RADIO PREPARES FOR WAR: By General J. G. Harbord

SCIENTIFIC AMERICAN

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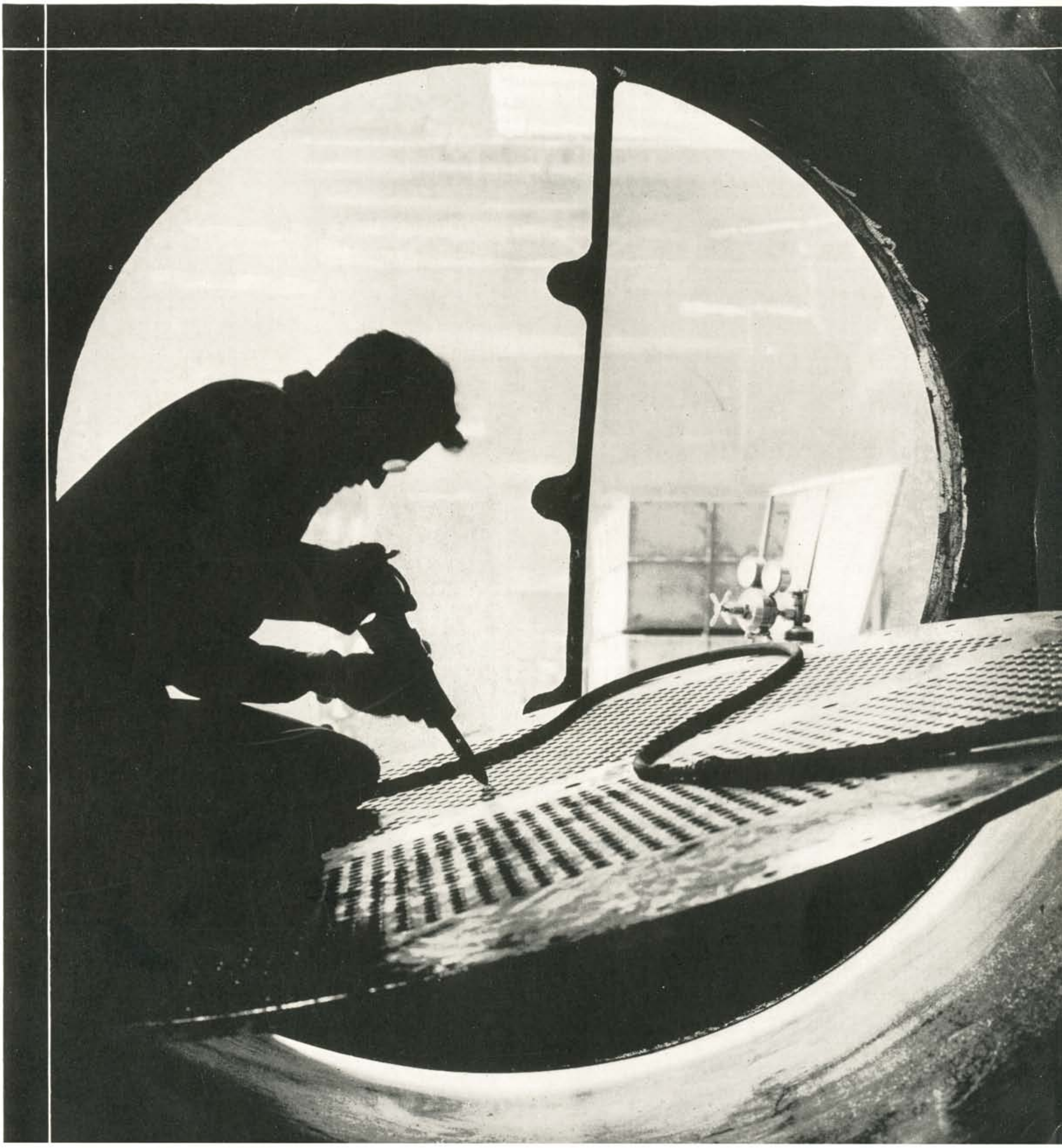


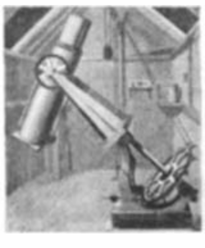
50 Years Ago in . . .

Scientific American

(Condensed From Issues of October, 1887)

SURGERY—"A new method of treating a fracture of the knee cap, 'wiring the patella,' as it is called, was successfully demonstrated at Bellevue Hospital a day or two ago. . . . An incision was made across what is familiarly known as the knee cap. The two sides of the fracture thus revealed were now to be brought together. A sort of crochet needle passed through at carefully sought and directly opposite points on either side was made to carry threads, and these in turn were used to draw through a wire by means of which the two sides of the fracture were pulled closely and firmly together."

HARVARD OBSERVATORY—"The telescope shown in the illustration is contained in a small gable-roofed house. The instrument is erected on a very solid foundation, one which had been used in observing the transit of Mercury in 1878. Attached to its base is a circular level of exceedingly great delicacy, by which it can, when necessary, be adjusted. . . . The gable roof is in two sections, being divided across its center, and is mounted on wheels running on tracks parallel to the ridge. When the instrument is in use, these two segments are pulled apart. . . . The mounting of the telescope is peculiar. A steel tube is carried by trunnions in the end of a large fork. Into this tube the brass tube containing the lenses is screwed. The polar axis is a prolongation of this fork."



HORN—"M. Zigang has devised a trumpet worked by electricity and designed to warn or signal vessels, trains, or tram cars. It consists of a trumpet tube and a sounding plate which is vibrated by the electric current passing through an electro-magnet having its poles close to a soft iron armature carried by the plate. A regulating screw contact, with a platinum point, rests against the iron armature and serves to interrupt the current of two Leclanche elements as the plate vibrates, thus keeping up the sound as long as desired."

MASS PRODUCTION—"A striking instance of the extent to which labor saving machinery is carried nowadays, says the *Industrial Journal*, is shown in the tin can industry. Everybody knows that tin cans are manufactured by machinery. One of the machines used in the process solders the longitudinal seams of the cans at the rate of fifty a minute, the cans rushing along in a continuous stream."

NIGHT FARMING—"Howard County farmers residing in the vicinity of the great Shrader gas well, near Kokomo, Indiana, go on record as harvesting the first wheat by natural gaslight."

HOMING PIGEONS—"Steps have been taken in nearly all European countries to establish military communication by means of carrier pigeons in time of war. England, France, Germany, Belgium, and Italy have definitely organized military carrier pigeon services and some have subsidized the private training establishments, with the right to use the pigeons in war."

MODERN GUNS—"General S. V. Benet, Chief of Ordnance, U. S. A. . . . is quoted as saying: 'We have now twenty-five of the new steel guns ready, and twenty-five more will be ready in a few months. That will be sufficient to arm all our light batteries with breech-loading guns. The steel for these guns was supplied by the Midvale Foundry, of Philadelphia. All modern steel guns are of one of two systems—either the Krupp bolt system or the "interrupted screw" system, which seems to offer the greatest advantages. Like all good modern inventions, it is an American one.' "

PUMPS—"The Lawrence Machine Company, Lawrence, Mass., have been awarded the contract for one of the largest pumping plants ever planned in America. The plant is for the city of Montreal, and consists of four centrifugal pumps, each with a discharging opening of 24 inches diameter, and capable of handling 18,000 gallons of water per minute, and four similar pumps of 15 inches discharge opening, and a capacity of 7,000 gallons per minute."

MUSKRAT—"Near Nashua, N. H., recently a muskrat, in digging a hole in the bank of a canal, caused a leak, and eventually, