to fit in with the general arrangement of the presentation.

Hot Wire. — When an electric current flows along a conductor the latter becomes heated, the heating effect being simple to use for measurement purposes. The heat produced per second in a conductor of any given resistance is proportional to the square of the current, and the conductor will, therefore, be heated up to the point at which it radiates each second all the heat which the current is producing. Its temperature rise above the surroundings will then be proportional to the square of the current flowing, and it is only necessary to measure this temperature rise in order to get a measure of the amount of the current.

The simplest way of measuring the temperature rise is by means of the linear expansion which it causes in the wire carrying the current, and hot-wire instruments work on this principle. Unfortunately the expansion is extremely slight, being of the order of one hundred thousandth of the length for each degree centigrade, and it

therefore becomes necessary to magnify the movement many times before transmitting it to the pointer of the instrument. This complicates what would otherwise be a very simple type of mechanism, and it also introduces errors due to the stretch of the various wires employed or to the interplay of the magnifying mechanism. Other errors may be introduced due to the expansion of the baseplate of the instrument and for these reasons the hot-wire instrument frequently exhibits a zero error and is usually only of second-grade accuracy.

Fig. 4 shows diagrammatically a hot-wire instrument employing what is called the double-sag method of magnifying the expansion movement. The current to be measured, or some definite fraction of it, passes through the expansion wire *E*, which is made of platinum-iridium or platinum-silver, either of which alloys will stand a high temperature without oxidization. When this wire is heated and expands, its sag is taken up by a phosphor bronze wire *P*, and the sag in this is taken up by a silk fibre *F*, which is kept taut by a small spring *S*. This silk fibre passes round a small pulley mounted on the instrument spindle and a very minute expansion in the hot wire *E* causes a considerable movement of the spindle, and is shown by the pointer mounted on it.

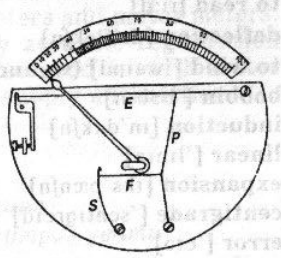


Fig. 4.

When the instrument is required to be a voltmeter the expansion wire is connected in series with a high resistance whose value will depend upon the voltage range which is required. The current necessary to operate the hot wire is usually of the order 0.1 to 0.2 amp., and as the resistance of the wire itself is only 10 ohms or so, it will be seen that except on very low ranges the added resistance absorbs the greater part of the voltage applied to the instrument terminals. Provided this added resistance does not vary with temperature, the current flowing through the expansion wire will be directly proportional to the applied voltage and the expansion will, therefore, be proportional to the square of the voltage.

When the instrument is to be an ammeter, the expansion wire can be made somewhat thicker, but if too stout, the instrument will be sluggish in action, as the wire will take an appreciable time to reach its final temperature. The sizes used in practice are therefore such as to require only a fraction of an ampere to raise them to their full temperature. Hence, when a bigger current than this is to be measured, the hot wire has to be shunted with a resistance of a lower value, and this reduces the accuracy of the instrument. As explained

previously, the shunt must be designed so that the current through the hot wire bears a constant ratio to the total flowing through the instrument so that the expansion obtained will be proportional to this current squared. The use of such a shunt is not very satisfactory, however, since the resistance of the hot wire will vary somewhat with different currents, while that of the shunt will remain constant.

Notes

to read [ri:d] — *показувати (прилад)*
deflection [dɪ'flekʃn] — *відхилення*
to wind ['waɪnd] **(wound)** — *намотувати*
bobbin ['bɔbɪn] — *котушка*
induction [ɪn'dʌkʃn] — *індукція*
linear ['lɪnɪə] — *лінійний*
expansion [ɪks'pænʃn] — *розширення; простір*
centigrade ['sentɪgreɪd] — *стоградусний*
error ['erə] — *помилка*
accuracy ['ækjurəsɪ] — *точність*
to sag [sæg] — *осідати*
spindle ['spɪndl] — *вісь, вал маховика*
sluggish ['slʌgɪʃ] — *млявий, інертний*
to shunt [ʃʌnt] — *заміняти; відкладати*

Text 10. Direct-Current Meters

Functions of a Direct Current Meter. — A direct current meter is an instrument intended for the measurement of electrical quantity in a direct current circuit. There are two main classes of direct current meters, (I) ampere-hour meters and (II) watt-hour meters. An ampere-hour meter measures the product of the current in amperes flowing in a circuit and the time in hours during which the flow is maintained. A watt-hour meter measures the product of the power in watts and the time in hours during which the flow of power is maintained.

Direct Current Ampere-hour Meters. — Ampere-hour meters are used by electrical undertakings for measuring the supply of electricity to domestic and industrial consumers. These undertakings are under a statutory obligation to maintain the voltage at consumers' terminals at a declared value within close limits; assuming that the supply voltage is maintained at the declared value, an ampere-hour meter can be calibrated to register in terms of kilowatt-hours at this voltage. This principle is accepted as satisfactory in most countries where

the voltage at consumers' terminals is maintained within narrow limits of the declared voltage, and since direct current ampere-hour meters are, in general, more reliable and less costly than direct current watt-hour meters the practice has much in its favour.

In addition to the foregoing, ampere-hour meters are used for measuring the current consumption in battery charging, electro-deposition and other electrolytic or industrial processes and in some instances they exercise a controlling function over these operations. Many types of ampere-hour meter have been manufactured in the past, the most important being electrolytic meters and motor meters. Theoretically the former are capable of very accurate registration but in practice the working results are not so good as with motor meters, and the latter are preferred by most supply authorities.

Notes

current ['kʌrənt] — *струм*
quantity ['kwɔntɪtɪ] — *кількість, величина*
to maintain [men'teɪn] — *підтримувати; утримувати*
to assume [ə'sju:m] — *припускати, вважати*
consumption [kən'sʌmpʃn] — *споживання*

Text 11. Auxiliary Equipment

Methods of Cooling

Various methods of cooling transformers are adopted in practice, depending upon the size and the local conditions. Very small transformers are cooled naturally by the atmosphere, no special cooling arrangements being necessary. Slightly larger transformers are oil-immersed, being enclosed in a tank for this purpose. The object of the oil is twofold. As an insulator, it is better than air, and it also keeps down the maximum temperature rise by setting up convection currents which tend to equalize the temperature. These convection currents carry the heat away to the walls and lid of the tank, whence it is dissipated into the atmosphere. Small tanks are made with a plain exterior, sufficient cooling surface being obtained in this manner. Rather larger tanks are made with a corrugated exterior, or are provided with fins, to increase the cooling surface. A more popular arrangement, however, is to obtain the desired increase in cooling surface by means of a number of tubes running from top to bottom on the outside of the tank. The oil immediately in contact with the transformer in the tank is heated by the transformer, and consequently rises. Convection currents cause the oil to flow outwards at the top of the tank and so it

enters the tubes at the top. It is now cooled in the tubes, sinks, and re-enters the tank at the bottom. It is now heated again by the transformer, and the cycle of operations is repeated.

The larger the tank, the greater is the number of tubes required. These are now arranged in rows, one behind the other, but very little advantage is gained by adding more tubes when they are already three deep. A fourth row of tubes is so shut in by the tubes on the outside that very little additional cooling surface is obtained. When this stage is reached, the simple tubular design is abandoned, and external radiators are substituted for the tubes.

With this type of cooling the tank surface itself now becomes plain again. The external radiators consist of a long horizontal chamber at the top, and another at the bottom, these being joined by numbers of radiator tubes.

Other transformers designed for use with an external oil cooler have no radiators fitted to the transformer tank itself, practically the whole of the heat dissipation taking place in the oil cooler.

Water-cooling is also employed. A number of tubes are arranged in a helical coil inside the top of the transformer tank, but underneath the oil level. A stream of cold water is then passed through this cooling coil. Since the presence of even a minute percentage of water in the oil reduces its insulating properties to an enormous degree, it is extremely important that no water should escape through any leak, should one occur. In order to prevent this, the tank is made oil-tight and the oil is put under pressure. If a leak should develop, oil will leak into the tubes (which does not much matter) instead of the water leaking into the oil.

In confined spaces, and where a supply of water is not available, air-blast cooling may be adopted. The tank is now dispensed with and a blast of cold air is forced over the transformer windings. Cooling by this means is usually confined to transformers operating on the lower voltages.

The oil used for transformer immersion is a pure hydrocarbon (mineral) oil, obtained by refining crude petroleum. Its insulating properties are very adversely affected by the presence of even a minute proportion of water, and so it must be clean and practically free from moisture. Certain oils tend to form a sludge in the course of time, this being due to the slow formation of solid hydrocarbons. If this sludge should form on the windings themselves it tends to produce overheating. Certain high-grade qualities are called non-sludging oils, and these should be used in transformers in which the working temperature of the oil exceeds 80° C.

The use of the oil-expansion chamber reduces the tendency of the oil to form sludge, since the access of atmospheric oxygen is effectively prevented. The addition of the breather also keeps the oil dry.

Notes

equipment [ɪ'kwɪpmənt] — *обладнання, устаткування*
transformer [ˌtræns'fɔ:mə] — *трансформатор*
to immerse [ɪ'mə:s] — *занурювати*
twofold ['tu:fould] — *подвійний; здвоєний*
whence [wens] — *звідки*
to dissipate ['dɪsɪpeɪt] — *розганяти*
to corrugate ['kɔrugeɪt] — *зморщуватися*
fin [fɪn] — *плавець (риби); кіль*
to dispense [dɪs'pens] — *розподіляти*
immersion [ɪ'mə:ʃn] — *занурювання*
adversely ['ædvə:slɪ] — *несприятливо*
sludge [slʌdʒ] — *грязюка; сало; дрібний лід*
tendency ['tendənsɪ] — *нахил; тенденція*
access ['ækses] — *доступ; підхід; прохід*

Text 12. Current Transformers

Why Current Transformers are Used. — A current transformer is an instrument transformer for the transformation of current from one value to another, usually a lower one, or for the transformation of current at a high voltage into a proportionate current at a low voltage with respect to earth potential. Current transformers are used in conjunction with alternating-current meters or instruments where the current to be measured is of such magnitude that the meter or instrument current coil cannot conveniently be made of sufficient carrying capacity. They are also used wherever high-voltage current has to be metered, because of the difficulty of providing adequate insulation in the meter itself. In this connection supply voltages exceeding 660 volts are considered to be high voltage. In meter practice current transformers are used wherever the current to be metered exceeds 100 amperes, and in some instances a lower value than this is regarded as the desirable maximum for direct measurement.

Construction of Current Transformers. — A current transformer comprises a magnetic circuit, usually in the form of iron stampings assembled together to form a core, on which are wound two electric circuits called the primary winding and secondary winding respectively. The primary winding carries the current to be measured

and is connected in the main circuit. The secondary winding carries a current proportional to the current to be measured and the secondary terminals are connected to the current winding of the meter or instrument. Both windings are insulated from the core and from each other. The secondary insulation is arranged to withstand a test pressure of 2,000 volts applied between the winding and the core for one minute. The insulation of the primary is arranged to withstand for one minute a test pressure applied between the primary and secondary windings approximately equal to four times the voltage existing under working conditions. During this test the core and the secondary winding are connected together.

The primary circuit of a current transformer may consist of a single conductor in the form of a bar or cable instead of a winding, when the current to be measured is of the order of 600 amperes or more. In low-voltage circuits the current to be measured may be so heavy that it is not convenient to provide a primary integral with the transformer and the latter then consists of an iron core of appropriate shape with a secondary winding thereon, the whole being mounted on the busbar or cable. The nominal full-load current of a transformer is termed the "rated primary current" and is the value in amperes of the primary current marked on the rating plate.

The secondary winding of a current transformer is usually constructed to deliver five amperes to the meter or instrument when rated primary current flows in the main circuit. This is referred to as the "rated secondary current" and five amperes is the standard value adopted in most countries.

Notes

proportionate [prə′pɔ:ʃnɪt] — *пропорційний*
magnitude [′mægnɪtju:d] — *величина*
to comprise [kəm′praɪz] — *містити; охоплювати*
to apply [ə′plaɪ] — *використовувати, вживати*
core [kɔ:] — *сердечник; стрижень*

Text 13. Voltage Transformers

Why Voltage Transformers are Used. — When an instrument or meter having a voltage winding is connected to a high-voltage alternating-current circuit, the use of a voltage transformer (sometimes called a potential transformer) is necessary. It is not practicable to wind the voltage coil of a meter for direct connection to, say, an 11,000-volt supply, because the space available on the voltage electromagnet is not sufficient to accommodate the number of turns of wire which would be necessary. Moreover it would be quite impossible to insulate adequately the winding and the terminals in such a manner as to render the meter safe to handle when the circuit to which it was connected was alive. Accordingly, a voltage transformer is always used when a meter is installed for use on a high-voltage system. In this connection potentials in excess of 660 volts are regarded as high voltage.

A voltage transformer may be defined as an instrument transformer for the transformation of voltage from one value to another, usually a lower one. The primary winding of a voltage transformer is the winding to which is applied the voltage to be measured or controlled, as the case may be. The secondary winding is the winding the terminals of which are connected to the meter or instrument. The standard voltage at the terminals of the secondary winding is 110 volts.

Construction of Voltage Transformers. — Voltage transformers are frequently fitted in switchgear cubicles, and owing to the restricted space available the dimensions of the transformer must be kept down to a minimum. Clearances between conductors or other live parts, which in power transformer design are regarded as minimum values, cannot always be provided in voltage transformers, and as reliability is the first consideration it is only by skilful design and care in manufacture that safety can be assured.

A voltage transformer comprises a magnetic circuit, usually built up with iron strips assembled together to form a core on which the primary and secondary windings are mounted. The primary winding which is connected to the high-voltage supply consists of a large number of turns of a fine-gauge wire and is usually divided into a number of separate sections. The object of dividing the primary in this manner is to limit the voltage across each section to a comparatively low value. In practice, the voltage per section does not usually exceed 1,000 volts, and frequently is much less than this figure.

In voltage transformers for operation at 6,600 volts or less, it is common practice for the sections of the primary to be assembled on a tube of insulating material adjacent to the core, a second tube surrounding the sections and carrying the secondary winding. This disposition of the windings is advantageous in the case of open-type transformers since the high-voltage winding is shielded from mechanical damage by the two tubes and only the more robust low-voltage winding is exposed. For voltages in excess of 6,600 volts this arrangement is undesirable, partly because the joints between sections which are increasing in number are inaccessible, and partly because of the increasing cost of the two tubes, both of which must

be capable of withstanding the full working voltage continuously. The alternative disposition in which the secondary winding is adjacent to the core and is surrounded by the primary, is more usual, a heavy tube separating the windings. Only a light tube separates the secondary from the core and no mechanical protection is provided over the high-voltage windings. This, however, is unnecessary since transformers for the higher voltages are protected by a tank or other enclosure containing oil or some other insulating medium.

Voltage transformers are made up in single units for connection to single-phase, two-phase or three-phase systems. The magnetic circuit of a single-phase voltage transformer may be of the core type or the shell type, somewhat similar in shape to the cores of current transformers. The windings are usually disposed on both limbs of the core-type carcase and on the middle limb of the shell-type. The shell-type construction is seldom employed where the system voltage exceeds 3,300 volts. Two-phase voltage transformers are required occasionally and if made up as single units, a three-limbed core is used, similar in shape to the shell-type current transformer core. The windings are disposed on the two outer limbs and as the middle limb carries the common flux for both phases it is of greater sectional area than the outer limbs. The more usual practice however is to use two separate single-phase transformers on a two-phase system. Three-phase voltage transformers are built up on three-limbed cores, all the limbs being of equal cross-sectional area. Each limb carries the primary and secondary windings for one phase of the supply, and when used for connection to a meter, the connections are usually arranged star/star.

When a transformer is switched on to a live line, the voltage between the turns of the high-voltage winding adjacent to the line terminal may be raised momentarily to a value many times the normal. A similar condition may arise as a result of switching operations elsewhere on the system and in an extreme case the voltage between successive end turns may reach a very high value; such a condition persists only for a minute fraction of a second but it imposes an additional stress on the inter-turn insulation which in the absence of precautionary measures may result in failure. The stress on the insulation is greatest between the first and second turns counting from the end of the high-voltage winding and diminishes turn by turn until, at some distance from the end, the abnormal stress disappears entirely.

In power transformer practice it is customary to reinforce the insulation between the end turns of the high-voltage winding and about ten percent of the winding may be dealt with in this manner. This reinforcement is graded and is heaviest on the first few turns, but progressively

less and less is added until finally reinforcement ceases. In a voltage transformer of comparable voltage, the number of turns in the high-voltage winding is very much greater than in a power transformer and reinforcement of the insulation on ten percent of the turns would be impracticable. It is customary, however, to reinforce the insulation of the whole of the turns in the first section of the winding. As an additional precaution, a reactance coil consisting of a few turns of heavily-insulated wire is sometimes connected between the high-voltage terminal and the end of the high-voltage winding. This reactance acts like a cushion between the line and the high-voltage winding and reduces the severity of the transient stresses without adding appreciably to the dimensions of the transformer or impairing its accuracy.

Notes

voltage ['voultɪdʒ] — *напруга*
to accommodate [ə'kɔmədeɪt] — *пристосовувати; розміщувати*
to render ['rendə] — *віддавати; подавати; відтворювати*
value ['vælju:] — *важливість; значення, величина*
strip [strɪp] — *смужка*
adjacent [ə'dʒeɪsənt] — *сусідній, суміжний*
robust [rə'bʌst] — *здоровий, міцний*
inaccessible [ˌɪnæk'sesəbl] — *недоступний, недосяжний*
limb [lɪm] — *гілка, сучок*
flux ['flʌks] — *постійний рух; потік*
precaution [prɪ'kɔ:ʃn] — *обережність; застереження*
reactance [ri:'æktəns] — *реактивний опір*
transient ['trænzɪənt] — *тимчасовий; швидкоплинний*
to impair [ɪm'peə] — *погіршувати(ся); псувати(ся)*

Text 14. Construction of the Field Magnet

The materials used in the construction of the **field magnets** are cast iron or cast steel for the yokes of small machines, rolled steel for large machines, the choice of material depending on its cost, its magnetic properties, and on the cost of working it to the required shape, e.g. whether machining is necessary or not. The poles may be cast steel or wrought iron, although laminated poles are also in common use. The cost of cast steel suitable for dynamo construction is more than twice the cost of the same weight of cast iron, but it has a permeability at least twice as great as cast iron, which means that to carry the same total magnetic flux, only one-half the cross section is required. Thus the weight of cast steel required will only be about

halt that of cast iron, so that from the point of view of the cost of these materials there is little to choose. The above considerations apply to the yoke. In the case of the poles there is another consideration, namely, the cost of the copper in the exciting coils, this obviously depending on the length of a mean turn and, therefore, on the cross section of the pole. This consideration rules out cast iron for any but small machines, the poles of medium-sized and large machines being either cast steel or of laminations. If steel poles are used, the poles and yoke can be cast together, and also the pole cores can be of circular cross section, which reduces the amount of field copper to a minimum, since the circle is the shape which has the minimum perimeter for a given area. If the armature has wide slots the tufting of the flux into the tops of the teeth may cause such variations in magnetic flux density in the air gap that excessive eddy currents may be set up in the pole faces, if these are solid. In such a case laminated poles can be used with advantage. It is quite common to employ laminated poles for small as well as large machines. Sometimes the pole core is solid, and only the pole shoe laminated, the shoe being secured to the pole core by means of countersunk screws.

It is unnecessary to deal at length with the exciting coils. In small sizes it is usual to wind the coils on a former, and to interlace the different layers with tape, so that, when the former is removed the coil is self supporting. The ends and inside are then covered with paper or other insulating material, depending on the voltage to frame which the coil has to withstand, and the whole coil is finally wrapped all over with tape. For large machines it is usual to wind the coil on to a bobbin, which may be either of metal or of some insulating material.

A common, and annoying, fault with shunt coils, which are wound with small-section wire, is for the lead in to the bottom layer of wire to break off close to the coil. To obviate this it is a good plan to solder a strip of copper to the first turn at the bottom, bringing out this strip between the coil and the inner face of the bobbin (if one is used). The voltage between this strip and the nearest turn on the outer layer of the coil will be practically the whole of the voltage across the coil, and in the event of the field circuit being broken when carrying the full current, it may reach a very high value. It is, therefore, advisable to insulate this strip with mica.

Series coils consist of comparatively few turns of thick wire, or for heavy-current work, of copper strip wound on edge.

Construction of the Armature Core. — The functions of the armature core are twofold: first, to provide a path of low magnetic reluctance to the magnetic lines of force; second, to act as a rigid structure

on which the armature winding is secured. In order that it may provide an easy path for the magnetic lines of force it must, of course, be composed of iron, and since iron is a conductor of electricity, it must be built up of thin discs, that is, it must be laminated. The reason for this is as follows: when the core is rotated it cuts the lines of force, and in consequence has e.m.f.'s induced in it in the same direction as the e.m.f.'s induced in the armature conductors, namely, in an axial direction. If the core were solid it would form a closed path of very low electrical resistance, so that heavy parasitic currents, called eddy currents, would be set up in it. Very serious heating and loss of power would result. It is impossible to reduce these eddy currents to zero, but the loss caused by them can be made very small by building up the core of thin laminations lightly insulated from one another by varnish or by the oxide on their surface. This lamination of the core being carried out in a plane perpendicular to the direction of the induced e.m.f's results in a very small e.m.f. being induced in each core disc; the induced e.m.f. per disc is obviously proportional to the thickness of the disc. Also the lamination splits up the eddy currents, which are now confined to a small path through each disc, the result being that the loss of power due to this cause is reduced to very small proportions. The core discs are usually from 16 to 25 mills in thickness.

In all modern machines the armature winding is housed in slots at the periphery of the core.

Excitation of the Field Windings. — There are several methods for the excitation of the field magnets, and the behaviour of the dynamo on load is governed by the method adopted. The three usual methods are known as (a) series, (b) shunt, and (c) compound excitation, the connections being indicated diagrammatically in **Fig. 5.** In the series dynamo the armature, field winding, and load are all connected electrically in series so that all are traversed by the same current. The field winding has thus to carry the full armature current, and the conductors of which it is composed must be of sufficiently large cross section to carry this current without overheating. The necessary magnetic flux per pole to induce a. given e.m.f. in the armature depends upon the ampere-turns of the field, that is, the product of the number of field turns into the exciting current. Since the field winding of the series dynamo

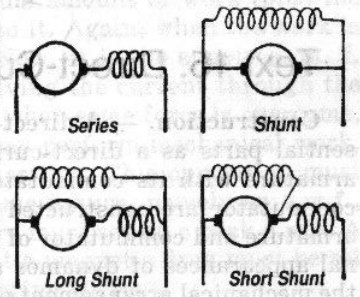


Fig. 5. Excitation of D.C. Generator

carries the full armature current, the number of field turns is small compared with other methods of excitation.

In the shunt dynamo the field winding has a very high resistance compared with that of the armature, the exciting current being small compared with the full-load armature current. The winding therefore consists of a large number of turns of wire of small cross section.

The compound dynamo has both series and shunt excitation acting together. The series coil carries the current supplied to the external load, while the shunt coil carries only a small current as in the plain shunt dynamo. It will be seen from Fig. 5 that there are two alternative methods of connection for the compound dynamo. In the "short shunt" the shunt winding is connected directly across the brushes, while in the "long shunt" it is connected across the machine terminals.

Notes

yoke ['jouk] — *зв'язок*
to work (wrought) — *приводити в дію*
laminated ['læmɪneɪtɪd] — *листовий, пластинчастий*
cast [kɑ:st] — *форма, зразок, тип*
permeability [ˌpə:mɪə'bɪlɪtɪ] — *проникливість*
slot — *щілина, паз*
gap [gæp] — *зазор*
to eddy ['edɪ] — *вирувати, крутитися*
screw [skru:] — *гвинт*
to interlace [ˌɪntə'leɪs] — *переплітатися*
tape — *рулетка*
mica ['maɪkə] — *слюда*
dynamo ['daɪnəmou] — *генератор, динамо-машина*
to induce [ɪn'dju:s] — *спонукати*

Text 15. Direct-Current Motors

Construction. — A direct-current motor consists of the same essential parts as a direct-current generator, namely, field magnet, armature with its commutator, and brush gear. The armature and commutator are constructed on exactly the same principles as the armature and commutator of a dynamo, and any difference in external appearances of dynamos and motors is due to a modification in the mechanical arrangement of the field magnets and frame, designed to give the motor the maximum amount of protection. Dynamos are employed mostly in a central power station where they are not exposed to any mechanical danger, such as the risk of heavy bodies falling on them, and as a result they can be of open construction. This is a great advantage since they are accessible for repairs, and also they are easily ventilated.

Motors, on the other hand, often work in very exposed situations thus necessitating partial or complete enclosure of the working parts. The type of duty to be performed also has an influence on the construction of the motor. The motor must, of course, be totally enclosed, but at the same time must be capable of rapid dismantling for inspection.

General Principles. — It is often thought that the principle of operation of a dynamo is quite unconnected with that of a motor; actually the two cannot be separated, since dynamo and motor actions go on field-magnets, the direction of rotation of a machine when running as a motor is opposite to its direction when running as a dynamo. On the other hand, if the directions of rotation are the same and the polarities the same, then the directions of the armature currents will be different for the two modes of operation.

Now when a machine is running as a motor, the conductors on the armature cut the lines of force of the magnetic field just as they do when the machine is acting as a dynamo. As a result they have e.m.f.'s induced in them. The direction of one such induced e.m.f. in an individual conductor is, of course, given by the right-hand rule, and applying this rule to the conductor shown in C, we see that the induced e.m.f. acts outwards, that is, in opposition to the current. This induced e.m.f. in the case of a motor is, therefore, called the "back e.m.f."

Application of the Principle of Work. — It is interesting to look at the above problems from another point of view. We know that an electric motor does mechanical work, and we also know that in order that any machine may do work, an equal amount of work (plus the losses in the machine) has to be put into it. Again, when the work is done some force has to be overcome. Now, it is the supply e. m. f. which puts work into the motor by driving the current through the armature, and since work is only done when some force is overcome, we see that in order that the motor may perform mechanical work, the supply e.m.f. must have some opposition. This opposition must obviously come from a force of the same nature, namely an e.m.f., from which it follows that the armature must set up a back e.m.f. A similar process of reasoning shows that a magnetic drag must be set up on the armature of a dynamo delivering current.

It will thus be seen that the motor action and the dynamo action, which for the sake of convenience are studied separately, cannot, as

a matter of fact, have separate existences. They are inextricably bound up together, and one cannot come into operation without the other. As soon as a dynamo delivers current, the motor action comes into play and sets up the resistance to motion called the magnetic drag; and when a motor is made to perform work the dynamo action immediately comes into play and sets up the back e.m.f.

Notes

commutator ['kɔmju:teɪtə] — *комутація*
gear ['gɪə] — *шестерня; прилад*
modification [ˌmɔdɪfɪ'keɪʃn] — *видозмінювання*
outward ['autwəd] — *зовні, назовні*
obviously ['ɔbvɪəslɪ] — *очевидно, явно*
thus [ðʌs] — *так, таким чином*
to reason ['ri:zn] — *міркувати; робити висновок; переконувати*
inextricable [ɪn'ekstrɪkəbl] — *складний, заплутаний*

Text 16. A. C. Generators

Principles of Operation

Generation of E.M.F. — The fundamental principle on which all a.c. generators depend is that an e.m.f. is induced when a conductor is made to cut across a magnetic flux. In order to obtain an e.m.f. of suitable magnitude, many conductors in series and a strong magnetic flux are employed, while the rate of cutting is made as high as practicable.

This fundamental principle is illustrated in **Fig. 6**, where a single turn is shown rotating in a constant magnetic field excited from a source of D.C. As the turn is made to rotate at a constant speed, the two active conductors cut the magnetic flux at a rate that gradually increases to a maximum when the turn is horizontal. The vertical portions of the turn in the position shown in the diagram are inactive from the point of view of the inducing of e.m.f., and serve merely as end connectors for the two active conductors which lie parallel to the axis of rotation.

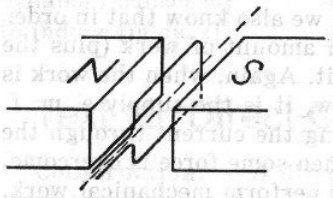


Fig. 6. Generation of Alternating E.M.F.

During the first 90° of rotation the rate of cutting flux is gradually increasing, while during the second 90° it is gradually decreasing, owing to the alteration in the angle at which the conductors cut

the flux. During the second half of the revolution the conductors cut the flux in the reverse direction, and during this period the reverse half of the e.m.f. wave is induced. One complete cycle of e.m.f. is induced in one complete revolution.

If a second turn were rigidly attached to the first, but at right angles to it, an e.m.f. of the same r.m.s. value would be induced in this second turn, but it would be 90° out of phase with the e.m.f. induced in the first turn. The arrangement would constitute a two-phase generator.

In practice three-phase generators are the most common, and a three-phase supply would be obtained by mounting three turns on the same shaft, these three turns being rigidly fixed at 120° to one another.

Rotating Field. — In d.c. generators the armature winding is mounted on the rotating member which rotates between the poles of a fixed magnet system, but with a.c. generators, or alternators, the standard practice is to place the armature winding upon the stationary element, now called the stator, while the field system is mounted on the rotating element, now called the rotor. This method of construction has many advantages from the designer's point of view, and is always adopted except in the case of a few special purpose machines.

The d. c. exciting current has to be led into the rotor, this being done by means of two insulated slip rings on which press a number of carbon brushes. This d.c. exciting current is usually provided by a special d.c. generator called an exciter, this being directly driven from the shaft of the main a.c. generator. In certain cases where a d.c. supply is available, this exciter is omitted, but in power station work each a.c. generator is provided with its own d.c. exciter.

Notes

flux [flʌks] — *потік; постійний рух*
horizontal [ˌhɔrɪ'zɔntl] — *горизонтальний*
inactive [ɪn'æktɪv] — *пасивний, бездіяльний*
merely ['mɪəlɪ] — *тільки, лише; просто*
angle ['æŋgl] — *кут*
rigid ['rɪdʒɪd] — *негнучкий*
to omit [ou'mɪt] — *випускати; нехтувати; пропускати*

Text 17. Powerhouse Auxiliary Motors

A complete description of the many and varied motor applications found in a modern steam station is almost a description of the station itself. Every phase of power generation requires some closely associated auxiliary equipment, which, in a modern power plant, is driven

almost exclusively by electric motors. Indicative of the large number of motor applications in a steam station, a recent power plant comprising two 75,000-kw turbines required over 700 auxiliary motors. In a typical plant the auxiliaries consume approximately 6 percent of the total power output and have a total horsepower rating of from 12 to 15 percent of the kilowatt rating of the main turbine generators.

No two generating stations are identical. It is impossible to state exactly the motor sizes and types that will be present in a steam generating station of a particular size. The requirements are governed by such factors as type of fuel, heat cycle, source of water, and anticipated station loading cycle.

Approximate sizes of the major auxiliary motors are given later as percentages of the nominal rating of the turbine-generator unit. The figures are average values based on a survey of steam stations with turbine-generator units of 100 megawatts and below.

Characteristics of Powerhouse Auxiliary Motors. — The primary characteristics to be considered in selecting auxiliary motors are size, speed, motor type, torque requirements, operating conditions, class of insulation, and type of enclosure. In addition, motors for central station service must have special features that insure reliability and ease of operation, features such as special moisture-resistant insulation, adequate provision for oil-ring inspection on motors with sleeve bearings, easy accessibility of the bearings and windings for servicing and inspection, and adequate terminal boxes. The reliability, efficiency, and simplicity of installation and control of the squirrel-cage induction motor have made it the almost universal choice for powerhouse applications.

Powerhouse auxiliary motors range in size from less than one horsepower, used to open and close valves, to several thousand horsepower, used to pump water into the boiler. They usually have drip-proof enclosures with class A insulation, and are designed to have low starting current and normal starting torque. However, some auxiliaries require special torque or speed characteristics, or present unusual service conditions such as excessive dirt, moisture, abrasive flyash, or high temperature; or the plant may be an outdoor installation. Motors for such applications must have special characteristics to satisfy these requirements.

Pump Motors. — Pumping is one of the major duties performed by powerhouse auxiliary equipment, and usually the largest motors in the station are those that drive the boiler-feed pumps. In a typical station the total horsepower rating of the boiler-feed-pump motors is between five and six percent of the kilowatt rating of the associated

turbine. At least two and usually three boiler-feed pumps of equal rating are used. These pumps operate against a very high head of water and require 3,600-rpm driving motors.

The output of the boiler-feed pumps is controlled by throttling or by varying the speed of the pump. The latter method is attractive because of reduced operating cost. Variable-speed control, when used, is achieved with a variable-speed coupling or by using a wound-rotor motor and a liquid rheostat.

The torque requirements of boiler-feed pumps and most other pumps are satisfied by motors with low starting current and normal starting torque. Most boiler-feed-pump motors are rated for a temperature rise of 40 degrees C above ambient and have class A insulation. Where the ambient temperature is above 40 degrees, class B insulation is used.

Although drip-proof construction is usual, special enclosures are sometimes used to reduce the noise level of the motor or to protect the motor from flyash and other unfavorable atmospheric conditions. Noise can be reduced by using pipe- or base-ventilated motors in which the inlet and exhaust for cooling air are at a remote location. In particularly dirty locations enclosed motors are used. Air for such motors is cooled by either an air-to-air or an air-to-water heat exchanger. Since outside air is never drawn into the motor, the windings are protected from contamination.

In addition to boiler-feed pumps, numerous other pumps are associated directly with the water cycle of the plant or perform auxiliary functions. These include pumps for handling circulating water, condensate, drain water, raw water, water-purification chemicals, ash, flood water, water for fire protection, sump water, lubricating oil, and station water supply. Usually the largest of these are the circulating-water pumps. In a typical station, there are two circulating-water pumps per turbine with a total horsepower slightly less than one percent of the turbine rating. The remaining pumps range in size from a fraction of a horsepower for small chemical-feed pumps to 100 to 300 horsepower for some raw-water, ash, and fire pumps. The size of the driving motor in a particular application is determined by the head and capacity requirements, which are influenced by the nature of the water source.

The location, and the speed and torque requirements of these pumps usually allow the use of standard drip-proof, squirrel-cage induction motors with low starting current and normal starting torque. Most pump motors have a synchronous speed of 1,200, 1,800 or 3,600 rpm; however, some motors, such as the circulating-water pumps, may require speeds as low as 277 rpm. Vertical motors are frequently used for pumping service because they require much less floor space.

Air-and Coal-Handling Motors. — Fans supplying air for combustion are usually driven by squirrel-cage motors. Where variable speed is desired for control and to reduce fan wear, wound-rotor induction motors or squirrel-cage induction motors with hydraulic or magnetic couplings are used. Frequently, two-speed squirrel-cage induction motors are used to take advantage of the reduced fan wear at the slower speed permissible during light-load periods.

In a typical station, induced-draft fans have a total horsepower of 2.5 percent of the turbine rating, while forced-draft fans have a total horsepower of approximately 1.2 percent. Usually two forced-draft fans and two induced-draft fans are used per boiler. Forced- and induced-draft fans are often installed in locations with abnormally high ambient temperatures. For such applications the motors must have class B insulation. With unfavorable atmospheric conditions, totally enclosed, fancooled motors are used for the fan drives.

Most stations using coal for fuel burn the coal in pulverized form. Pulverizers present the problem of a high starting torque, high-inertia load. The starting torque requirements vary with the type of pulverizer, the amount of moisture in the coal, and the duration of shutdowns. Motors are selected that can start the mill with favorable coal conditions after a momentary shutdown and have sufficient thermal capacity to allow two consecutive normal starts at full voltage. The motors are either high-torque or low-torque, drip-proof, squirrel-cage induction machines with class A insulation.

Motors driving coal-handling machinery are subjected to particularly severe operating conditions and must possess special characteristics. They operate in dust- and moisture-laden areas; therefore, totally enclosed or totally enclosed fan-cooled motors are necessary.

Notes

powerhouse ['pauəhaus] — *електростанція*
rmp = revolution(s) per minute
equipment [ɪ'kwɪpmənt] — *устаткування, обладнання*
exclusively [ɪks'klu:sɪvlɪ] — *виключно*
bearing ['beərɪŋ] — *відношення; поведінка*
to throttle ['θrɔtl] — *душити*
ambient ['æmbɪənt] — *оточуючий*
to lubricate ['lu:brɪkeɪt] — *мастити*
squirrel ['skwɪrəl] — *білка*
synchronous ['sɪŋkrənəs] — *одночасний*
combustion [kəm'bʌstʃn] — *згоряння*
consecutive [kən'sekjutɪv] — *послідовний, наступний*
favorable ['feɪvərəbl] — *сприятливий*

Text 18. Types of Motors for Powerhouse Applications

Motors for powerhouse auxiliaries are available in three standard constructions: drip-proof, splash-proof, and totally enclosed fan-cooled. The correlation between type of enclosure, temperature rise, ambient temperature, and type of insulation is shown in **Table I.**

All motors rated for a temperature rise of 40 degrees C will carry a 15-percent overload continuously with a safe temperature rise when operating in an ambient temperature of 40 degrees C.

Table I — Types of Motors Most Used on Powerhouse Auxiliaries

Types of Enclosure	Temperature Rise Above Ambient Degrees C	Ambient Temperature Degrees C	Class of Insulation	Service Factor
Drip-proof	40	40 max.	A	15%
		41 to 50	A	None
		41 to 60	B	15%
		61 to 70	B	None
Splash-proof	50	40 max.	A	None
		41 to 60	B	None
Totally Enclosed Fan-Cooled	55	40 max.	A	None
		41 to 60	B	None
	75	40 max.	B	None

In addition to the three standard enclosures, special ones are necessary for unusual operating conditions. These enclosures include self base-ventilated, self pipe-ventilated, forced-ventilated, explosion-proof, and outdoor types. Self base- and pipe-ventilated motors are totally enclosed and cooled by air circulated through ducts or pipe. The air intake and discharge are located in areas remote from the motor. This reduces the noise at the motor location and, where the air around the motor is dirty, makes it possible to obtain cleaner air from another location. Base-ventilated enclosures have openings at the floor line for connection of air ducts. Duct work to the source of air can then be installed underneath the floor if more space is available there. Pipe-ventilated motors have openings above the floor line.

There is a growing trend toward outdoor or semi-outdoor installation of new steam stations. Motors in such applications must be capa-

ble of providing reliable operation during all types of weather. On each side of a motor designed for outdoor service are two inlet-air openings protected by screens and louvers. From these inlets, air passes upward through a low-velocity space where the movement of the air is slow enough that air-borne particles of water and dust drop out and do not enter the motor. When the air reaches the top of this space, it is circulated through the motor and leaves at either end between the motor feet. A straight-through path is provided in both the inlet and discharge passages so that winds of hurricane velocity will not blow water into the motor.

This outdoor enclosure is also available for vertical motors. Again two inlet and two discharge openings are provided. These are alternately spaced at 90-degree intervals around the circumference of the motor. The inlet openings are at the top of the motor; the discharge openings are at the bottom. Low-velocity air passages are provided to remove entrained water from cooling air and straight-through passages for winds of hurricane velocity.

Many motors, even in a modern steam station, are located in extremely unfavorable atmospheres. Frequently moisture, coal dust, oil, weak acid fumes, and other elements that impair motor insulation, are present. For such applications, special protection must be given the motors. Totally enclosed, fan-cooled motors are especially applicable where large amounts of flyash and dust are present, or in outdoor installations where salt spray is a problem. In the tube-type, totally enclosed, fan-cooled motor, air from the atmosphere is not used inside the motor for cooling. A copper-tube heat exchanger is used to cool the motor. Air contained inside this enclosure never comes in contact with the atmosphere.

If totally enclosed motors are not justified, but extra protection of the motor insulation is needed, special moisture-resistant insulation should be specified to insure reliability. This insulation consists of additional dips and bakes of the motor winding.

If open-frame motors are to be subjected to unusually abrasive flyash the coils should be given the additional protection of a Neoprene coating. The abrasive particles bounce off the Neoprene and thus do not become embedded in the insulation where they might ultimately cause failure.

Extra Precautions Taken During Manufacture. — Motors for powerhouse auxiliary drives must meet a wide range of requirements. All motors must provide the maximum possible reliability even under severe operating conditions.

Motors for central-station use are frequently purchased by the manufacturer of the auxiliary equipment. To assure special treatment, it is essential that the manufacturer be notified that the motors are going into power plants. For complete assurance of the best insulation, the purchaser should specify special moisture-resistant insulation for all motors to be installed in powerhouses.

Notes

available [ə'veɪləbl] — *придатний, корисний*
proof [pru:f] — *доказ; випробування*
splash [splæʃ] — *плескіт; пляма*
duct [dʌkt] — *трубопровід*
to intake ['ɪnteɪk] — *впускати*
hurricane ['hʌrɪkən] — *ураган*
dip — *занурення; умочання*
to subject [səb'dʒekt] — *підкорять*
to bounce [bauns] — *підскакувати; підстрибувати*
to embed [ɪm'bed] — *впроваджувати*
ultimately ['ʌltɪmɪtlɪ] — *зрештою, кінець кінцем*
to notify ['noutɪfaɪ] — *повідомляти, сповіщати*
to specify ['spesɪfaɪ] — *визначати*

Text 19. The Wahleach Hydroelectric Development

There is a number of relatively high-head hydroelectric plants in British Columbia and the Pacific coast states. In December 1972, the Wahleach Plant was placed in service by the British Columbia Electric Company, Ltd. To serve it, water is diverted through a 2-mile tunnel from Wahleach Lake to a penstock partly underground and partly on the surface of the steeply sloping Four Brothers' Mountain to a powerhouse on the left bank of the Fraser River approximately 78 miles from the river mouth. The single generating unit representing the full development operates under supervisory control from the company's central office in Vancouver, a distance of 72 miles. A transmission line, the first of its kind on the North American continent, is associated with this development, but designed for later extension to the company's Bridge River Plant, approximately 110 miles to the north. This line is designed for 345-kv operation with two parallel conductors per phase. It is presently operating at 230-kv with only one of the two conductors, but full insulation has been

provided for the higher voltage and hardware is in place to permit the second conductor to be added with a minimum of change when it is desired to operate at 345 kv.

Commencement of Construction. — After preliminary studies had indicated the practicability of the project, detailed field studies were commenced in May 1969. A Vancouver firm of consulting engineers was employed on this work and in later phases of the project. The field studies for the location of the damsite and reservoir were completed by the end of 1969; investigation of the various sites for the components of the development was resumed in 1970 as soon as weather conditions permitted. The powerhouse was located a $^1/_2$ mile from the site for the initial plan, and the tunnel line established from the intake to the powerhouse.

Powerhouse and Tailrace. — The substructure of the powerhouse is of reinforced concrete on rock foundations. The lowest portion of the structure is at elevation 41 feet, the center line of the turbine at 70 feet, and the generator supports at 90 feet.

The superstructure is structural steel with precast aerocrete roof and asbestos cement siding. The frame supports two 130-ton travelling electric overhead cranes. These cranes were transferred from another plant and one was returned after erection of the unit was completed. On the upstream side of the building is a steel and concrete wing housing the control equipment and low-voltage switchgear. The main building is 87 feet long by 61 feet wide and the wing is 70 feet long by 18 feet wide.

Protective Relaying. — The generator is provided with split-phase, differential, overvoltage, overtemperature, overspeed, and current-balance protection. The neutral has an overcurrent relay in the secondary of the grounding transformer. Operation of any of these devices opens the generator circuit breaker and field circuit breaker and shuts down the unit. The main and 60-kv transformers have phase-differential and ground differential protection with overcurrent relays for stand-by.

A gas-pressure relay fitted into the cover of the main transformer operates to disconnect the transformer from the circuit if an arc or explosion should increase the oil pressure rapidly. Each of the transformers in the 13.8/60-kv bank is also equipped with this type of protection.

For protection of the transmission line, carrier-current type relaying is provided with a 3-zone impedance relay on each phase, and a directional overcurrent relay for ground faults. Out-of-step blocking is provided to prevent disconnection of the line under out-of-phase conditions, unless the second zone of the relay comes into operation. Transmission-line relays are presently arranged to trip the generator circuit breaker. Transformer protective relays are arranged to trip the generator circuit breaker and close the motor-operated grounding blade on the 230-kv disconnecting switch to open the circuit breaker at the other end of the line.

Notes

hydroelectric ['haɪdroʊɪ'lektrɪk] — *гідроелектричний*
steeply ['sti:plɪ] — *стрімко*
hardware ['hɑ:dwɛə] — *металеві вироби*
preliminary [prɪ'lɪmɪnərɪ] — *попередній*
practicability [ˌpræktɪkə'bɪlɪtɪ] — *здійснення; реальність*
to reinforce [ˌri:ɪn'fɔ:s] — *підсилювати; підкріплювати*
concrete ['kɔnkri:t] — *бетонний*
elevation [ˌelɪ'veɪʃn] — *підняття; піднесення*
turbine ['tə:bɪn] — *турбіна*
superstructure ['sju:pəˌstrʌktʃə] — *надбудова*
to side — *приєднувати*
upstream ['ʌp'stri:m] — *угору течією; проти течії*
impedance [ɪm'pi:dəns] — *перешкода; затримка*

11.

Section. Metallurgy

Text 1. Ores

The art of metallurgy includes the deriving of metals from their ores, or the condition in which they are found in nature; their purification, or their admixture with other metals; and finally their manufacture into shapes and forms usable in industry. The science of metallurgy includes the study of these processes with a view to their control and improvement, and the development of new metal mixtures or alloys and of new test methods.

An ore is a solid crude containing a valuable constituent in such amounts as to constitute a promise of possible profit in extraction, treatment and sale.

The valuable constituent of an ore is ordinarily called valuable mineral or often just mineral: the associated worthless material is called gangue. In some ores the mineral is in the chemical state in which it is desired by primary consumers, e.g. graphite, sulphur, asbestos, talc, garnet; in fact this is true of the majority of nonmetallic minerals. In metallic ores however, the valuable mineral is rarely the product desired by the consumer, and chemical treatment of such mineral is a necessary step in the process of benefication. In such cases the sale product is usually the result of concentration by the method of ore-dressing, followed by further concentration by the chemical methods of metallurgy. The valuable product of the ore-dressing treatment is called *concentrate*, the discarded waste is tailing.

Concentrate is, in most cases, the feed to the metallurgical plant. If the metallurgical process is one in which separation is effected in a melt, the process is called *smelting*; if the separation is effected by

differential or selective solution, the process is *leaching* where the process is one of selective vaporization, it is called, *retorting*.

The valuable metal product of smelting is usually differently named according to the metal involved, e.g. *blister* (copper), *base bullion* (lead), *pig* (iron), etc.; the waste is *slag*.

The metal or mineral is invariably associated with more or less — usually more — barren rock. The form in which the metal is required by the primary customers is a relatively pure substance. Hence a more or less extended process of purification, usually involving, in order, ore-dressing, metallurgical extraction, and chemical refining, intervenes between delivery of ore at the mine exit and delivery of the metal to the customers.

One way in which the nonferrous metals differ from iron is in the manner of their occurrence. Iron oxide occurs in large and comparatively pure deposits; the other metals and compounds from which metals are derived are scattered through large volumes of rock, such as limestone or quartz. Since it would be difficult and costly to smelt these large amounts of barren rock, metallurgists have recourse to concentration or "ore dressing" by which the metals or metallic compounds are partially separated from the "gangue," or worthless material, before smelting.

Gravity Methods of Ore Dressing. — The simplest method of ore dressing depends on the fact that in general the metallic compounds have a higher specific gravity than the gangue, and hence settle faster in a stream of water. Gold panning is the simplest illustration of the procedure. On a lager scale, it is carried on in jigs where the ore is placed on a screen and a pulsating stream of water forced through the screen, causing the lighter gangue to be washed out. Another form of gravity concentrator is the "table", consisting of a surface with longitudinal ridges, which is given a jerking end-to-end motion while a stream of water flows across it laterally. By this means the heavy ore is shaken over the end while the gangue washes off the front.

Notes

metallurgy [me'tælədʒɪ] — *металургія*
ore [ɔ:] — *руда*
purification [ˌpjuərɪfɪ'keɪʃn] — *очищення*
admixture [əd'mɪkstʃə] — *домішка; суміш*
alloy ['ælɔɪ] — *сплав*
constituent [kən'stɪtjuənt] — *складова частина*
to extract [ɪks'trækt] — *добувати*
treatment ['tri:tmənt] — *ставлення; обробка*
to concentrate ['kɔnsentreɪt] — *випарювати*

to smelt — *виплавляти; плавити*
to retort [rɪ'tɔ:t] — *відповідати тим же*
blister — *пухир*
waste ['weɪst] — *необроблений*
barren ['bærn] — *сухий, неродючий*
to intervene [ˌɪntə'vi:n] — *знаходитися; відбуватися*
exit ['eksɪt] — *вихід*
non-ferrous ['nɔn'ferəs] — *кольоровий (про метал)*
limestone ['laɪmstoun] — *вапняк*
gravity ['grævɪtɪ] — *важливість, серйозність*
jig [dʒɪg] — *дрібний ручний інструмент*
to jerk [dʒə:k] — *різко штовхати*
laterally ['lætrəlɪ] — *збоку*

Text 2. Principles of Flotation

A flotation machine and its contents, in continuous operation, comprise a system in a rough sort of dynamic and chemical equilibrium. Into this system ore, water, air, and a variety of chemicals in small quantities are introduced continuously; from it flow continuously two or more streams of products which differ obviously in physical state and somewhat less apparently in chemical composition. The overflow stream is usually a froth carrying a load of solid which is different in mineralogical character from that of the other product streams and of the feed stream. The underflows are suspensions of the residue of the feed solid in the balance of the feed water.

Determination of the distribution of the added chemicals in these product streams has been the key to the understanding and control of the process. From such study it has developed that the added reagents have a variety of functions. These have been assigned descriptive names as follows:

1. *Collection* is a selective change in the surface of one mineral species or genus present in the ore, as a result of which the changed mineral is rendered water repellent, the other mineral species present remaining unaffected and water-wet. Reagents which effect collection are called *collectors*, or *collecting agents*, and less frequently, *promotors*.

Collection is performed for the purpose of producing selective water-repellent coatings on the mineral particles which are to be separated from the pulp, in order that gas bubbles may cling to these particles. The coatings are of hydrocarbon or hydrocarbonlike nature. In the simplest case all that is necessary to effect collection is to add to the pulp a small amount of one of a certain class of organic chemicals (collectors), and to agitate the mixture long enough to effect thorough dispersion and permit the desired chemical reaction. If the pulp contains substances that interfere with the reaction, or lacks other substances that facilitate it, remedial treatment is required.

2. *Conditioning* comprises changes in mineral surfaces and in the composition of the aqueous solution. Such changes in surface as aid collection of the changed particle are called *activation*.

Surface changes that prevent collection are called *depression*; changes in the solution which do not at the same time effect changes in particle surfaces are designed to protect other reagents and are, therefore, called *protection*. Other treatments of the flotation pulp such as heating, desliming, dewatering, etc., which contribute to the success of flotation, are also usually classed under the head of conditioning.

3. *Levitation* is the act of lightening collector-coated particles by causing them to become attached to air bubbles. By extention the term is also applied to flotation at the upper surface of the suspending medium, and to attachment to droplets of a liquid lighter than an immiscible with the suspending liquid.

4. *Frothing* is the act of producing a collection of bubbles froth at the surface of the suspending medium. It is usually implied that the froth carries a load of levitated solid.

Notes

froth ['frɔθ] — *піна*
suspension [səs'penʃn] — *припинення; підвішування*
residue ['rezɪdju:] — *осад*
species ['spi:ʃi:z] — *вид*
genus ['dʒi:nəs] — *вид*
to facilitate [fə'sɪlɪteɪt] — *полегшувати; сприяти*

Text 3. Selection for Use

The selection of the proper metal or alloy for a given use is an important part of the practice of metallurgy. Because iron and steel are used in larger quantities than any of the other metals, it is common practice to divide metallurgical materials into ferrous, or iron-bearing, and nonferrous, of those containing no iron or only small proportions of iron.

Strength, ease of shaping and relatively low cost are of greatest importance for major structural purposes. For these purposes, steel is ideally suited. Steel is used for the structural members of buildings, for rails, locomotives, and ships. For automobile parts, and wherever

greater strength and toughness are required, more expensive special steels are used. As a general rule, if strength alone is the main consideration, nonferrous alloys would not be used. However, where the requirement is for strength combined with resistance to rusting, aluminum-bronze or "monel"-metal may be used. There are purposes for which strength is not so important as ease of machining. In making screws, for instance, another kind of steel, or perhaps a brass, may be used.

Where the finished form is to be produced by casting, and great strength is not required, cast iron, or cast brass are employed. The steel that is used in tools might be called the master metal of them all. This steel can be made soft enough for machining, or for cutting or forming to the desired shape, and then by heat treatment it can be properly hardened for use as a tool.

Metals Light in Weight. — For making airplane parts, and in other applications where strength must be combined with light weight, metals such as aluminum or magnesium and their alloys are used.

Softness. Ease in Bending. — For uses requiring softness and ease in bending, as in cable-sheathing or plumber's pipe, and where certain chemical properties are needed, lead and its alloys may be employed.

Susceptibility to Corrosion. — Metals vary greatly in their susceptibility to atmospheric and chemical corrosion. The rusting of iron is the commonest example. A list of the elements in the order of their susceptibility to attack would start with potassium, which actually catches fire in contact with water, and would end with platinum and gold, which are unattacked by almost all chemical reagents. Such a list known as electromotive or electrochemical series, is as follows:

a) Potassium	g) Zinc	m) Copper
b) Sodium	h) Iron	n) Mercury
c) Calcium	i) Nickel	o) Silver
d) Magnesium	j) Tin	p) Platinum
e) Aluminum	k) Lead	q) Gold
f) Manganese	1) Hydrogen	

The electromotive series is an arrangement of the metals in the diminishing order of their tendency to oxidize or corrode. Hydrogen is not a metal, but is included in this series to show its activity in relation to that of the various metals.

Oxidation or corrosion of those metals at the top of this list takes place at ordinary temperatures. Such activity decreases from top to bottom. Copper and those below it do not oxidize at ordinary temperatures when exposed to pure dry air.

Metals above hydrogen are difficult to obtain free in nature as they unite readily with other elements. Such metals are rarely found

in the native state. Metals below hydrogen are found free in nature because they combine with other elements with difficulty. Hence, they do not corrode and are not easily oxidized.

Although the list indicates the varying effects or lack of effect of corrosion, it is misleading in practice since both aluminum and zinc form protective coatings in the early stages of oxidation and are not further destroyed; whereas iron and steel, if unprotected will rust completely through. For this reason iron and steel when used in exposed position, are protected by paint or by a thin coat of zinc (galvanized sheet) or tin.

Electrical Conductivity. — Copper and aluminum are used for conducting electricity since they offer less resistance to the passage of the current. Silver offers even less resistance but it is too expensive for commercial use. Copper offers less resistance than aluminum for the same size wire, but aluminum, due to its lighter weight, offers less resistance per unit of weight. Despite this fact, from a cost standpoint the advantage is still with copper. In the passage of current through a conductor, resistance results in the giving off of heat; the greater the resistance, the greater the heat for the passage of a given current. Hence for electrical heating, metals with high electrical resistance are needed. These are found in the alloys; among the best are alloys of nickel and chromium.

Resistance to Heat. — The resistance to the flow of heat is of the same order as the resistance to electricity; hence, ordinarily we use copper for boiler tubes, heating coils, and soldering irons.

In magnetic properties, iron and its alloys stand alone.

Melting Point. — The melting point is the temperature at which a substance passes from a solid to a liquid condition. For water this is 82° F. Pure substances have a sharp melting point, that is, they pass from entirely solid to entirely liquid form in a very small temperature range. Alloys usually melt over a much wider temperature interval. The melting points and other temperatures in this article are expressed in degrees Fahrenheit. According to this scale, water melts at 32° and boils at 212°. In metallurgy, temperatures are expressed frequently in degrees Centigrade.

Notes

ferrous ['ferəs] — *чорні метали*
toughness ['tʌfnɪs] — *міцність*
brass [brɑ:s] — *мідь; латунь*
to cast [kɑ:st] — *лити, відливати (метал)*
plumber ['plʌmə] — *паяльник*
susceptibility [sə,septə'bɪlɪtɪ] — *сприйнятність; вразливість*

potassium [pə'tæsjəm] — *калій*
manganese [ˌmæŋgə'ni:z] — *марганець*
tin — *олово*
lead [led] — *свинець*
hydrogen ['haɪdrɪdʒən] — *водень*
copper ['kɔpə] — *мідь*
mercury ['mə:kjurɪ] — *ртуть*
to corrode [kə'roud] — *іржавіти*
resistance [rɪ'zɪstəns] — *опір*
standpoint ['stændpɔɪnt] — *точка зору, погляд*

Text 4. Producing Iron and Steel

Iron Ore. The more common impurities in iron ore is silica, titanium and phosphorus; the ores containing the smallest amounts of these impurities are the most valuable. Much silica and titanium are undesirable because they require extra fluxes to slag in the blast furnace, while phosphorus and sulphur are undesirable because of their adverse effect on iron and steels. The iron ores mined in Sweden are almost entirely free from phosphorus and sulphur, which explains the fame of Swedish iron and steel as high purity metals.

Coke. — The heat required for melting ore in blast furnaces is obtained from the burning of coke. Coke is the residue left after certain soft coals have been heated in the absence of air. It is hard, brittle, and porous material containing from 85 to 90% carbon, together with some ash, sulphur, and phosphorus. The strength, brittleness and impurities in the coke are dependent both on the coal used and on the methods of manufacture. There are two ways of making coke. In the older, wasteful process of destructive distillation, it is made in beehive ovens with no by-products obtained by distillation. In the newer process it is made in retorts, and many by-products, such as tar, ammonia, and benzol, are obtained from the distillate.

Scrap. — Of all the materials used in the field of engineering, only the metals can be used over and over again. Other engineering materials, such as wood, glass, and concrete, become a liability when they have outlived their usefulness. However, the metals from discarded structures, such as boilers, bridges, ships, automobiles, etc. become valuable scrap. The need for scrap metals in the manufacture of both ferrous and nonferrous metals and alloys is one of the major problems facing the manufacturer, particularly in the steel industry where large quantities of selected and segregated scrap are needed. During ordinary periods of productivity, the difficulties of obtaining

an amount of good scrap are not serious; however, it remains an important factor in the everyday operation of a steel mill.

Scrap metals receive varying treatments from the melter. A common practice is to place it in the belly of a furnace where it is fused and blended with some primary or virgin metal and then refined and cast into some useful product. Difficulties of controlling the exact composition of the final heat of the metal may be largely due to the improper segregation of the scrap charged into the furnace. With our continuing practice of using the metals over and over again, ultimately all of the scrap used will contain elements that may be undesirable in some finished product.

Notes

iron ore ['aɪən'ɔ:] — *залізна руда*
impurity [ɪm'pjuərɪtɪ] — *домішка*
flux [flʌks] — *витік*
blast furnace ['blɑ:st 'fə:nɪs] — *доменна піч*
adverse ['ædvə:s] — *несприятливий*
coke ['kouk] — *кокс*
brittle ['brɪtl] — *крихкий*
ammonia [ə'mounjə] — *аміак; нашатир*
scrap [skræp] — *металевий брухт*
to fuse ['fju:z] — *плавити(ся)*
to blend (blended, blent) — *змішувати*
virgin ['və:dʒɪn] — *чистий*
improper [ɪm'prɔpə] — *неправильний*
segregation [ˌsegrɪ'geɪʃn] — *відділення; ізоляція; сегрегація*
ultimately ['ʌltɪmɪtlɪ] — *зрештою, кінець кінцем*

Text 5. The Blast Furnace

The reduction of the iron ores is brought about by a reaction with carbon from the fuel used to smelt them, at the high temperature made to prevail in the container of the material — the furnace. The advantages of the *blast furnace* lie in the recovery of practically all the iron from the ore, the delivery of both iron and slag in liquid form, and the desulphurization of the metal, and in the cheapness of the method.

Construction of the Blast Furnace

General. — The changing industrial conditions have brought about radical changes in the construction of the modern blast furnace. A

blast furnace is now designed so that a mixture of ore, fuel, and flux in proper proportions can be charged through a specially constructed opening in the top of a cylindrical-shaped furnace and top-gas and flue dust withdrawn for recovery, treatment and use. At the same time heated air from stoves, which obtain their heat from the combustion of this top gas, is blown in near the bottom through opening forming carbon monoxide, which passes up through the openings in the charge to reduce the iron ore. The process is a continuous one except for the periodic removal of the impurities, in the form of slag, and of the metal, through large openings in the crucible of the furnace.

In present-day practice the production of a ton of pig-iron involves the use of about 2 tons of iron ore, 1 ton of fuel, 4 tons of air, and 0.35 ton of flux and produces, besides the 1 ton of pigiron, 6 tons of gas, 0.6 ton of slag, and 75 to 375 pounds of flue dust.

While the central equipment in a blast-furnace plant is the furnace with its auxiliary apparatus for hoisting the materials to the top and handling the slag and molten metal, a considerable investment, and much space must be provided for auxiliary apparatus.

The modern 1000-ton blast furnace is circular in cross section, 90 to 100 feet high and lined with fire brick, held in a close-fitting steel shell which is divided vertically, for convenience, into three main parts. The bottom, cylindrical in form and some 10 to 12 feet deep, is termed the *hearth* or the *crucible*; the second section, in the form of an inverted frustum of a cone, 9 to 12 feet in height, is called the *bosh*; and resting on the bosh, and extending up for a distance of about 70 feet, is the *stack*. Finally, the whole is capped by a *furnace top*, providing means for the introduction of the charge and the withdrawal of the gas and the flue dust.

Foundations. — The foundations of a modern blast furnace must carry a total load of nearly 4000 tons. In view of this immense weight and the fact that a small amount of settling will crack the lining or throw the skip and the charging devices out of line, the stability of this foundation is of great importance. No generalization can be given as to size and depth; they will vary with the conditions of soil, (sand, clay, or rock) on which the furnace is built. On a proper bed the foundation is built up with several feet of concrete, on top of which is laid common brick of good quality and strength except directly beneath the hearth and walls of the furnace, where fire brick is used.

Hearth or Crucible. — This portion of the furnace which contains the molten metal and slag is constructed of fire brick of the best quality, usually 60 inches or more in thickness and reinforced by means of strong bands and protected in places with water-cooled

plates. The bottom is given a cup-shaped cross section. In the large furnaces the hearth will be 22 to 28 feet in diameter and 11 feet in depth. In view of the fact that the 7 to 10 feet of slag and metal within the crucible creates a considerable pressure on this hearth (namely about 30 pounds per square inch) and because of the high temperature prevailing there these refractory bricks, must be reinforced by heavy metal jackets made of riveted steel or plates of segmental iron castings that are closely fitted and bolted together. They are always water cooled: those of cast iron by internal circulating systems and those of steel by coolers set between the brick work of the jackets.

Tapping Hole and Cinder Notch. — The tapping hole or cinder notch is an opening about 6 to 8 inches on the inside, through which the molten metal may be drawn from the crucible. The outside dimensions are somewhat larger in order to permit the insertion of the tapping tools, and at this point the hearth jacket is usually protected by a water-cooled "dam plate". There is usually only one cinder notch, located about 6 feet from the floor of the hearth and 4 or 5 feet above the tapping hole, generally placed 45 degrees from this opening if there are two notches, or 90 degrees if there is only one.

Bosh. — The bosh is that part of the furnace, at the mantle level, just above the upper limits of the crucible, where the furnace attains its greatest diameter. Actually, it is the weakest part and must be very carefully constructed and maintained. Starting at the top of the hearth, the brickwork, which is normally about 27 inches in thickness, is stepped outward, externally, about 6 inches for each 12 inches of vertical rise. Each of these step-outs is supported by means of heavy steel "bosh bands". Between these bosh bands, or in large furnaces each pair of bosh bands, are inserted cooling plates called bosh plates. These bosh plates are in horizontal rows about 2 feet vertically apart, the plates in each row being about 2 feet apart and the plates in different rows staggered vertically so as to avoid making weak joints in the brickwork. The bosh plates, which are of course water-cooled, serve to protect the brickwork, because this point, being opposite the zone of fusion in the furnace, is likely to be corroded very rapidly by the hot slag. At the upper limit of the bosh is the furnace. Upon it rests the weight of the stack, and this in turn is supported by a series of cast iron or fabricated steel columns which rest on the main furnace foundation.

Shaft or Stack. — This comprises that part of the furnace located above the bosh but below the bells, and, for convenience, is divided into three almost equal parts, called the upper, middle, and lower

inwalls. The blast furnaces are lined with thick walls up to 5 feet in thickness. The brickwork forming the hearth, bosh, and inwalls is referred to as the lining; and obviously, because of the very different thermal and mechanical conditions existing at these different levels, each requires a different type of brick. Fire-clay brick is universally used and great care must be exercised because the life of the furnace depends in a large measure upon the lining.

Stoves. — A blast-furnace stove is a chamber where the blast or air for the blast-furnace is heated. A blast-furnace stove has the shape of a cylinder of boiler plate about 22 feet in diameter by 100 feet in height filled with a checkerwork of the fire-brick. This checkerwork is heated by the combustion of blast-furnace gas and subsequently gives up a part of its heat to air from the atmosphere, passed through it in the reverse direction. Common practice is to provide four stoves for each blast-furnace, on the basis that, as the number of stoves increases: 1) the velocity of the gas, and hence the rate of heat transfer, falls off; 2) the heat losses through radiation increase; and 3) leakage increases.

Uses of Blast-Furnace Gas. — The burning of blast-furnace gas in stoves for the regenerating heating of air for the blast-furnace is the oldest and, metallurgically, the most important of uses. It is universally performed with unmixed blast-furnace gas and normally requires for a blast temperature 730° C not over 25 percent of the total gas generated by the blast-furnace.

Notes

flue [flu:] — *пил*
combustion [kəm'bʌstʃn] — *згоряння*
molten ['moultən] — *розтоплений*
circular ['sə:kjulə] — *круглий*
hearth [hɑ:θ] — *вогнище*
to invert [ɪn'və:t] — *перевертати*
bosh [bɔʃ] — *дурниці; нісенітниця*
stack [stæk] — *труба*
cinder ['sɪndə] — *шлак, попіл*
notch [nɔtʃ] — *виїмка, паз*
insertion [ɪn'sə:ʃn] — *прокладка*
dam [dæm] — *дамба*
mantle ['mæntl] — *по́крив*
to stagger ['stægə] — *хитати*
lining ['laɪnɪŋ] — *облицювання, обкладка*
subsequently ['sʌbsɪkwəntlɪ] — *згодом, потім*

Text 6. Bessemer Steel

Bessemer Process of Making Steel. — Steels made either in a Bessemer or an open-hearth furnace are designated as either acid or basic steels, depending on the nature of the refractory linings of the furnace. Silica is an acid lining, while dolomite and magnesite are basic linings. The nature of the linings controls the slag since a basic slag could rapidly dissolve an acid lining and an acid slag would have the same effect on a basic lining. With a basic lining, a large percentage of the phosphorus and some of the sulphur can be removed, but the greater amount of iron oxide left in the steel renders basic steel inferior to acid steel. The basic Bessemer process is used extensively in Europe. In the U.S.A., where iron sufficiently low in phosphorus for acid Bessemer is still available, that process is used instead.

In making Bessemer steel, molten iron direct from the blast furnace is poured into the converter. In the bottom of this vessel (converter) are a number of holes through which air is blown. The air first oxidizes the silicon and manganese, which, together with some iron oxide, rise to the top and form a slag. The carbon then begins to burn, and the blowing is continued until all but about 0.05% of the carbon has been eliminated. The progress of the blow can be determined from the flame coming from the vessel. The oxidation of the impurities has raised the temperature of the metal to the point where it can be cast conveniently. When the blow is completed, the amount of carbon necessary to bring the carbon content to the specific percentage, together with manganese to counteract the influence of sulphur, and silicon to degassify, are added to the molten metal. The finished steel is then poured into a ladle by tipping the vessel, and from the ladle it is poured into ingot molds for subsequent rolling or forging.

Bessemer steel is likely to be highly oxidized and dirty, and, although it is usually considered inferior to steel produced by other methods, it can compete with steels made by these other methods on jobs calling for low-carbon steel with not very high requirements for strength, ductility, and toughness. The acid process does not remove sulphur and phosphorus, with the result that these elements are excessive for a good grade of steel. Because no extraneous fuel is used in Bessemer process, and a heat of 15 to 25 tons can be made in 10 or 15 minutes, the cost of the process is low. However, the process is losing its prominence and is increasing in operational costs, due to the exhaustion of low-phosphorus iron ores. Bessemer steels find extensive use in low-grade sheets, wire, pipe, skelp for the manufacturing of pipe, and screw stock; also wherever a steel is required which is not subjected to severe loadings, and where easy machining is desirable.

A *duplexing process* where acid Bessemer steel is additionally refined in the basic open-hearth results in a low-carbon steel inferior to that of the basic open hearth, but one which finds much use because of its cheapness. Another duplexing process takes steel produced by either Bessemer or the open-hearth process and refines it in the electric furnace. Such steel is superior, usually, to open-hearth steel. A *triplexing* process starts with steel from the Bessemer process, removes part of the phosphorus in the basic open hearth and further refines it in the electric furnace.

The important feature to be kept in mind when studying open-hearth practice is that it is primarily an oxidizing process. Refining depends on the oxidation of impurities under basic conditions and, with the exception of sulphur, only impurities that will be oxidized under these conditions can be removed. The sources of oxygen are rust and scale on the scrap, iron ore in the charge and added during the refining period, carbon dioxide (CO_2) obtained from the calcination of limestone, and air and other oxygencontaining gases in the furnace atmosphere. The rust and scale, and the oxides formed by the oxidation of the scrap by the furnace gases, supply oxygen during the melting period. When iron ore and limestone are added with the charge these are also important sources of oxygen during this period. After the charge is melted and the liquid metal bath is covered by slag, oxygen is transmitted to the bath by the slag. The oxygen in the slag is obtained from oxides carried over from the melting period and from oxidation of the slag by the furnace gases. Iron ore is also usually added during refining, and this supplies oxygen both to the slag and directly to the bath.

The type and amount of fluxing and oxidizing materials used depend on the composition of the metallic part of the charge. The metallic charge consists of various combinations of blast-furnace hot metal and cold pig-iron, cupola iron, cast-iron scrap, steel scrap, and Bessemer-blown metal. With the exception of the scrap steel and usually the Bessemer metal, the metallic components of the charge contain relatively high percentages of carbon, silicon, manganese, and phosphorus. The fluxing and oxidizing additions must therefore be adjusted to the type and amount of these materials in the metallic charge.

Notes

refractory [rɪ'fræktərɪ] — *вогнестійкий*
charge ['tʃɑ:dʒ] — *навантаження*
molten ['moultən] — *розтоплений, литий*
silicon ['sɪlɪkən] — *кремній*

oxygen ['ɔksɪdʒən] — *кисень*
slag [slæg] — *шлак*
to counteract ['kauntə,rækt] — *протидіяти, перешкоджати*
sulphur ['sʌlfə] — *сірка*
ingot ['ɪngət] — *зливок, брусок (металу)*
to forge ['fɔ:dʒ] — *кувати*
subsequent ['sʌbsɪkwənt] — *наступний*
to roll ['roul] — *обертати(ся)*
ductility [dʌk'tɪlɪtɪ] — *в'язкість; гнучкість, пластичність (про метал)*
excessive [ɪk'sesɪv] — *надмірний*
extraneous [eks'treɪnjəs] — *зовнішній; чужий*
exhaustion [ɪg'zɔ:stʃn] — *виснаження*
duplex ['dju:pleks] — *подвійний, двосторонній*

Text 7. Refining Period

The beginning of the **refining period** is usually taken as the time when the metallic charge has melted and the limestone has been partly calcined and has floated up from the bottom of the furnace. The time from the finish of charging to the point when the heat is melted varies with the size and condition of furnace, the fuel, and the type of charge.

The following discussion covers the practice for 150-ton furnaces using oil. In type 1, a charge consisting of lime, ore, and liquid iron, the melting time will be from 3 to 7 hr. In type 2, which is an entirely liquid metallic charge, the first liquid steel (Bessemer-blown metal) poured into the furnace freezes over the lime on the bottom, but the later additions remain molten. The chilled metal melts rapidly and releases the lime from the bottom so that this type of heat reaches the refining stage within 30 to 45 min. after the last ladle of liquid metal is added. In type 3, cold steel scrap and liquid iron, the normal melting time is from 3 to 5 hr., but when ore is added with charge and a larger proportion of liquid iron is used, the time is usually decreased. In the case of types 4 and 5, which are wholly cold charges, the melting time varies from 4 to 8 hr.

The Working Period. — The stage in a heat following the charging and melting periods is the "working" or final refining period. This extends from the time the heat is melted to the deoxidation or tapping time. It has been pointed out that during melting a certain proportion of the carbon, manganese, phosphorus, and silicon was eliminated by

oxidation. The oxygen during this period was obtained from the iron oxide present and formed on the scrap during charging and melting, from the furnace gases after the heat was "under cover", i. e., when the charge was covered by slag, and from the carbon dioxide in the limestone. An additional source of oxygen during the melting period is iron ore in the types of practice where this is added with the charge. During the working period the refining is also accomplished by oxidation, but the sources of oxygen during this period are the furnace gases and iron ore added to the bath. The oxygen that comes from furnace gases is a relatively small proportion of the amount required to oxidize the elements in the bath within a reasonable length of time. Consequently, iron ore is used to control and accelerate the rate of oxidation. The ore also accelerates the "shaping up" or solution of the undissolved lime in the slag, and creates a boiling action in the bath which is advantageous in eliminating gases from the steel and controlling the temperature.

Notes

to refine [rɪ'faɪn] — *очищати*
to oxidize ['ɔksɪdaɪz] — *окисляти(ся), окислювати(ся)*
to eliminate [ɪ'lɪmɪneɪt] — *усувати, знищувати*

Text 8. Deoxidation and Final Additions

The purpose of the basic open-hearth process is to produce steel with a desired composition and with other characteristics that determine the manner in which the molten steel solidifies after it is tapped from the furnace and poured into molds or castings.

Obtaining the Required Final Compositions. — The composition of the finished steel will depend on the chemical specification for which it is made. The specification will usually require that the analysis of the steel be within certain ranges of carbon, manganese, phosphorus, and sulphur contents. Other components, such as silicon and the alloying elements, may also be specified. In the case of elements which are considered undesirable in a certain grade, only the maximum percentages are given.

It is usually necessary to add manganese, and the addition of other elements may be required for various grades of steel. Some elements, such as nickel, molybdenum, and copper, may be added with the charge or during refining, since they are not oxidized; the elements that are oxidized such as manganese and silicon, may be added to the bath just before tapping or to the ladle.

An important element in steel which is not usually shown in the analysis is oxygen. The amount of oxygen in the steel varies with the

carbon content, temperature, and slag composition. Although oxygen is not included in chemical specifications for finished steel, the amount and form in which it is present influence the type of solidification which will result when the steel is cast into molds, and also the properties of the product.

In the case of type which is termed *killed steel* it is necessary to remove some of the oxygen present in the bath at the end of the refining period and to fix the remainder in an inactive form. This is accomplished by making deoxidizing additions to the steel before tapping or to the ladle. These convert most of the oxygen in the bath to insoluble oxides which tend to float upward and pass into the slag. The furnace deoxidizing additions are selected, and the additions are spaced so that maximum elimination of the oxides formed will take place before the heat is tapped from the furnace. When the heat is tapped, other deoxidizing additions are usually added to the steel as it runs into the ladle. The object of these is to complete the deoxidation and to obtain the type of oxides desired in the finished steel.

Pouring the Heat. — The final operation in the production of a heat of steel is teeming or pouring of the steel into molds to make ingots or castings. The tapping ladle is carried from the furnace to the pouring stand by the pit crane and suspended over the molds. The steel is poured into each mold in sequence through a nozzle in the bottom of the ladle. The stream of steel passing through the nozzle is controlled by a stopper which fits into a well at the top of the nozzle. The stopper is attached to a stopper rod which is suspended from the top of the ladle by a linkage through which the steel pourer can control the movement of the stopper. A spoon is used to take steel sample — the spoon being filled from the stream flowing out of the nozzle. There are usually at least two ladle tests taken from each heat, one from the first part and another from the last part of the heat, to obtain a representative average analysis of the steel in the ladle. These tests are sent to the laboratory where they are drilled and a determination is made of the significant elements. This is called the ladle analysis, and the application of the heat is governed by this analysis, supplemented on some grades by additional check analyses obtained from blooms, billets, or the finished product after the ingots are rolled.

After the heat is poured into the molds, the cars are held at the pouring stand for varying lengths of time, depending on the grade of steel. The cars are then shunted to the stripper crane.

Notes

to solidify [sə'lɪdɪfaɪ] — *твердnути, застигати*
alloy ['ælɔɪ] — *сплав (металів)*

ladle ['leɪd] — *ківш, черпак*
to kill — *знищувати; руйнувати; губити*
to suspend [səs'pend] — *припиняти, відкладати*
nozzle ['nɔzl] — *сопло, форсунка*
stopper ['stɔpə] — *ко́рок; затичка*
sample ['sɑ:mpl] — *шаблон, модель*
billet ['bɪlɪt] — *колода, поліно*
to shunt [ʃʌnt] — *змінювати*

Text 9. Electric Furnace Steel

The electric furnace has proved to be an ideal melting and refining unit for the steel industry. Its advantages include the following: the nonoxidizing condition of the carbon arc, which is pure heat, makes possible a tightly closed furnace and permits maintenance of reducing atmospheres; the temperature attainable is limited only by the refractory nature of the furnace lining; close limits of regulation and control are obtainable; the efficiency of the unit is extremely high; refining and alloying are readily accomplished and controlled. The steel industry has at its command a method of producing steel, which in competent hands, can operate on a tonnage basis and meet the most exacting specifications.

In most electric furnaces the heat is produced by means of an arc either above the bath, or by means of arcs between the slag and electrodes suspended above the bath, the latter being the more satisfactory and common method. There are generally three carbon or graphite electrodes suspended from the roof. Each of these electrodes is connected to one phase of a three-phase current and lowered into the bath in such a manner that an arc is formed between the slag and each electrode.

The modern *arc-type electric furnace* is cylindrical in shape and of the standard three phase, three electrode service arc type as it was originally developed. Basic differences of construction lie in the mechanical design. Some of these include different methods of filling, various methods of applying removable roofs to medium-sized furnaces, and arrangement and application of electrical equipment.

The lining of the basic electric furnace is of extreme importance and one of the principal features of the furnace. The hearth must be made from a magnesite or burned dolomite material to withstand the lime slags used in the basic process. The walls and roof may be made from a silica brick and need not be basic, but must withstand extremely high temperatures.

In making up a heat of steel, the bulk of the charge is made up of carefully selected steel scrap of such a composition that, upon melting down, the bath will contain a smaller amount of the alloying elements than is required in the finished steel. The practice permits the addition of suitable ferro-alloys and carbon for proper adjustment of the chemical analysis of the steel charge. Other melting methods such as open-hearth, may use pig-iron as a raw charge, whereas the electric furnace never starts out with a charge of pig-iron. Through the use of carefully selected raw materials a greater economy may be had in this process. The electric furnace may start with cold charge, and the steel made this way is spoken of as cold-melt electric furnace steel to distinguish it from that resulting from the practice of using a hot or molten charge previously melted in an open-hearth furnace and transferred to the electric furnace. In the manufacture of high grade steel for tools, the slower and more expensive cold-melt method is almost always used.

When the heat of steel has been properly deoxidized or killed and is of proper chemical composition, it is ready to tap into the ladle. The melt is tapped into the ladle and subsequently poured or teemed into a mold made from cast iron.

The resulting casting is called an ingot, and the mold used is the ingot mold. The tapping and pouring of the steel into the ingot molds is carried out with the greatest care. It is important that the cast ingot be as free from blowholes, shrinkage holes, segregation, etc., as is possible to insure a good ingot. No steel from an ingot is sounder than the ingot from which it was made.

A radically different type of electric furnace, sometimes used in making small tonnages of steel or special alloys, is the high frequency induction furnace. In this, the melting method consists of a crucible furnace into which the charge is placed. An electric current is induced within the metal charge from a coil of copper tubing carrying a high frequency current, which surrounds the crucible. The induced current is forced to flow directly through the charge, causing very rapid heating. A fortunate phenomenon of induction furnaces insures a thorough mixing of the molten metal. This is a natural stirring action which takes place in the liquid charge as soon as the molten state of the charge is reached. By the induction method high melting temperatures are obtained, as well as exact and controllable melting conditions. It is more economical than the electric-arc type of furnace; in some instances it may replace the open-hearth furnace, particularly when small quantities of special alloys are required.

Notes

competent ['kɔmpɪtənt] — *спроможний, достатній*
tonnage ['tʌnɪdʒ] — *тоннаж*

to teem — *бути багатим на*
to sounder [ˈsaundə] — *вимірювати*
crucible [ˈkruːsɪbl] — *вирішальний*
to induce [ɪnˈdjuːs] — *спонукати; викликати; спричинятн*
induction [ɪnˈdʌkʃn] — *індукція*

Text 10. Shaping and Forming Metals

Hot Rolling. — Rolling and forging serve the following two purposes: first, they serve the purely mechanical purpose of getting the steel into the desired shape; and second, but by no means of minor importance, they improve the mechanical properties by destroying the cast structure. This breaking up of the cast structure or "refining the grain" is important because it makes the steel stronger and more ductile and gives it greater shock resistance.

Where simple shapes are to be made in large quantity, rolling is the most economical process and is used for sheets, structural shapes, rails, etc., as well as for the production of intermediate shapes for wire drawing or forging.

The process of shaping steel by rolling consists essentially of passing the material between two rolls revolving in opposite directions but at the same peripheral speed. The rolls are spaced so that the distance between them is somewhat less than the height of the section entering them. The rolls grip the piece of metal and deliver it reduced in section and increased in length in proportion to the reduction. The amount of reduction and the width of the piece will govern the amount of lateral spreading.

Rolling mills, although alike as to gross features, differ greatly as to details of construction.

The Rolls. — The rolls themselves may be either steel or cast iron, consisting of a body or barrel on which the rolling is done, the neck on which the roll revolves in the bearing, and a star-shaped coupling or wobbler through which the roll is driven. The body of the roll may be a simple cylinder for flat rolling, or it may be grooved if the piece is to be rolled to a definite shape. The diameters of rolls vary from a few inches up to five feet. The amount of reduction depends on the size and weight of the roll. Since very large rolls are expensive, "backed-up" rolls are sometimes used; that is, rolls of small diameters do the actual work, supported by heavy idlers which prevent working rolls from being bent by the tremendous pressure.

Rolls are driven by means of a hollow cylinder which fits over the wobbler of the roll on one end and over the driving shaft on the other. This method of driving gives a certain flexibility, and, if the rolls become stuck, the coupling breaks rather than the rolls.

In every hot rolling mill there are furnaces, known as soaking pits, which heat the steel for rolling. These pits are ordinarily heated with gas, often waste gases from the blast furnace or coke oven. The steel is heated to a temperature of from 1900° F. to 2250° F., depending upon the kind of steel being made. In making small quantities of tool steel or alloy steels, the ingots are allowed to cool before heating for rolling, but the large ingots are charged into the soaking pits as soon as possible after the mold has been removed. Inasmuch as the ingots are at a red heat when charged into the pits, it takes only one to two hours to bring them to the proper temperature for rolling. In heating for rolling, care must be taken to heat both the inside and the outside of the ingot to approximately the same temperature.

Notes

peripheral [pəˈrɪfərəl] — *зовнішній пристрій*
lateral [ˈlætrəl] — *бічний, боковий*
barrel [ˈbærl] — *вал, барабан; циліндр*
to groove [gruːv] — *робити виїмку*
hollow [ˈholou] — *порожній; пустий*
to wobble [ˈwɔbl] — *гойдатися, хитатися*
coke [ˈkouk] — *кокс*
flexibility [ˌfleksɪˈbɪlɪtɪ] — *гнучкість*
to soak [ˈsouk] — *вбирати (в себе)*
inusmuch [ɪnəzˈmʌtʃ] — *так як; що*

Text 11. Aluminum

Of the five metals that now show the highest figures for annual tonnage production in the world, three (iron, copper, and lead) have been known and used by man for many thousands of years. The fourth (zinc) did not come into general use until the Middle Ages. Only the fifth (aluminum) is of ultramodern origin, as far ar mankind is concerned. Discovered in 1825, and first publicly exhibited at the Paris Exposition in 1855, aluminum was still so difficult to obtain that it was more expensive than silver, until the development of the dynamo provided cheap electricity and the development of the present electrolytic process for its production made it possible to make large quantities cheaply. Even today, the world production of aluminum is only about one percent of the world production of iron, although about half that of copper by weight.

The fundamental properties upon which the usefulness of *aluminum* depends are its lightness, workability, resistance to corrosion, high electrical and thermal conductivity, silvery luster, and high power of reflecting light and radiant heat. With these, there must, of course, be combined a strength adequate for the purpose; and since pure aluminum is not very strong (as compared with iron, for example), the development of the required strength with a minimum reduction in its other desired properties has been a basic problem of the fabricating industry. Since, when the metal was new, the established metal-working industry was broadly content with the metals and practices available to it, and disinclined to spend money in developing a new and untried metal, the whole burden of both technological and commercial development had to be shouldered by the producers of the metal, in order to sell their product, and they became fabricators as well as producers.

Notes

aluminum [ə'lju:mɪnəm] — *алюміній*
publicly ['pʌblɪklɪ] — *відкрито*
workable ['wə:kəbl] — *придатний для роботи*
radiant ['reɪdjənt] — *сяючий*
adequate ['ædɪkwɪt] — *достатній; відповідний*

Text 12. Castings

For many purposes, the simplest process of producing metal articles is that of **casting** the molten metal into a suitable mold. The relatively low melting point of aluminum permits the use of a variety of casting processes that are not suitable for metals like iron and copper. The cheapest type of mold is one made of moist ("green") sand, which is rammed around a wooden or metallic pattern. Where only a limited number of castings are to be made, or where the casting is very large or intricate, sand molds produce the cheapest castings. If very large numbers of the same casting are to be produced, and if the casting is not too large, a permanent mold (usually iron) may be used, because of the moderate casting temperatures employed, and may produce castings that are both cheaper and metallurgically superior. By rapidly forcing metal under pressure into a suitable permanent mold, "die castings" are produced. They have very high surface smoothness and dimensional accuracy. A special type of plaster used for molds produces castings with surface smoothness and dimensional accuracy comparable with those of die castings, but with somewhat lower mechanical properties.

Of the alloying elements used with aluminum, zinc was the cheapest and was the one earliest used. It very decidedly increases the strength of the aluminum and at least 15 or 20 pct of it may be added with beneficial results, as far as the strength and ease of casting are concerned. It was soon found, however, that binary aluminum-zinc casting alloys were quite inferior to pure aluminum, from the standpoint of hot shortness and resistance to corrosion as well as specific gravity, and that they had a marked tendency to become brittle with age, so they have not been used extensively for many years.

Zinc was very largely replaced more than 40 years ago by copper, and for years the standard aluminum casting alloy was the binary aluminum-copper alloy containing 8 pct of the latter metal. This is a very stable alloy with good casting characteristics and better corrosion resistance than the type of zinc alloys previously used. Its strength was adequate for most purposes (about 22,000 psi sand-cast) although its elongation was low. Some improvements were made over a series of years by the addition of 1 or 2 pct of zinc and an increase in the iron content to around 1.2 pct, and later by adding up to 2.5 pct of silicon; and such alloys have produced many of the aluminum castings used in the automobile field. One of their strong points is their great case of machining. This is particularly advantageous in automobile castings, where large numbers of castings are put through complicated machining operations and the time required for each operation must be reduced to a minimum. This time is considerably less for these aluminum-alloy castings than for iron castings.

Silicon and iron are the two most common impurities in aluminum and traditionally both were generally looked upon as undesirable. Iron, indeed, in amounts up to perhaps 1.5 pct or a little more, may improve the tensile strength of some of the alloys, but if there is much more than this the high-melting iron-aluminum constituent increases the viscosity of the alloy at the pouring temperature and also tends to make the castings brittle. In the early days of the aluminum industry, metallic silicon was not available as an alloying ingredient, and although a number of investigators showed that aluminum alloys containing considerable amounts of silicon had reasonably good properties, it was not until after World War I that serious attempts were made to introduce such alloys.

Notes

to cast [kɑ:st] — *лити, відливати (метал)*
article ['ɑ:tɪkl] — *виріб*
to ram [ræm] — *трамбувати, забивати*
intricate ['ɪntrɪkɪt] — *заплутаний, складний*
pct = percent

Text 13. Wrought Aluminum Alloys

For many purposes, castings are not suitable, and worked or wrought articles are required. In general, their production starts with a casting operation in which an ingot of suitable size and shape is formed. This ingot is then rolled, pressed, extruded, or otherwise deformed by the application of severe mechanical stresses so as to produce the article desired.

Of all the working processes, hammer forging is the simplest in its essence and probably was the first to develop in the history of metal working. In connection with aluminum, however, it was one of the later developments. One of the difficulties to be overcome is that the temperature range over which aluminum can be forged satisfactorily is rather narrow, particularly for the strong alloys. Also, at their forging temperature these alloys are much stronger than steel is at its forging temperature, so that the size of hammer and the power required to forge a connecting rod (for example) out of aluminum are greater than that required to forge the same article out of steel.

Any mechanical working, such as rolling, breaks down the cast structure of the original ingot and tends to produce a fibrous structure, which very much improves the physical properties of the article. Working under a hammer — the simplest method of forging — may sometimes be advantageously replaced by a press-forging operation in which the lump of metal, preferably previously broken down by rolling, is formed into the desired shape while hot, by successive strokes of a press provided with suitable dies. In any forging operation, care must be taken to control and direct the flow of the metal during the working operation, so that the direction of the resulting "fiber" gives the results desired in the finished article. The dominant characteristic of the forging process, as compared with any casting process for producing the same article, is the marked metallurgical superiority of the product. Not only are the mechanical properties higher but forgings are also inherently much freer of hidden defects, such as dross or porosity, and at the same time have nearly the dimensional accuracy of permanent-mold castings.

A special kind of permanent-mold *casting process* is spoken of as "die casting", or sometimes "pressure die casting". In this, the water-cooled steel mold or "die" is mounted adjacent to a crucible of molten metal, and by an ingenious device successive "shots" of molten metal are squirted into the die, so that the die is filled at each "shot" with the molten metal under pressure. In the subsequently developed "cold-chamber" process, the charge of molten metal is cooled

to partial solidification and then forced into the die by heavy hydraulic pressure. By both processes, it is possible to fill the die in a fraction of a second. Consequently, castings with extremely thin walls can be made, with the assurance that the metal will not freeze before the narrow cavities of the mold have been properly filled.

The oldest of the wrought aluminum alloys now in production is the one called 3S, which contains about 1.25 pct of manganese added to commercial aluminum. The addition of this small amount of manganese increases the tensile strength of the sheet or other wrought article by about one third without very seriously reducing its elongation. Moreover, manganese is one of the few elements that can be added to aluminum without decreasing its corrosion resistance. This alloy is said to have been developed under stress in the early days to meet a very serious condition threatening the loss of a large amount of business because of the inferior corrosion resistance of the binary copper-alloy sheet that was then being produced, and it was extensively made and sold for many years before it was introduced abroad. Its most common use is in cooking utensils, where it increases the hardness and strength of the utensil without increasing its weight, and without unduly increasing its fabrication cost.

Attempts to add copper and zinc in alloys for the production of sheet were at first unsuccessful because of the poor corrosion resistance of such sheet. It was only after the introduction of the heat treatment of copper alloys that their corrosion resistance became satisfactory. Early attempts to produce aluminum-magnesium alloys, on the other hand, failed because of rolling difficulties. The alloys themselves had excellent properties but their economical fabrication was beyond the skill of the industry at that time. As the result of intensive study and improvements in fabricating technique, these alloys are now coming into their own, and are among our most corrosion-resistant aluminum alloys.

Notes

wrought [rɔ:t] — *діючий; впливаючий*
to extrude [eks'tru:d] — *виштовхувати, витіснять*
essence ['esns] — *сутність, суть*
fibrous ['faɪbrəs] — *волокнистий*
lump — *грудка*
inherently [ɪn'hɪərəntlɪ] — *притаманно, властиво*
dross — *шлак*
porosity [pɔ:'rɔsɪtɪ] — *пористість*
ingenious [ɪn'dʒi:njəs] — *винахідливий, дотепний*
hydraulic [haɪ'drɔ:lɪk] — *гідравлічний*

to elongate [ˈi:lɔŋgeɪt] — *розтягати(ся); подовжувати(ся)*
binary [ˈbaɪnərɪ] — *подвійний*
utensil [ju:ˈtensl] — *посуд; прилáддя*

Text 14. Special Heat Treatment and Aging of Wrought Alloys

The advent of the airplane and the dirigible balloon brought a tremendous desire for aluminum alloys that would combine the strength of steel with the lightness of aluminum. The first step along this line was taken by a German investigator, Dr. Alfred Wilm, about 1906, when he discovered that the aluminum-copper alloys containing about 4 pct of the latter element were susceptible to a decided improvement in physical properties by a simple heat treatment. If the hard-rolled alloy was heated for some time to a temperature of about 500° C and then quenched, both the tensile strength and elongation were markedly increased. The properties were still better if about 0.5 pct each of magnesium and manganese was added to the alloy; and, strange to say, if this alloy was allowed to rest for a few days after heat treatment, a further considerable increase in tensile strength took place spontaneously. The resulting alloy, when properly fabricated, had substantially the strength of mild steel — a tensile strength of 55,000 to 60,000 psi and an elongation of about 20 pct in 2 inches.

A few years before World War II, a considerably stronger alloy of this type (24S) was developed, which became the most important aircraft structural alloy used during the war.

At that time, no one knew just what was happening during the heat treatment or during the aging. Later investigations have given a picture of these phenomena, which seems to be quite accurate. Apparently, when the aluminum alloys are heated at a temperature near the melting point of their lowest-melting constituent the copper particles, which were dispersed in the form of crystalline fragments of a copper-aluminum compound throughout the mass of the wrought article, gradually dissolve and diffuse through the main body of solid aluminum. Magnesium silicide particles behave similarly, all being much more soluble at the heat-treating temperature than at room temperature. A nearly saturated solution is formed, and when the alloy article is quenched in cold water this solution does not have time to precipitate the excess of dissolved copper. The result, therefore, is a supercooled solid solution.

If only copper is present, the gradual precipitation of the excess and the attainment of equilibrium takes place very slowly at ordinary

temperatures, but if some magnesium is also present it is practically completed in about four days. This excess of copper, probably in the form of a compound of copper and aluminum, appears to be precipitated in minute particles throughout the mass of the object, and the size of these particles depends upon the conditions under which they are precipitated. If these are correct, we have what is known as a critical dispersion, and the hardening and strengthening effect of the precipitated particles is of maximum intensity.

In general, the mechanical properties are improved (for example, the tensile and yield strengths are increased) as the amounts of the alloying constituents are increased, up to a certain limit. However, as has already been indicated, each increase in the amount of copper, magnesium, or manganese increases markedly the difficulty and expense of working the alloy, and particularly the amount of scrap produced. The choice of a suitable alloy composition thus always involves a compromise between the desire for maximum mechanical properties and the necessity of fabricating the material at a reasonable cost.

Notes

advent [ˈædvənt] — *поява*
dirigible [ˈdɪrɪdʒəbl] — *керований*
susceptible [səˈseptəbl] — *вразливий, сприйнятливий*
treatment [ˈtri:tmənt] — *ставлення; обробка*
to quench [kwentʃ] — *гартувати*
magnesium [mægˈni:zɪəm] — *магній*
spontaneously [spɔnˈteɪnjəslɪ] — *стихійно, спонтанно*
to disperse [dɪsˈpə:s] — *розсіювати(ся)*
to dissolve [dɪˈzɔlv] — *розчиняти(ся)*
to diffuse [dɪˈfju:z] — *розповсюджувати*
to equilibrate [ˌi:kwɪˈlaɪbreɪt] — *урівноважувати(ся)*
constituent [kənˈstɪtjuənt] — *складова частина; елемент*

Text 15. Extrusion and other Working Operations

Another method of working that has special applications is extrusion. In this process, a heated ingot of the metal is squirted through a die under very great pressure. Its purpose is to produce special shapes, such as moldings, small structural shapes, hollow cylinders, and so forth, at a moderate cost. It is very often possible to thus produce shapes that could not be produced by rolling or any other

method, and the possibility of making these odd shapes has considerably increased the usefulness of aluminum alloys in architectural work and in the construction of trucks, railroad cars, and other equipment. The extrusion of hollow cylindrical blooms, from which tubing can be drawn, is also very important.

Like the other working processes, extrusion is not without its troubles. Surface scratches caused by defects in the die, foreign particles that get into the metal, and other faults, may be very troublesome. Sometimes the combination of the amount of working and the temperature of extrusion produces peculiar grain-size effects. A considerable proportion of the grains may be oriented in a definite direction, generally so as to increase the tensile strength and decrease the elongation of the extruded article in the longitudinal direction. This may be important in connection with certain articles made of extruded heat-treatable alloys.

There are two forming operations that are termed "drawing", of which the simplest is wire drawing. Rod as small as 3/8-in. diameter can be most easily and cheaply produced by hot-rolling an ingot of suitable shape on special rolls, but to produce smaller rod or wire this hot-rolled rod must be drawn through dies made of chilled cast iron or special steels, or even of diamonds for the smaller sizes. By repeatedly drawing or pulling this wire through successively smaller holes in these dies, the diameter of the wire may be reduced as desired. Here the control of the process involves an adjustment of the successive die sizes, so that internal fractures of the wire may be avoided, and suitable lubrication to reduce the die friction to the minimum.

Cooking utensils and articles of similar shape are also "drawn", but this drawing is accomplished in a press, and generally starts with a circle cut from sheet of the proper thickness. A plunger pushes the center of the circle downward into a hollow die having rounded upper corners, and the outer portions of the circle are drawn in over these rounded corners to form the cylindrical side of the article. The metal circle being drawn is thus subjected to tension radially and compression tangentially. Here again, lubrication is important, as well as die design, and fine-grained material is necessary in order to avoid the "eggshell" effect on the drawn portions.

"Spinning" is a very useful metal-working operation for the formation of hollow aluminum utensils of shapes that cannot be drawn in a die, or of sizes that are not feasible to make in a draw press. In the spinning operation, the blank may be either a flat circle cut from a sheet of suitable thickness or a drawn cuplike article made from such sheet. In either case, the blank is fastened in a spinning lathe in contact with

a wooden or steel form having the shape of the article desired, and the blank and form are rapidly rotated together. By pressing on the outside of the blank with a suitable well-lubricated tool, the metal may be gradually forced or "spun" in, until it makes contact with the form. A produced article is the aluminum teakettle, where a drawn cuplike blank has its top spun over a collapsible form to make the top of the kettle. In forming certain articles, such as pitchers or cuspidors, where it would be difficult, if not impossible, to withdraw the internal form, the article may be spun "free hand" by the workman, who then adjusts the pressure and motion of the spinning tool by eye to give the desired shape to the article. After spinning or drawing, there are, of course, necessary trimming and beading operations, which do not require explanation.

The development of free-cutting aluminum alloys which machine as easily as free-cutting brass or steel, permitted the use of aluminum to make screw-machine products. A "screw machine" is an automatic lathe provided with a variety of tools on an automatic turret. It is fed long lengths of rod, which it automatically machines into small articles such as bolts, screws, pipe inserts. In a "free-cutting" alloy, the tools must produce short, brittle chips, and not long turnings that may wind around and clog the machine. This is accomplished by means of appropriate alloying additions.

Another interesting type of working performed on aluminum is the stamping operation by which bronze powder was formerly made. "Bronze" powders may be made of aluminum, copper, or some grade of brass, but at present most of the bronze powder is made of aluminum. Sheet scrap or foil scrap or other small pieces of this metal, together with a suitable amount of lubricant, may be fed to batteries of stamps. By continual stamping, they are gradually hammered down into fine flakes, which are extremely thin in proportion to their diameter. In the ordinary aluminum powder, most of these flakes will pass through a 120-mesh sieve, while their average thickness may be on the order of 0.00002 in. The very great reduction in cross section produced by hammering the metal into such thin flakes reduces the elongation to the point where the flakes break up very easily, and that is the reason why these small flakes are produced instead of larger sheets. These little flakes are then polished by rotating brushes in a special machine and are ready for use in the manufacture of aluminum paint.

The stamping process has now been largely replaced by a special sort of grinding operation. Ball mills with a multitude of small steel balls "grind" atomized aluminum powder with the lubricant and mineral spirits. The small balls flatten the powder to flakes like those produced by the stamping process. The paste that remains after the excess of mineral

spirits has been removed can be used directly for the manufacture of paint. Abroad, the grinding is reported to be carried out but dry, originally in a special type of beater mill, with an inert atmosphere. The dry powder easily forms an explosive mixture with air.

It will be apparent that while aluminum is a metal with a multitude of uses, it is also one presenting a multitude of problems, some of them being the common problems of the metal industry and others peculiar to itself. The steady progress of investigation and development, however, has carried the industry a long way in its 60 years of life, and may be expected to make this metal increasingly useful to mankind as the years go by.

Notes

extrusion [ɛks'tru:ʒn] — *штампування; виштовхування*
to squirt [skwə:t] — *бити струменем*
to extrude [ɛks'tru:d] — *виштовхувати; витіснити*
lubrication [ˌlu:brɪ'keɪʃn] — *змазка*
to plunge [plʌndʒ] — *поринати; занурювати(ся)*
to spin (span; spun) — *крутити(ся)*
feasible ['fi:zəbl] — *можливий*
blank [blæŋk] — *порожнє місце*
collapsible [kə'læpsəbl] — *розбірний*
pitcher ['pɪtʃə] — *глечик*
foil ['fɔɪl] — *фольга; рапіра*
lubricant ['lu:brɪkənt] — *мастило*
inert [ɪ'nə:t] — *млявий*
to paste ['peɪst] — *склеювати*
multitude ['mʌltɪtju:d] — *безліч*

Text 16. Copper

Physical Properties. — Copper is distinguished by its red colour from all other metals.

Malleability and Ductility. — It can be rolled into very thin sheets beaten out into leaves and drawn into fine wire, and thus possesses the properties of malleability and ductility in a high degree. By cold rolling or other mechanical treatment it becomes hard, but its malleability is regained by annealing. It is immaterial whether the copper be quenched in water or cooled slowly after the annealing process.

Tenacity. — Its tenacity when cast is 8 to 10 tons per s. i.; when rolled or drawn 16 to 23 tons or even more, according to the amount of mechanical treatment it has received.

Specific Gravity. — The specific gravity of pure Cu, rolled, forged, or drawn, and afterwards annealed, may be taken as 8.89 at 20° C, but that of ordinary commercial copper usually ranges from 8.2 to 8.6.

Action of Heat. — The melting point of Cu lies somewhat about 1,083° C. When molten it is rapidly oxidized with the formation of cuprous oxide (Cu_2O), which dissolves in the metal. It also absorbs hydrogen, carbon, monoxide, and sulphur dioxide, which are given off during solidification, part, however, remains in the metal producing more or less porosity. Hence arises the difficulty of obtaining sound casting of copper.

The metal is not volatilized at the temperature of ordinary furnaces, but readily in the electric furnace, its boiling point being about 2,100° C. When heated to near its melting point it becomes so brittle that it may be easily powdered.

Electrical Conductivity. — As a conductor of electricity copper is only surpassed by silver, and hence is largely used for electric wires and cables. Its electrical conductivity is 976 if silver be taken as 1000. This is greatly reduced by the presence of impurities, especially by cuprous oxide, phosphorus, arsenic, antimony, and silicon.

Conductivity for Heat. — Copper is an excellent conductor of heat, and in this property is about two and a half times more efficient than iron.

Atomic weight is 63.57.

Chemical Properties. — Copper undergoes no change in dry air at ordinary temperatures, but in moist air a green coating of basic carbonate is formed.

When heated to redness with access of air, as in annealing sheets, etc., a dark coloured scale is formed, which consists almost wholly of cuprous oxide. It may be removed by plunging the copper when red-hot into cold water; in practice the water used contains sulphuric acid. Copper is slowly dissolved by weak acids in the presence of air. It is soluble in nitric acid, "aqua regia", and in hot concentrated sulphuric acid.

Alloys of Copper. — In addition to the extensive application of copper itself, it is largely used in the manufacture of alloys. Its alloys, especially those with zinc (the brasses) and with tin (the bronzes) are of vast importance for engineering and other purposes, while its alloys with other metals have numerous uses in many industries. When copper is cast in what is termed a closed mould — i. e., a mould with a small aperture or "ingate" — unsound vesicular castings only can be produced. To obtain a sound casting the mould must be an open one, hence none but articles of simple forms can be cast of the metal. This is why alloys of copper have come into such extensive use.

Notes

copper [ˈkɔpə] — *мідь*
malleable [ˈmælɪəbl] — *ковкий*
ductility [dʌkˈtɪlɪtɪ] — *в'язкість; гнучкість*
sheet — *лист (заліза)*
immaterial [ˌɪməˈtɪərɪəl] — *неістотний, нематеріальний*
gravity [ˈgrævɪtɪ] — *тяжіння; важливість*
cuprous [ˈkju:prəs] — *мідний*
oxide [ˈɔksaɪd] — *о́кис*
arsenic [ˈɑ:snɪk] — *миш'як*
antimony [ˈæntɪmənɪ] — *сурма*

Text 17. Brass

Brass is an alloy of copper and zinc in various proportions. The color of brasses varies widely with the composition. When increasing amounts of zinc are added to copper, the resulting brasses show a range of color all the way from copper red, which persists for about 5 pct of zinc through a bronze color at about 10 pct, a golden color at about 15 pct and increasing dilution of color to the typical brass yellow at around 30 pct of zinc. With more than 38 pct of zinc (alloys obtainable only in rod form) the alloy again takes on a buff red cast. This question of color is tremendously important in some applications, particularly costume jewelry, fasteners, fuse boxes, architectural trim, and so forth. In the range from about 80 to 90 pct of copper, the color changes very rapidly, and for such uses a given nominal alloy must be held within rather narrow limits in order that different parts of an assembly may not show variations in color.

Red brass, containing 85 pct of copper, is, next to cartridge brass, the most important of the nonleaded brasses, being produced in very large quantities in all the common forms but particularly favored for pipe for use in plumbing because of its high resistance to aqueous corrosion, and for a host of manufactured parts for which a combination of ductility, good fabricating properties, golden color, and ease of polishing render it especially well suited.

A 90-10 mixture, commonly known as commercial bronze because of its color, finds a wide field of application for such things as angles, channels, costume jewelry, etching bronze, grille work, hardware, projectile rotating bands, screen cloth, screws, rivets, and many others.

The brasses containing from 61 to 54 pct of copper are called "Muntz-metal". The essential features that distinguish the Muntz metal brasses from the plain brasses are extreme plasticity at red heat followed by

conditions tending in the opposite direction when cooled to room temperature; viz., these alloys can be worked hot easily and drastically by rolling, extrusion, and other methods, but are not suitable for severe cold-working operations. The former condition makes for cheapness of production because heated billets may be almost instantly extruded through dies into rod or other shapes at a minimum expenditure of energy, and the long extruded rods may be finished by a cold-drawing operation to give them the exact dimensions and mechanical properties required by a given specification.

Moreover, the qualities of hardness, stiffness, and strength, not softness and pliability, are desired in countless objects such as screws and other shapes rapidly turned from rod on high-speed automatic screw machines. The necessary shortness of chip or general free-cutting quality is secured by adding amounts of lead up to approximately 3.5 pct. Some manufacturing operations are favored by combining hot-working in the breaking down or initial processing followed by a series of cold-working and annealing operations substantially as would be conducted with plain alpha brasses.

The alloy that is used in greater quantity than all others in this group combined is free-cutting brass, containing 61.5 pct of copper, 3 of lead and 35.5 of zinc. It can be cut at high speeds with low tool pressure, causing minimum rate of tool wear and with very short chips that clear the tool well. However, since free-cutting brass does not lend itself particularly well to cold-working procedures often required in addition to machining operations, a medium-leaded or high-leaded brass, or perhaps leaded Muntz metal, might be used in preference; viz., a compromise is necessarily made between optimum machining properties obtainable only with the higher lead content and good cold-fabricating properties obtainable with lower lead content (and usually somewhat higher copper content).

Where hot pressing or hot forging is to be used as the principal shaping procedure, forging brass containing nominally 60 pct of copper, 2 of lead and 38 of zinc is by all odds the favored material. This alloy, which is extruded readily, also can be forged into intricate shapes over a wide range of temperature, and the 2 pct of lead facilitates extensive and ready machining thereafter.

In fabricating various articles from strips involving drawing or forming operations and where some machining operations are also necessary, various lead-bearing alloys are available, including low-leaded brass, medium-leaded brass, high-leaded brass and extra-high-leaded brass. The choice between cartridge brass containing no lead and one of these four lead-bearing brasses will depend on the relative importance of the cold-fabricating operations necessary, on the one hand,

and the degree of machining required, on the other, it being impossible to attain the maximum of both these qualities in any one material.

Of the tin and aluminum brasses admiralty and aluminum brass are used almost exclusively for heat-exchanger tubes, primarily because of their high resistance to most conditions of aqueous corrosion encountered in such service. The admiralty alloy, which has been a leader in this field for many years, is now usually modified by the addition of a few hundredths of one percent of an element from the group including antimony, arsenic, phosphorus, and silver, for the purpose of inhibiting dezincification (preferential removal of zinc by corrosion, leaving spongy metal), which otherwise might occur under some conditions of operation. The aluminum brass is more specifically used where high water velocities are encountered, as for instance in marine condensers, it has been found highly resistant to so-called impingement attack frequently resulting from such conditions of use. It also is now currently made with an inhibitor, as is the admiralty mixture.

The plain and leaded naval brasses and manganese bronze are widely applied where a high-strength structural material resistant to salt-water corrosion is needed. In point of strength, the manganese bronze is distinctly superior to the naval brasses. A leaded variety of the latter is of course used in preference to the nonleaded one when extensive machining is necessary.

Notes

brass [brɑːs] — *мідь (жовта); латунь*
alloy [ˈælɔɪ] — *сплав*
cartridge [ˈkɑːtrɪdʒ] — *патрон*
aqueous [ˈeɪkwɪəs] — *водний; водяний*
expenditure [ɪksˈpendɪtʃə] — *витрата*
pliability [ˌplaɪəˈbɪlɪtɪ] — *гнучкість; податливість*
substantially [səbˈstænʃəlɪ] — *істотно, важливо*
procedure [prəˈsiːdʒə] — *процедура*
exclusively [ɪksˈkluːsɪvlɪ] — *виключно*
to encounter [ɪnˈkauntə] — *стикатися*
marine [məˈriːn] — *морський*
condenser [kənˈdensə] — *конденсатор*

Text 18. Magnesium

Magnesium has long been known as the lightest of our engineering metals. This metal, silvery white in color, has a specific gravity of only 1.74. Aluminum, the next lightest structural metal, is $1^1/_2$, times heavier; zinc is 4 times heavier; iron and steel are $4^1/_2$ times heavier; and copper and nickel are 5 times heavier. Magnesium does not occur in the free state but is very abundant in nature, constituting 2.5 pct of the earth's crust in the form of various ores. It is the third most abundant structural metal, being exceeded only by iron and aluminum.

Magnesium is unique, however, in that in the form of magnesium chloride it also exists in the oceans. Sea water is the source most widely used for production in the United States but magnesium is also commercially produced from magnesite, dolomite, and other ores as well as from certain inland brines.

Not only is magnesium potentially very abundant but it is in addition a very versatile metal and can be shaped and worked by practically all methods known to the art of metal working. It can be cast by sand, die, and the various permanent-mold methods; extruded into an endless variety of shapes and rolled into sheet, plate, and strip. Magnesium is readily forged and can be formed into useful shapes by drawing, bending, spinning, impact extrusion, and other standard methods. The joining of magnesium is accomplished by gas, arc and electric-resistance welding methods and by brazing, bolting, and riveting. The machinability of magnesium is unsurpassed by that of any other structural metal and magnesium is often selected for an application because of this characteristic. The chemical and electrochemical properties of magnesium also provide the bases for important commercial uses.

Because of the two outstanding characteristics, availability and workability, magnesium is now considered to be destined to become one of the world's common structural metals. This is in contrast to conditions existing only about a decade ago, before sea-water plants had been developed and before common metal-working techniques had been sufficiently adapted to magnesium fabrication.

Notes

magnesium [mægˈniːzɪəm] — *магній*
abundant [əˈbʌndənt] — *багатий (на), рясний*
crust [krʌst] — *земна кора*
unique [juːˈniːk] — *унікальний; незвичайний*
chloride [ˈklɔːraɪd] — *хлорид*
versatile [ˈvəːsətaɪl] — *різнобічний*
brine [ˈbraɪn] — *розсіл; солона вода*
to accomplish [əˈkɔmplɪʃ] — *виконувати; здійснювати*
to weld — *зварювати*
to braze [ˈbreɪz] — *паяти*
to bolt [ˈboult] — *скріплять болтами, замикати на засув*

to rivet ['rɪvɪt] — *клепати*
availability [ə,veɪlə'bɪlɪtɪ] — *придатність, корисність*
to destine ['destɪn] — *призначати, прирікати*

Text 19. Workability

The workability of magnesium is an important factor in its practical utilization in many fields of use. The term "workability" as used here refers to the facility with which the metal can be converted into useful forms such as castings, extrusions and sheet, and the ease of additional fabrication into final shape by machining, drawing, forging, bending and other processes.

Casting

Most metals can be fabricated by casting processes, of which casting in sand molds is probably the oldest and most common. Magnesium, however, has been cast by practically all known methods.

These include sand, permanent mold, die, plaster mold, investment, and centrifugal casting. The sand casting process has been used for years but it has been difficult for magnesium sand castings to be price competitive with other cast metals. Low metal efficiency and the need for special fluxes and sand addition agents account for this extra cost. Die casting of magnesium, on the other hand, is competitive with the die casting of other metals such as aluminum and zinc. Molten magnesium can be handled in iron equipment without reaction with the iron and as a consequence there is no corrosion of the equipment, nor is there any iron pickup in the alloy. This advantage permits pumping and metering arrangements so that production die-casting operations can be mechanized. The fact that molten magnesium does not attack the die allows rapid operation of the die-casting machine because a minimum of die surface treatment is required. Magnesium does not solder to the die and it is therefore possible to cast small cored holes and slots without draft. Dimensional accuracy is good and tolerances of 0.0015 in. per inch are readily maintained on production runs. Magnesium die castings have good dimensional stability and are not subject to growth.

Extruding

Magnesium is readily extruded on conventional hydraulic extrusion presses into an almost endless variety of shapes. These include round rods, square bars, angles, channels, I-beams, zees, tees and other standard structural shapes. By means of the extrusion process,

shapes can be produced that are designed to replace assemblies of smaller parts. A substantial saving in cost can thus be accomplished.

The most commonly used method of extrusion begins with a solid cast ingot, which is placed into the heated container of the extrusion press. Pressures up to 100,000 psi are applied to force the metal through a steel die. Shapes emerge from the die at speeds ranging from 5 ft. to as much as 100 ft. per minute, depending upon the shape and size of the section. The extrusion of powdered magnesium is also possible. In this process, atomized magnesium particles are charged into the container of the extrusion press and are compressed and extruded from the die as solid metal possessing unique properties. The process makes it possible to produce alloys that cannot be made by melting and casting in the ordinary manner. Magnesium-aluminum alloys containing zirconium are an example, since zirconium will not alloy with molten magnesium when aluminum is present. However, powdered alloys of magnesium-aluminum and magnesium-zirconium can be co-extruded. A heat treatment then serves to produce an "interference" precipitation with a resultant increase in strength and hardness. Similarly, it is possible by the co-extrusion of metal powders to produce a dispersion of anodic and cathodic constituents which serves to give the alloy corrosion protection by electrochemical action.

Rolling

For many years, magnesium sheet and plate were produced by rather primitive methods, consisting of initial breakdown on two-high hot breakdown mills with frequent retreating between passes, until a thickness of 10 to 20 pct of the final gage was reached. At this point, a short-time anneal was given followed by cold-rolling on a two-high or preferably four-high finishing mill. This method of rolling was practiced by all mills rolling magnesium in the United States through 1951. However, shortly after World War II, pilot-plant tests on continuous rolling were carried out and the tests were successful.

Machining

The unsurpassed machinability of magnesium permits machining operations at extremely high speeds — usually at the maximum obtainable on modern machine equipment. Heavier depths of cut and higher rates of feed than are used on other metals are possible and the life of high-speed-steel cutting tools on magnesium equals the life of carbidetipped tools when machining other metals. There is no tendency for magnesium to tear or drag during the machining operation and as a result an excellent surface finish can be obtained. Close dimensional tolerances can be held and the free-cutting characteris-

tics of magnesium produce well-broken chips which do not obstruct the cutting tool or the machine. Indicative of these good machining characteristics of magnesium is the fact that the power required to remove a given amount of metal is lower for magnesium than for any other structural metal.

Joining

Most of the common joining methods used with other metals are used on magnesium. Bolting, riveting, brazing, and the various types of welding are applicable. The welding methods used include arc, gas, and electric resistance; spot, seam, and flash welding. Arc welding probably is the most widely used method of joining magnesium by fusion methods and with this process welds are made in plate as thick as $^1/_2$ in. in just one pass. Another method of joining, which first found its most extensive use in the aircraft industry, is adhesive bonding. This method of joining is particularly well adapted to magnesium. Brazing is a relatively new development in joining methods for magnesium and, although limited as to alloys that can be joined, the process has been successfully used in commercial practice. Soldering has had only limited use as a method of joining magnesium, but this process is used as a means of filling dents and other surface imperfections.

Notes

to convert [kən'və:t] — *перетворювати, обертати*
in. = inch
centrifugal [sen'trɪfjugl] — *відцентровий*
flux [flʌks] — *течія, потік*
pickup ['pɪkʌp] — *вибір*
arc [ɑ:k] — *електрична дуга*
seam [si:m] — *пласт; шар*
adhesive [əd'hi:sɪv] — *липкий*
psi = pounds per square inch

Text 20. Uranium

The unfamiliarity of metallurgists with the materials that in 1942 suddenly became in demand for atomic energy purposes was not due so much to their rarity as to their general metallurgic cussedness. Uranium, thorium, and beryllium are about as abundant in the earth's crust as are copper and lead, but they are less well concentrated by geological processes and are extremely difficult to reduce to a pure metallic form. If they were not so reactive with oxygen and nitrogen, they would have been made at least a generation ago and thoroughly studied. Had their oxides been reducible with carbon, they would have been known centuries ago. The metallurgist still seems to limit his interest to those materials that are easily prepared and avoids even the abundant ones which have desirable propeties if they need unusual means of preparation.

Metallic uranium is highly reactive, though when exposed to air, in clean massive form, it quickly develops a nearly black oxide coating that prevents continuous attack except at somewhat elevated temperatures. As a powder, uranium is highly pyrophoric, particularly in moist air, and in water it corrodes rapidly. For any severe service (as in air-cooled or water-cooled piles) it has to be clad or canned with a completely protective material. Uranium metal, even in solid form, reacts avidly with hydrogen to give an extremely fine gray powder of the hydride, UH_3. This reaction is rapid and reversible, the hydride having a well-marked dissociation pressure at any temperature (760 mm pressure at 430° C and 1 mm at 212° C). The hydride, when slightly heated, provides an excellent source of high-purity hydrogen, which is evolved to restore the equilibrium pressure whenever gas is removed from the system, and of uranium powder which remains after the hydrogen has left.

Because of its strongly electropositive character, uranium is difficult to reduce to the metallic form, and once prepared is difficult to keep pure. The reduction process cannot be used as in common metallurgical practice to separate impurities in the ore, and some compound has first to be prepared in a sufficiently pure form by chemical methods. Though uranium can be made electrolytically, most metal to date has been prepared by various modifications of the historic method of Peligot who, in 1840, first prepared the metal by reducing the tetrachloride with sodium at a red heat. Reductants that have been named include calcium and magnesium and other halides have been substituted for the chloride. The process is similar in principle to the well-known Goldschmidt process. Refractory problems are severe, but with proper control the method can give almost quantitative recovery of metal.

The reduced metal is generally of slightly lower purity than the reactants used, and needs to be remelted, preferably in vacuum, to remove the last traces of the reductant and (as with any other metal) to cast it either into billets for subsequent mechanical working or into appropriate molds to give directly objects of the final desired shape. Though uranium can be melted under a heavy flux cover, it is simpler to melt and cast it under a fairly good vacuum. This operation is quite straightforward if properly designed apparatus is used, with pumps of large enough capacity. As with all metals, the experienced skill of the founder is essential for good results, but granted this and proper mold materials that do not liberate gas, sound and strong castings of almost

any desired shape can be made. The metal machines well with tungsten carbide-tipped tools and copious coolant. Machining is a completely safe operation despite the occasional spectacular but nearly smokeless fires that occur if the turnings get hot enough to ignite.

Though uranium is not very plastic at room temperatures, it does have reasonable ductility and can be shaped to a limited extent. For extensive working, it is necessary to heat it, either high within the alpha range or into the gamma range where it has extreme plasticity, comparable with beta brass but even softer. Deformed grains (particularly those of certain critical orientations in relation to the deformation) will recover by "polygonization" before recrystallization starts, hence it is difficult to produce very fine grain size. Such sub-grains are formed also on transformation, and the large grains that at first glance appear in the microstructures of castings will often be found on closer examination to consist of many sub-grains differing slightly in orientation.

Uranium metal can be fabricated by most of the usual metal-shaping methods. It has been forged, made into rod by both rolling and extrusion, into wire by drawing, and into sheet by rolling. Sheet can be cupped once its peculiarities have been mastered. Its welding is difficult.

Uranium exists in three different allotropic modifications, with transitions at about 668° and 774° C. It melts at 1133° C. The alpha phase, stable below 668° C, has an orthorhombic unit cell. It has a layer structure composed of corrugated sheets of atoms, the distance between atoms in the sheets being much less than the distance between sheets, in a similar manner to the structure of antimony, arsenic, and bismuth.

Notes

uranium [juə'reɪnɪəm] — *уран*
unfamiliarity [ʌnfə,mɪlɪ'ærɪtɪ] — *необізнаність*
beryl ['berɪl] — *берил*
straightforward ['streɪt'fɔ:wəd] — *чесний, прямий*
tungsten ['tʌŋstən] — *вольфрам*
to ignite [ɪg'naɪt] — *запалювати; загорятися*
copious ['koupjəs] — *багатий, рясний*
spectacular [spek'tækjulə] — *ефектний*
to corrugate ['kɔrugeɪt] — *зморщувати(ся)*
bismuth ['bɪzməθ] — *вісмут*

12.

Section. Radio Engineering

Text 1. The Elements of a System of Radio Communication

Radio Waves

Electrical energy that has escaped into free space exists in the form of electromagnetic waves. These waves, which are commonly called radio waves, travel with the velocity of light and consist of magnetic and electrostatic fields at right angles to each other and also at right angles to the direction of travel.

One half of the electrical energy contained in the wave exists in the form of electrostatic energy, while the remaining half is in the form of magnetic energy.

The essential properties of a radio wave are the frequency, intensity, direction of travel, and plane of polarization. The radio waves produced by an alternating current will vary in intensity with the frequency of the current and will therefore be alternately positive and negative.

The distance occupied by one complete cycle of such an alternating wave is equal to the velocity of the wave divided by the number of cycles that are sent out each second and is called the wave length.

The relation between wave length λ in meters and frequency f in cycles per second is therefore

$$\lambda = \frac{300\,000\,000}{f}$$

The quantity 300 000 000 is the velocity of light in meters per second. The frequency is ordinarily expressed in kilocycles, abbreviated KC; or in megacycles, abbreviated MC. A low-frequency wave has a long wave length while a high frequency corresponds to a short wave length.

The strength of a radio wave is measured in terms of the voltage stress produced in space by the electrostatic field of the wave and is usually expressed in microvolts stress per meter.

Since the actual stress produced at any point by an alternating wave varies sinusoidally from instant to instant, it is customary to consider the intensity of such a wave to be the effective value of the stress, which is 0.707 times the maximum stress in the atmosphere during the cycle. The strength of the wave measured in terms of microvolts per meter of stress in space is exactly the same voltage that the magnetic flux of the wave induces in a conductor 1 meter long when sweeping across this conductor with the velocity of light.

Thus the strength of a wave is not only the dielectric stress produced in space by the electrostatic field, but it also represents the voltage that the magnetic field of the wave will induce in cutting across a conductor.

In fact, the voltage stress produced by the wave can be considered as resulting from the movement of the magnetic flux of the same wave.

The minimum field strength required to give satisfactory reception of a wave depends upon a number of factors, such as frequency, type of signal involved, and amount of interference present. Under some conditions radio waves having signal strengths as low as 0.1μγ per meter are usable. Occasionally signal strengths as great as 5,000 to 30,000 μγ per meter are required to ensure entirely satisfactory reception at all times.

In most cases the weakest useful signal strength lies somewhere between these extremes.

A plane parallel to the mutually perpendicular lines of electrostatic and electromagnetic flux is called the wave front.

The wave always travels in a direction at right angles to the wave front, but whether it goes forward or backward depends upon the relative direction of the lines of electromagnetic and electrostatic flux.

If the direction of either the magnetic or electrostatic flux is reversed, the direction of travel is reversed; but reversing both sets of flux has no effect.

The direction of the electrostatic lines of flux is called the direction of polarization of the wave. If the electrostatic flux lines are vertical the wave is vertically polarized; when the electrostatic flux

lines are horizontal and the electromagnetic flux lines are vertical, the wave is horizontally polarized.

Notes

engineering [ˌendʒɪ'nɪərɪŋ] — *техніка*
frequency ['fri:kwənsɪ] — *частота*
to vary ['vɛərɪ] — *змінювати(ся)*
alternately [ɔ:l'tə:nɪtlɪ] — *по черзі*
cycle ['saɪkl] — *макт, оберт*

Text 2. Propagation of Radio Waves of Different Frequencies

As radio waves travel away from their point of origin, they become attenuated or weakened. This is due in part to the fact that the waves spread out.

In addition, however, energy may be absorbed from the waves by the ground or by ionized regions in the upper atmosphere, and the waves may also be reflected or refracted by the earth, by ionized regions in the upper atmosphere, or by conditions within the lower atmosphere. The resulting situation is quite complex and differs greatly for radio waves of different frequencies.

Radiation of Electrical Energy

Every electrical circuit carrying alternating current radiates a certain amount of electrical energy in the form of electromagnetic waves, but the amount of energy thus radiated is extremely small unless all the dimensions of the circuit approach the order of magnitude of a wave length. Thus, a power line carrying 60-cycle current with a 20-ft. spacing between conductors will radiate practically no energy because a wave length at 60 cycles is more than 3 000 miles, and 20 ft. is negligible in comparison.

On the other hand, a coil 20 ft. in diameter and carrying a 2 000-kc current will radiate a considerable amount of energy because 20 ft. is comparable with the 150-meter wave length of the radio wave.

From these considerations it is apparent that the size of radiator required is inversely proportional to the frequency.

High-frequency waves can therefore be produced by a small radiator, while low-frequency waves require a large antenna system for effective radiation.

Every radiator has directional characteristics as a result of which it sends out stronger waves in certain directions than in others.

Directional characteristics of antennas are used to concentrate the radiation toward the point to which it is desired to transmit, or to favor reception of energy arriving from a particular direction.

Generation and Control of Radio-Frequency Power

The radio-frequency power required by a radio transmitter is practically always obtained from a vacuum-tube, oscillator or amplifier.

Vacuum tubes can convert direct-current power into alternating-current energy, for all frequencies from the very lowest up to 30 000 mc, or even greater.

Under most conditions the efficiency with which this transformation takes place is in the neighborhood of 50 percent or higher. At frequencies up to well over 1,000 mc, the amount of power that can be generated continuously by vacuum tubes is of the order of kilowatts.

Notes

to attenuate [ə'tenjueɪt] — *виснажувати*
to absorb [əb'sɔ:b] — *вбирати; поглинати*
magnitude ['mægnɪtju:d] — *величина*
negligible ['neglɪdʒəbl] — *незначний*
oscillator [,ɔsɪ'leɪtə] — *вібратор*

Text 3. Reception of Radio Signals

In the reception of radio signals it is first necessary to abstract energy from the radio waves passing the receiving point.

After this has been done, the radio receiver must next separate the desired signal from other signals that may be present, and then reproduce the original intelligence from the radio waves. In addition, arrangements are ordinarily provided for amplification of the received energy so that the output of the radio receiver can be greater than the energy abstracted from the wave.

Any antenna system capable of radiating electrical energy is also able to abstract energy from a passing radio wave, because the electromagnetic flux of the wave in cutting across the antenna conductors induces a voltage that varies with time in exactly the same wave as the current flowing in the antenna radiating the wave.

The energy represented by the current flowing in the receiving antenna system is abstracted from the passing wave and will be greatest when the reactance of the antenna system has been reduced to a minimum by making the antenna circuit resonant to the frequency of the wave to be received.

Since every wave passing the receiving antenna induces its own voltage in the antenna conductor, it is necessary that the receiving equipment be capable of separating the desired signal from the unwanted signals that are also inducing voltages in the antenna.

This separation is made on the basis of the difference in frequency between transmitting stations and is carried out by the use of resonant circuits which can be made to discriminate very strongly in favor of a particular frequency.

It has already been pointed out that, by making the antenna circuit resonant to a particular frequency, the energy abstracted from radio waves of that frequency will be much greater than the energy from waves of other frequencies; this alone gives a certain amount of separation between signals.

Still greater selective action can be obtained by the use of additional suitably adjusted resonant circuits located somewhere in the receiver in such a way as to reject all but the desired signals.

The ability to discriminate between radio waves of different frequencies is called selectivity and the process of adjusting circuits to resonance with the frequency of a desired signal is spoken of as tuning.

Although intelligible radio signals have been received from stations thousands of miles distant, using only the energy abstracted from the radio wave by the receiving antenna, much more satisfactory reception can be obtained if the received energy is amplified.

This amplification may be applied to the radio-frequency currents before detection, in which case it is called radio-frequency amplification; or it may be applied to the rectified currents after detection, which is called audio-frequency amplification.

The use of amplification makes possible the satisfactory reception of signals from waves that would otherwise be too weak to give an audible response. The only satisfactory method of amplifying radio signals that has been discovered is by the use of vacuum tubes. Before such tubes were discovered, radio reception had available only the energy abstracted from the radio wave by the receiving antenna.

Notes

to receive [rɪ'si:v] — *сприймати, приймати*
amplification [,æmplɪfɪ'keɪʃn] — *збільшення, поширення, посилення*
reactance [rɪ:'æktəns] — *реактивний опір*
voltage ['voultɪdʒ] — *напруга*
detection [dɪ'tekʃn] — *детектування*
audible ['ɔ:dəbl] — *чутний*

Text 4. Detection

The process by which the signal being transmitted is reproduced from the radio-frequency currents present at the receiver is called detection, or sometimes demodulation. Where the intelligence is transmitted by varying the amplitude of the radiated wave, detection is accomplished by rectifying the radio-frequency currents.

The rectified current thus produced varies in accordance with the signal originally modulated on the wave radiated at the transmitter and so reproduces the desired signal.

Thus, when the modulated wave is rectified, the resulting current has an average value that varies in accordance with the amplitude of the original signal.

In the transmission of code signals by radio, the rectified current reproduces the dots and dashes of the telegraph code and could be used to operate a telegraph sounder. When it is desired to receive the telegraph signals directly on a telephone receiver, it is necessary to break up the dots and dashes at an audible rate in order to give a note that can be heard, since otherwise the telephone receiver would give forth a succession of unintelligible clicks.

The detection of a frequency-modulated wave involves two steps.

First, the wave is transmitted through a circuit in which the relative output obtained from the circuit depends upon the frequency.

The circuit output is then an amplitude-modulated wave since, as the frequency of the constant-amplitude input wave varies, the output will vary correspondingly.

The resulting amplitude-modulated wave is then rectified.

Notes

to transmit [trænz'mɪt] — *передавати*
to rectify ['rektɪfaɪ] — *виправляти*
correspondingly [ˌkɔrɪs'pɔndɪŋlɪ] — *відповідно*
click — *клацання; защіпка*
dot — *крапка*
dash [dæʃ] — *тире*

Text 5. The Telephones

The telephones are connected in series with the detector.

A brief explanation of how the telephone works, is here necessary. The sensation of sound is excited in the ear by the motion imparted to the air by vibrating bodies. If a flat steel spring be fixed in a vertical position in a vice, and the free end of it be displaced, on releasing it a vibratory motion will follow. The free end will pass backwards and forwards along a gradually decreasing arc. During its first movement to the right, it compresses the air on its right-hand side, and causes a state of rarefaction on its left-hand side. A reverse movement has exactly the opposite effect. As long as the spring continues to vibrate, waves of rarefaction and compression are propagated, the frequency of these waves or the number of complete vibrations per second determining whether they are audible or not. If the frequency be anything between 30 and 20,000 per second, audible sounds are produced. The telephone is an instrument capable of producing waves in the air of such a frequency A disc of thin soft iron, varnished to prevent rusting, takes the place of the spring just described, and it is set in vibration by fluctuations in the intensity of a magnetic field. Fig. 1 shows an electro-magnet with its two poles in close proximity to a disc of soft iron D, which is firmly clamped in position by its edges. The core of the magnet is permanently magnetized and exercises a force of attraction on the disc. If a current be passed through the coils wound round its pole pieces, this force of attraction is increased or decreased according to the direction of the current. If the force be increased, the centre of the disc is pulled towards the magnet; and if the force be decreased, it is released to some extent. If, then, rapid alternations of current, or intermittent unidirectional currents, be passed through the windings, the disc or "diaphragm", as it is called, is caused to vibrate; and if the frequency of the vibrations be within the limits stated above, they will produce the sensation of sound in the ear.

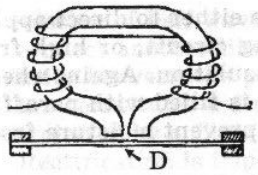


Fig. 1. Principle of the Telephone

On account of its shape the telephone receiver used in a wireless installation is called a "watch" receiver.

Two complete watch receivers are connected in series at the ends of a steel or aluminium strip spring, to form the telephone head-gear. As the space available is very small, the wire used in the coils of the electro-magnets must of necessity be very thin, in order to obtain the necessary ampere-turns required for the high degree of sensitiveness of the telephone. In low resistance telephones the wire is insulated with silk, but where a much greater number of turns is required, as in the case of telephones of from two to eight thousand ohms resistance used with a valve or crystal receiver, the wire insulation usually consists of a coating of enamel, as space is thus economized. In the high resistance telephone a pair of protective spark points is often included, as a guard for

the coil windings against excess voltage due either to direct application, inductive kick on suddenly breaking circuit, or high-frequency surge — all tending to damage the insulation. Again, where enamelled wire is used, the interior of case is filled with paraffin wax, further to ensure good insulation and prevent moisture from reaching the windings.

Notes

detector [dɪ'tektə] — *детектор*
sensation [sen'seɪʃn] — *відчуття*
to excite [ɪk'saɪt] — *збуджувати*
to impart [ɪm'pɑ:t] — *надавати, наділяти*
spring — *пружина*
arc [ɑ:k] — *електрична дуга*
compression [kəm'preʃn] — *компресія; здавлювання*
to propagate ['prɔpəgeɪt] — *розповсюджуватися; поширюватися*
to clamp ['klæmp] — *затискувати*
core [kɔ:] — *стрижень, сердечник*
intermittent [ˌɪntə'mɪtənt] — *переривчастий*
insulation [ˌɪnsju'leɪʃn] — *відособленість*
surge [sə:dʒ] — *хвиля*

Text 6. Functions of Vacuum Tubes

Although the applications of vacuum tubes are almost infinite, the specific functions that vacuum tubes can perform by virtue of their own properties are relatively few. It is these few fundamental functions and their combinations that give rise to the numerous applications.

A list of the functions of vacuum tubes is bound to be an arbitrary one since the tube cannot function by itself without an associated circuit. However, some of the jobs that vacuum tubes can perform are so fundamental that they may be considered properties of the tube itself, independent of the associated circuits.

The principal functions that may be performed by vacuum tubes are listed below.

Rectification. — Vacuum tubes are able to convert alternating currents to direct currents. This is known as "rectification". Rectification is an inherent property of vacuum tubes because current can flow in only one direction from a source of electrons.

If a sinusoidal wave of voltage is applied to a vacuum tube of the right type, current will flow in only one direction, giving rise to a succession of half-wave pulses all of the same polarity. It is possible to connect another like tube to insert half-wave pulses of the same polarity between the pulses of the first tube. The average of these pulses constitutes a direct current; the other frequency components are rejected by a filter circuit.

Rectification is important because electronic devices operate best on direct current, while power is usually generated and transmitted in alternating form. It is thus necessary to convert or rectify, the a-c power to d-c power.

Amplification. — The amplification of voltage or power is the outstanding function that vacuum tubes are able to perform. With the exception of the mechanical torque amplifier, no other device can do anything like it. Strictly speaking, the vacuum tube does not amplify power but rather controls the flow of a relatively large amount of power from one source with a small amount of power to another source. The British use the expression "electric valve" for certain types of electron tubes. This term indicates the nature of the amplifying action.

Oscillation. — The generation of high-frequency alternating currents, or oscillation, is another remarkable function that vacuum tubes can perform. Oscillation is obtained by causing part of the output of an amplifier to excite the amplifier and thus make the device self-excited and self-sustaining. Tubes can be built that will produce oscillations at frequencies as low as 1 cycle per sec, while other tubes can be built that will oscillate at frequencies as high as 60,000 mc per sec.

Frequency Conversion. —Vacuum tubes are able to shift the frequency of a wave. This they are able to do by an electrical "beat" action. Thus a wave of a given frequency can be mixed with a wave of another frequency in a vacuum tube, and among the products of the interaction is found the difference of the two frequencies. If one of the original waves had certain effects associated with it, these same effects are associated with the difference frequency. The beat action results from the nonlinear characteristics of the vacuum tube.

Modulation. — The transmission of intelligence by radio waves or by certain types of wire telephone requires the use of frequencies higher than those audible. It is necessary to superimpose the audible frequencies upon the higher transmitted frequency. This superimposition is known as "modulation". Modulation is best performed by vacuum tubes.

Basically, modulation takes the form of varying some property of the r-f wave at the audible rate. The commonest form of modulation varies the amplitude of the r-f wave in accordance with the intelli-

gence to be transmitted. This is known as "amplitude modulation". Frequency modulation is also common.

Detection. — Detection is the inverse of modulation and is sometimes known as "demodulation". It is the process of extracting the intelligence from the modulated wave. In the case of amplitude modulation the detection may be effected by rectifying the r-f wave and then utilizing the average value of the rectified wave, since it follows the amplitude variations in magnitude. Detection of modulated radio signals is best performed by vacuum tubes over most of the range of radio frequencies.

Light-image Production. — It is possible for vacuum tubes to convert part of their output energy into visible light. This is done in cathode-ray tubes in which a stream of electrons is caused to hit a fluorescent screen, causing light to be emitted. The cathode-ray tube can be used for viewing wave forms and for doing many other wonderful things, including the reproduction of visual scenes. The fundamental property involved here is the conversion of electrical energy into visual energy.

Photoelectric Action. — Vacuum tubes can be made that will convert light energy into electrical energy. This is possible by virtue of the photoelectric effect, which is the emission of electrons from certain surfaces when illuminated with visual energy. The liberated electrons constitute an electric current whose measure is related to the frequency and intensity of the exciting light. Tubes making use of this principle are known as "photoelectric tubes". The photoelectric tube is one of the tubes most extensively used in industrial-control systems.

Notes

vacuum-tube ['vækjuəmtju:b] — *електронна лампа*
infinite ['ɪnfɪnɪt] — *нескінченний, безмежний*
by virtue ['və:tju:] **of** — *завдяки*
arbitrary ['ɑ:bɪtrərɪ] — *довільний, випадковий*
to associate [ə'souʃɪeɪt] — *мати зв'язок; сполучати*
to rectification [ˌrektɪfɪ'keɪʃn] — *детектування*
inherent [ɪn'hɪərənt] — *притаманний, властивий*
amplification [æmplɪfɪ'keɪʃn] — *збільшення, посилення*
oscillation [ˌɔsɪ'leɪʃn] — *коливання, вібрація*
interaction [ˌɪntər'ækʃn] — *взаємодія*
to utilize ['ju:tɪlaɪz] — *використовувати, утилізувати*
cathode ['kæθoud] — *катод*
to emit [ɪ'mɪt] — *виділяти*

Text 7. Basic Tube Types

Vacuum Diode

The vacuum diode is a two-electrode vacuum tube. One electrode acts as an emitter of electrons and is called the "cathode". The other electrode acts as a collector of electrons and is called the "anode" or "plate". The emitter may be either directly or indirectly heated. In physical form the vacuum diode may vary from a small metal tube to a large glass rectifier tube.

The most useful property of the diode is that it passes current only in one direction. This property makes the diode useful as a detector and as a rectifier for d-c power supplies.

Vacuum Triode

A vacuum triode is a three-electrode tube containing an emitting electrode called the "cathode", a control electrode called the "grid", and a current-collecting electrode called the "anode" or "plate".

The emitting electrode may be an indirectly heated oxide cathode, an oxide-coated filament, or a filament of tungsten or thoriated tungsten.

The control electrode, usually in the form of a grid of fine wire, surrounds the emitter and is in turn surrounded by the plate in the commonest form of triode. By virtue of its proximity to the cathode the grid is able to influence the electrostatic field at the cathode to a greater extent than can the plate, and thus it is able to control the flow of current from the cathode. The grid is usually operated on a slight negative potential so that the electrons will pass between the grid wires without hitting the wires themselves.

Triodes have their greatest use as power amplifiers. They are also used extensively in control applications wherever a small voltage is wanted to control an appreciable amount of current.

Notes

anode ['ænoud] — *анод*
plate — *пластина*
tungsten ['tʌŋstən] — *вольфрам*
filament ['fɪləmənt] — *нитка, волосок накала*

Text 8. Screen-Grid Tube

The screen-grid tube is a four-element vacuum tube. The four elements are cathode, control grid, screen grid, and plate. The electrode construction is similar to that of the triode except that an

extra grid of mesh a little coarser than that of the control grid is inserted between the control grid and the plate.

The screen-grid tube is the historical predecessor of the pentode. Its invention was the result of an effort to overcome a limitation of the triode. Triodes do not work well as amplifiers of high frequencies, for the high interelectrode capacity between plate and grid causes the tube to regenerate and oscillate. In the screen-grid tube the capacity between the control grid and plate is reduced by inserting the extra grid, known as the "screen grid", between these elements. The insertion of the screen grid and its operation at a constant potential succeeded in producing the low control-grid-plate capacity desired but caused distortions in the plate-current and plate-voltage characteristics, for the new electrode arrangement permitted secondary electron flow between plate and screen grid. This detrimental effect was overcome in the pentode by the addition of a coarse-mesh suppressor grid between screen grid and plate.

The screen-grid tube is usually operated with cathode near ground potential, control grid at a small negative potential, and screen grid and plate at a medium and high positive potential, respectively. Screen-grid tubes may be used as a-f and r-f amplifiers. They are also occasionally used in laboratory apparatus in which it is desirable to utilize the negative resistance characteristic which is available at the points on the current characteristics where the slope is negative.

Pentode

The pentode is a five-element high-vacuum tube. The five electrodes, in the order in which they occur in the tube, are cathode, control grid, screen grid, suppressor grid, and plate. In normal operation the cathode is operated near ground potential, the control grid at a small negative potential, the screen grid at a relatively large positive potential, the suppressor grid at cathode potential, and the plate at the screen potential or a more positive potential.

The pentode is a versatile tube. It is probably the most extensively used tube in low-power applications. There are probably more pentodes in use today than any other type of electron tube.

Beam-Power Tube

The beam-power tube is a special type of tetrode. It is designed so that the electrons move from cathode to plate in dense sheets. This effect is achieved by making the control grid and screen grid of the same pitch and aligning the grid wires.

The effect of the dense current sheets between the screen grid and plate is to depress the potential between these two electrodes within

the tube because of the high concentration of negative charge. The potential between screen grid and plate is depressed enough so that secondary electron flow from plate to grid is suppressed without the aid of a suppressor grid. Thus the tube represents another solution to the problem of overcoming the distortions in the current characteristics of the ordinary screen-grid tube.

The beam-power tube is made in small and medium-size metal tubes and in a medium-size glass tube. The beam-power tube is used in many ways. It is extensively employed as an audio-power amplifier tube and also as a r-f amplifier and oscillator tube.

Notes

predecessor ['pri:dɪsesə] — *попередник*
to oscillate ['ɔ:sɪleɪt] — *коливатися, вібрувати*
distortion [dɪs'tɔ:ʃn] — *викривлення*
versatile ['və:sətaɪl] — *різнобічний*
to align [ə'laɪn] — *вирівнювати*

Text 9. Cathode-Ray Tubes

The cathode-ray tube is in a class by itself among the vacuum tubes. It makes use of the geometrical form rather than the intensity of its electron stream and converts the energy of its electron stream into a visual indication. In its commonest application the cathode-ray tube uses its electron beam to show the shape of an applied voltage wave as a light trace upon a fluorescent screen. The cathode-ray tube is an electronic oscilloscope that produces on a screen a light spot that can be deflected in two dimensions.

The cathode-ray tube is generally housed in a large glass envelope shaped like an Erlenmeyer flask. In the neck of the glass envelope is located a set of electrodes known as the "electron gun". This gun serves to produce a circular beam of electrons that is fired at the large end of the envelope, which is covered with a fluorescent material. Also housed in the neck of the envelope are deflecting devices that serve to bend the beam in horizontal and vertical directions. The fluorescent screen on the inside of the large end of the envelope gives off light at the point at which the electron beam strikes.

In physical size the ordinary cathode-ray tubes range from 10 to 20 in. in length and have fluorescent screens from 3 to 5 in. in diameter. The tubes operate with a beam-accelerating potential between 800 and 10,000 volts.

Cathode-ray tubes are principally used to observe electrical wave forms. They may also be used to compare frequencies, plot the B-H curves of iron, and plot the current-voltage characteristics of vacuum tubes. They are extensively employed as indicators of elapsed-time intervals in ionosphere height-measuring devices and radar sets. They are built in a special form known as the "kinescope" for use as television viewing tubes. They have so many uses as measuring and testing devices that no radio or electronic laboratory worthy of the name is without one.

Klystron

The klystron is a newcomer to the group of vacuum tubes in use today. It is a special ultra-high-frequency tube that is capable of generating, detecting, and amplifying radio waves ranging in frequency from 600 to 30,000 mc (50 to 1 cm).

The principle of operation of the klystron amplifier differs from that of other vacuum tubes. It makes use of a velocity-modulation principle that causes a stream of electrons, which initially has a uniform current density, to form in bunches. It is the periodic bunch impact that excites the output resonator, from which energy is extracted. This use of a beam passing through gaps in closed cavity resonators built into the tube made it possible for the klystron to overcome the transit-time limitations that the conventional negative-grid tubes encounter at high frequencies.

Notes

intensity [ɪn'tensɪtɪ] — *інтенсивність; напруженість*
stream [stri:m] — *потік*
beam [bi:m] — *промінь*
indication [ˌɪndɪ'keɪʃn] — *ознака; показання (приладу)*
to deflect [dɪ'flekt] — *відхилятися*
to range ['reɪndʒ] — *коливатися*

Text 10. Magnetron

The magnetron is a vacuum tube whose current may be influenced by a magnetic field. In certain special forms it is useful as an ultra-high-frequency oscillator. As such it may oscillate at wave lengths from 100 to 1 cm. It is capable of a continuous power output of several hundred watts and instantaneous powers of several thousand kilowatts.

Early forms of the tube were of the split-anode type. The important parts of this type of magnetron are the cathode, frequently in the form of a straight wire filament, and the anode, in the form of a circular plate concentric with the cathode and split into an even number of similar segments. The segments of the plate are operated at the same positive d-c potential relative to the cathode, and a magnetic field is applied parallel to the tube axis. This combination of electric and magnetic fields causes the electrons emitted from the cathode to move in nearly circular paths in the region between cathode and anode.

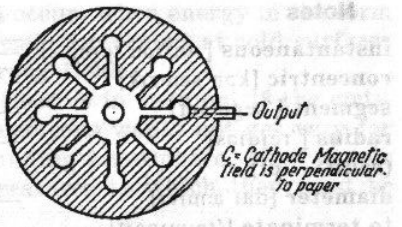


Fig. 2. Electrode structure of a multianode cavity-resonator magnetron. The outer electrode serves as the anode. Each of the hole-and-slot combinations acts like a parallel resonant L-C circuit.

The radii of the nearly circular electron paths in a magnetron depend upon the strength of the radial electric field and the axial magnetic field. The radii of the paths decrease as the electric field is decreased or as the magnetic field is increased. Thus if a magnetron has its circular plate segments maintained at a constant d-c potential and the strength of the axial magnetic field is increased from zero strength to a large value, the electrons in the tube will at first move radially from the cathode to the plate and then move in paths which are more and more strongly curved until finally the magnetic-field strength is reached at which the electrons miss the plate entirely.

Modern super-high-frequency magnetrons are made in the form of a multianode cavity. The basic structure of such magnetrons is shown in **Fig. 2.** The cathode is in the form of a cylinder of appreciable diameter located in the center of the structure. The anodes are cut out of one piece of metal and have the form of a large circular hole in a block with radial slots leading out to smaller circular holes. Electrically, each slot and terminating hole are equivalent to a tuned resonant circuit, the slot having a predominantly capacitive action and the terminating hole having a predominantly inductive action. One of the resonant conditions possible in this equivalent circuit is one in which alternate segments of the anode exhibit the same electrical polarity and thus give the same action as a split multisegment anode, with the advantage that the fields associated with this resonance are confined. Under proper conditions of voltage and magnetic-field strength parallel to the long axis of the cathode, energy will be transferred from the swarm of gyrating electrons around the anode to the resonant circuit and powerful oscillations will be sustained.

Notes

instantaneous [ˌɪnstən'teɪnjəs] — *миттєвий; негайний*
concentric [kɔn'sentrɪk] — *концентричний*
segment ['segmənt] — *відрізок*
radius ['reɪdɪəs] — *радіус*
(radii — pl)
diameter [daɪ'æmɪtə] — *діаметр*
to terminate ['tə:mɪneɪt] — *завершувати; закінчувати (ся)*
resonant ['rezənənt] — *гучний; резонуючий*
circuit ['sə:kɪt] — *цикл; ланцюг (ел.)*
predominantly [prɪ'dɔmɪnəntlɪ] — *переважно*
inductive [ɪn'dʌktɪv] — *індуктивний*
swarm [swɔ:m] — *рій, зграя, натовп*
to gyrate [ˌdʒaɪə'reɪt] — *обертатися по колу; рухатися по спіралі*

Text 11. Electronic Emission

Every vacuum tube depends for its action upon a stream of electrons that acts as a carrier of current. As necessary as the stream of electrons is the electrode that emits them. Whatever the nature of the tube and the arrangement of electrodes, an emitting electrode cannot be dispensed with. Even in cold-cathode tubes, one of the electrodes is treated with a low-work-function material to facilitate the production of some electrons that will initiate the action.

In general, the excellence of performance of a given tube depends upon the efficiency with which free electrons are produced. When the emission fails, the tube is useless. We infer correctly then, that the subject of electron emission is worthy of considerable study.

The types of electronic emission may be listed as follows:

1. Thermionic, or primary, emission.
2. Secondary emission.
3. Photoelectric emission.
4. Field emission.

The types of emission differ only in the way in which the escape energy is imparted to the free electrons. Thermionic emission occurs when a material is heated to incandescence in a vacuum. In this case the escape energy is imparted by heating the material. Secondary emission occurs when a high-velocity electron or ion strikes a material in a vacuum and knocks out one or more electrons. In this case the energy that enables the free electrons to escape comes from the striking particle. Photoelectric emission occurs when energy in the form of light falls upon a surface. Field emission occurs at cold surfaces under the influence of extremely strong fields.

All types of emission are most effective in vacuum. If the emission did occur in air, the emitted electrons would not get very far through the relatively dense surrounding atmosphere. Most metals would burn up in air at the temperatures to which they must be raised to emit satisfactorily.

Notes

emission [ɪ'mɪʃn] — *виділення; випромінювання*
to dispense [dɪs'pens] — *розподіляти*
to escape [ɪs'keɪp] — *утекти; витікати*
sufficiant [sə'fɪʃənt] — *достатній*

Text 12. Handie-Talkie

Handie-Talkies (Fig. 3) have made a fine contribution in our war effort and have found extensive application in the armed services. However, the military were not the only ones to recognize their value. Various commercial interests have found this means of communication indispensable.

Handie-talkies are complete self-contained radio sending and receiving stations. They contain, in a single housing, the transmitter, a receiver, and dry batteries for power. The microphone, earphone, and the antenna are mounted on the exterior of the housing. The complete unit is compact enough to be held in one hand and operated in much the same fashion as an ordinary telephone handset.

The completness of the handie-talkie makes maintenance as well as operation easy. There is no additional equipment to plug in, to attach or to worry about bringing along. This is very important when considering emergency operation.

There are numerous everyday uses for the handie-talkie, one most of you will appreciate is aiding in TV antenna installation and main-

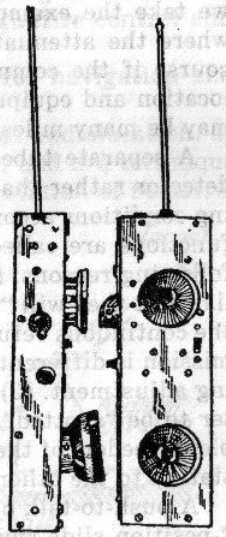


Fig. 3. Front and side views of the handie-talkie. The antenna was a surplus item but a TV antenna of the "rabbit ears" type can be used as well.

tenance. Civil Defence and other emergency services have varying needs for hand-carried, portable transmitter-receivers.

The conditions under which portable equipment must operate are often overlooked in many cases. Hams who have operated mobile stations can readily understand the handicaps of such operation. There are three main obstacles to such operation and they are: (1) Antenna site. It is of course right where you are standing and seldom, if ever, is it a spot you would select for an antenna. (2) Low power. Dry battery operation is extremely low power when compared to mobile equipment. (3) Interference. Usually there are noise and distractions that make operating difficult.

A difficult, if not impossible, task is to fix a performance figure for such units as these handie-talkies. A desirable statement would be to say that these units will maintain reliable communication over a specific distance. To explain, here are the two extremes: The maximum distance between two of these units is slightly over one mile. This is unobstructed line of sight distance. The minimum distance if we take the example of one unit being enclosed in a screen room where the attenuation may be 100 db or greater, is zero. And of course if the communication is between a fixed station with good location and equipment, and one of the handie-talkies, the distance may be many miles.

A separate tube and components are used for the oscillator and detector rather than using a common stage and changing its operating conditions accordingly. Such units that use a single tube for both functions are called transceivers. Separate stages are used for the following reasons: (1) With transceivers when working another similar unit they will "walk" across the band. This happens as a result of the continuous retuning of each unit because the frequency of transmission is different than the frequency of reception for a single tuning adjustment. (2) The use of separate stages permits the transmitter to be "spotted" in the band on a particular frequency and complete freedom of the receiver is maintained. It may be tuned from one station to the other without disturbing the transmitter.

A push-to-talk button was used merely for convenience. A 3-pole, 2-position slide switch would perform better electrically but would not permit this operating ease.

Notes

indispensable [ˌɪndɪsˈpensəbl] — *дуже необхідний*
housing [ˈhauzɪŋ] — *будова*
to mount [ˈmaunt] — *установлювати; монтувати*

exterior [ekˈstɪərɪə] — *зовнішній*
maintenance [ˈmeɪntɪnəns] — *обслуговування, ремонт*
to overlook [ˌouvəˈluk] — *ігнорувати*
obstacle [ˈɔbstəkl] — *перешкода*
site — *місце*
distraction [dɪsˈtrækʃn] — *відвернення уваги*
extreme [ɪksˈtri:m] — *крайність*
transceiver [trænˈsi:və] — *передатчик-приймач*

Text 13. Fundamentals of Radar

How Radar Works

The design of a radar begins with consideration of its intended use, that is, the function to be performed by the radar as a whole. The uses generally divide into three categories:

1. Warning and surveillance of activity, including identification.
2. Aids to the direction of weapons, that is, gunfire control and searchlight control.
3. Observation of terrain echoes or beacons for navigation and control of bombing.

There is nothing mysterious or complex about radiolocation. It rests on the foundations of ordinary radio theory, and is a technique based on the transmission, reception, and interpretation of radiofrequency pulses. Considered as a whole, it must be admitted that even the most elementary of radar equipment is difficult to visualize, but this is simply due to the fact that so many (normally) curious circuits and pieces of apparatus are gathered together under one roof. No particular circuit or detail of the equipment is in itself especially difficult to understand, and once the elements are known the complete assembly is no longer mentally unmanageable.

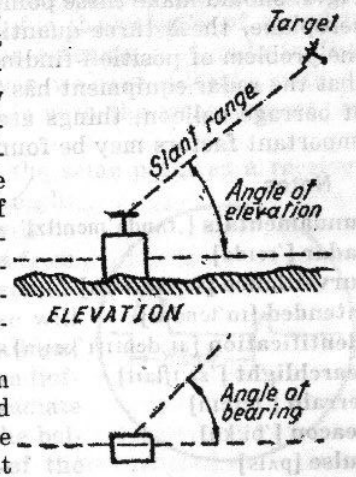


Fig.4

The word "radar" is derived from the phrase "radio direction-finding and range", and it may be more expressive than the older "radiolocation", or it may not. Finding the position of an

aircraft or a ship by means of radio covers a very wide field of electronic application, covers, in fact, the whole area of radio direction-finding (R. D. F.) from the elementary bearing-loop to the principle of the reflected pulse which represents the latest principle of the technique. In this article the term will be used to cover only those methods of detection which depend upon the reflected pulse, the characteristic (by popular opinion) which distinguishes radar from all other methods of position-finding in that no cooperation is required on the part of the target. We shall not dwell, therefore, upon the older and more familiar methods which depend upon the reception at two or more points of a signal transmitted by the body under location itself.

The actual equipments in use which employ the reflected pulse principle are greatly varied from the point of view of physical appearance, but their basic principles are the same.

First, let us tabulate and briefly analyse the problem to be met. The aim of radar is to find the position of a target with respect to a fixed point on the ground — say the position of an aeroplane or a barrage balloon with respect to the radar equipment situated in a field a mile or so away: Three quantities must be measured in order to define the position of the aeroplane or the barrage balloon: first, the slant range, the length of the most direct line drawn from the radar site to the target; second, the angle of bearing, i.e. which point of the compass the target occupies; third, the angle of elevation. Fig.4. should make these points clear for you. When the target is an aeroplane, these three quantities are continuously varying so that the problem of position-finding is somewhat complicated by the fact that the radar equipment has to "follow" as well as find. In the case of barrage balloon, things are not quite so difficult, and the three important factors may be found at leisure.

Notes

fundamentals [ˌfʌndəˈmentlz] — *основа; основні принципи*
radar [ˈreɪdə] — *радіолокатор*
surveillance [səːˈveɪləns] — *нагляд*
intended [ɪnˈtendɪd] — *навмисний*
identification [aɪˌdentɪfɪˈkeɪʃn] — *розпізнавання, ототожнення*
searchlight [ˈsəːtʃlaɪt] — *прожектор*
terrain [təˈreɪn] — *місцевість, територія*
beacon [ˈbiːkn] — *маяк*
pulse [pʌls] — *вібрація*
target [ˈtɑːgɪt] — *ціль*

to dwell — *докладно зупинятися*
barrage [ˈbærɑːʒ] — *загородження; гребля*
at leisure [ˈleʒə] — *на дозвіллі*

Text 14. Slant Range

The measurement of slant range is, in principle at least, a surprisingly simple procedure.

Post Office engineers lay claim to being the first people to recognize that aircraft reflections were detectable, for they suffered "interference" on their short-wave equipment when aircraft were flying in the vicinity. This was in 1933, but pulse measurements, equivalent to range -finding, had been carried out successfully on the upper ionized layers of the earth's atmosphere long before that time. The application of the latter to the problems of the former came later, in 1935.

Consider for a moment the familiar business of "measuring" the distance of a thunderstorm. We watch for a flash of lightning, observe it at a particular moment, then we wait for the peal of thunder. We know that sound travels approximately 1100 feet per second through air at normal temperatures, or about 1 mile in 5 seconds, therefore the time interval between the flash of lightning and our knowledge of the thunder noise is a measure of the distance from where we are standing to the centre of the atmospheric disturbance. The method is correct, though crude, for the velocity of sound is liable to quite large variation and our estimate of 1 mile in five seconds is rough in the extreme. However, we have at least a method, and a very simple method it is. So it is with the measurement, by radio, of slant range.

Suppose a transmitter situated at the same point as a receiver sends forth a short, powerful pulse of high-frequency carrier wave. This wave will be radiated in all directions, travelling out from the transmitter site like a rapidly expanding ball. At a certain point this wave will strike the target, say, the barrage balloon, and induce in its conducting parts a radiof-requency current which in turn will radiate its own carrier into space — that is, the balloon will re-radiate or reflect, part of the original transmitted pulse. Some of this re-

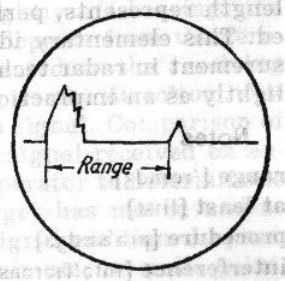


Fig. 5

radiated energy, also expanding in every direction from the balloon, will make its way back to the receiver where, by suitable means which need not concern us at the moment, it may be made to produce a response. If now we have also permitted the transmitted pulse to produce a response in the receiver at the precise instant that it left the transmitting aerials, then clearly the response caused by the reflected pulse will occur some finite time after that due to the pulse received directly, for the former has had to travel a much greater distance.

The simplest way to measure extremely short time intervals is by means of a cathode-ray indicator tube, and nearly all radar receivers are equipped with one or more of these devices. Suppose a transmitter is sending out a series of radio pulses of some few microseconds duration, a regular repetition of short bursts of radiofrequency carrier wave. The signals reflected from a target are detected by the receiver and are presented to a cathode-ray tube. In the most elementary instances, a linear "time-base"— a deflection of the electron beam that is proportional to time — is provided and this time-base is "fired" in synchronism with the transmitted pulse; that is, the spot on the tube commences to sweep the screen every time a pulse leaves the transmitter aerial array. Then two vertical deflections appear along the time-base as shown in **Fig.5**; the direct transmitter pulse causes the large deflection on the extreme left of the time-base, while the reflected pulse appears a little farther along. The amount by which these two deflections are displaced depends upon the distance of the target, and by measuring the length of the time-base between them, provided the speed of the latter is known, the range of the target can be found. This simple system is, of course, not very accurate as it stands, for even with a large cathode-ray tube and a linear scale a measurement of range within, say ± 100 yards on a time-base whose length represents, perhaps, up to 20 miles is hardly to be expected. This elementary idea is, however, the basis of all range measurement in radar technique, and must not therefore be dismissed lightly as an impracticable scheme.

Notes

range ['reɪndʒ] — *діапазон*
at least [li:st] — *принаймі*
procedure [prə'si:dʒə] — *процедура*
interference [ɪntə'fɪərəns] — *втручання, перешкода*
in the vicinity [vɪ'sɪnɪtɪ] — *поблизу*

equivalent [ɪ'kwɪvələnt] — *рівноцінний, еквівалентний*
peal [pi:l] **of thunder** — *гуркіт грому*
approximately [ə'prɔksɪmɪtlɪ] — *приблизно*
velocity [vɪ'lɔsɪtɪ] — *швидкість*
liable ['laɪəbl] — *відповідний*
precise [prɪ'saɪs] — *точний*
deflection [dɪ'flekʃn] — *відхилення*
to displace [dɪs'pleɪs] — *переміщувати; витісняти, усувати*
scale ['skeɪl] — *шкала*
scheme ['ski:m] — *схема, проект*

Text 15. Bearing

The determination of bearing is not quite so easy as finding range, but it is, nevertheless, much simpler than the determination of elevation. Target bearing is determined by the use of special aerial arrays. Proud owners of portable broadcast receivers who regard their loop aerial as a "special" array, may find the bearing of the local B.B.C. station by suitable orientation of their equipment. Radar, requiring a somewhat more refined method, with corresponding accuracy, finds itself unable to rely on simple loops and generally uses such a system as that of the Slowcock array. This system consists essentially of two collinear horizontal half-wave dipoles with centres one wavelength apart connected to the receiver as shown in **Fig. 6**. When the line of the aerials is perpendicular to the horizontal direction of arrival of the reflected pulse, zero signal is presented to the receiver, even if the wave is arriving obliquely from above. If now the receiver moves slightly off bearing, the direction of arrival of the reflected signal departs from the zero-signal position and a small signal is presented to the receiving circuits, the phase of this signal reversing as the direction of it passes through that of "on bearing" or zero signal. Comparison of the phase of this signal with a "standard" signal received on another canal then makes it possible for the operator to determine to which side of the receiving array the target has moved and so enables him to return quickly to the zero signal position. In practice it is not convenient to work to a minimum, or null, point, especially when the signal is being observed on a cathode-ray tube,

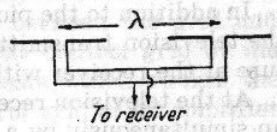


Fig. 6

and so special methods of presentation are adopted which in the main consist of either a maximum signal or the equality of two signals for the correct on-bearing position of the receiving array. There are many variations of this type of aerial array for special purposes, but most radar equipments depend on the above simple fundamental system.

Notes

bearing [ˈbɪərɪŋ] — *навантаження; значення*
determination [dɪˌtəːmɪˈneɪʃn] — *визначення*
array [əˈreɪ] — *ряд, порядок, маса*
loop [luːp] — *петля*
obliquely [əˈbliːklɪ] — *косо*
aerial [ˈɛərɪəl] — *антена; ефірний*

Text 16. Brief Analysis of the Television System

In addition to the picture impulses, special signals are sent out by the television transmitter for the purpose of synchronizing the picture at the receiver with that being picked up by the camera.

At the television receiver, the picture and audio signals are picked up simultaneously by a single antenna. The voltages induced in the receiving antenna are fed into the r-f stage of the receiver, and the picture carrier and the sound carrier are converted by the superheterodyne conversion method into two separate i-f signals, one corresponding to the sound carrier and the other to the video or picture carrier with its associated sidebands. Two separate i-f amplifier channels are employed, one for the picture signal and the other for the sound signal.

The sound i-f signal, after suitable amplification, is demodulated by an FM detector. After sufficient amplification by the audio amplifier, the sound signal is reproduced by the loudspeaker in the usual way.

The picture i-f signal is amplified by several stages having wideband frequency characteristics and is then fed into the video (picture) detector, where the i-f signal is then demodulated in the same fundamental manner as in an ordinary sound receiver. The video (picture) signal which appears in the output of the detector is then amplified in a video amplifier, which corresponds to the audio amplifier in a sound receiver except that it must pass a much wider range of frequencies.

In place of the loudspeaker used in the sound system, a device is used which converts the varying amplitude of the video signals into corresponding variations of light which reproduce the original scene.

The picture-reproducing device is a cathode-ray tube, similar in many respects to the ordinary cathode-ray tube used in service-shop oscilloscopes. The cathode-ray tube may be called a picture tube, because the desired picture is reproduced on the face of this tube. Without going into the details of the cathode-ray tube at this time, we shall assume that it consists of a glass envelope, a source of electrons which are formed into a beam, a control grid for varying the intensity of the electron beam, a deflection system for deflecting the beam, and a screen coated with a fluorescent material that emits light upon impact by the electron beam.

The fundamental action of the cathode-ray tube in reproducing a picture consists in the electron beam's moving horizontally and vertically simultaneously so as to cover the entire area of the picture-tube screen at the same time that the intensity of the spot is being varied by the video signal which is applied between the grid and cathode elements of the cathode-ray tube. The control grid of the picture tube controls the intensity of the beam which strikes the screen in exactly the same way that the control grid of an amplifier tube controls the plate current. In this way, each portion of the picture tube is made to have the proper degree of light or shade to reproduce the original scene.

The brief description of the action taking place in the television receiver omitted the necessary scanning and synchronizing action which locks or synchronizes the picture at the receiver with that at the television camera.

Notes

to synchronize [ˈsɪŋkrənaɪz] — *відбуватися одночасно, співпадати у часі*
to band [bænd] — *зв'язувати*
amplification [ˌæmplɪfɪˈkeɪʃn] — *збільшення, поширення*
impact [ˈɪmpækt] — *поштовх, вплив*
simultaneously [ˌsɪməlˈteɪnjəslɪ] — *одночасно*
to scan [ˈskæn] — *вивчати, розглядати*

Text 17. Basic Structure of a Picture

Before considering the process of converting the image into an electrical signal, it is necessary to consider the elements that make up a picture.

The basic structure of any picture consists of small areas of light or shade, known as picture elements.

The amount of detail in the picture depends on the size and number of elements making up the picture. For fine detail, the picture elements should be small and numerous, as in an ordinary photograph, and should not be visible except on very close inspection. However, if the picture elements are few and large, they will show quite plainly, as evidenced by the halftone engravings employed in newspapers.

The number and size of picture elements required for satisfactory visual representation depend upon two factors: the amount of detail desired, and the distance at which the picture is to be viewed.

It has been found that if a television picture has approximately 200,000 picture elements it will have adequate detail. However, the distance at which it should be viewed for a pleasing picture depends upon the size of the screen. If a picture containing approximately 200,000 elements is enlarged, say to twice its size, then the picture elements will be larger, and if viewed close to the screen, it will not appear as pleasing as it would if viewed from a greater distance where the individual picture elements seem to blend into one complete picture. It is for this reason that the picture on a large screen appears much better at some distance from the screen.

Electrical Transmission of an Image

The optical image is changed into a corresponding electrical signal, which is then transmitted to the television receiver. However, the picture elements contained in a picture are not transmitted simultaneously, since this would involve thousands of separate channels. Instead, the optical image is changed into an electrosensitive image, which is then dissected into its individual picture elements or electrical impulses by a process known as scanning, and only one picture element is transmitted at any one instant.

The process of scanning is similar to the manner in which a reader scans a printed page, reading from left to right and dropping down

toward the bottom of the page after each line of type has been scanned or read from left to right. In this way the electrosensitive image produced by the action of the television camera is scanned line by line until the entire image has been dissected into thousands of separate electrical impulses which represent the individual picture elements of the scene being televised. In the present television system the image is scanned into 525 lines, which gives a picture detail of approximately 200,000 picture elements.

Notes

image ['ɪmɪdʒ] — *зображення, копія*
plain ['pleɪn] — *простий, зрозумілий*
evidenced ['evɪdənst] — *доказаний*
to dissect [dɪ'sekt] — *аналізувати*
impulse ['ɪmpʌls] — *поштовх, імпульс*

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Підручник з англійської мови (частина III) зорієнтований на особливості опанування її студентами інженерних, аграрних, медичних вищих навчальних закладів. З огляду на специфіку навчальних вимог до студентів, а також їх майбутньої фахової діяльності дібрано оригінальні тексти, коментарі до них, передбачено відповідні форми індивідуальної роботи. Зміст текстів не тільки сприятиме збагаченню фахової англомовної лексики, а й розвиватиме культуру мовлення студентів.

Для студентів інженерних, аграрних, медичних вищих навчальних закладів.

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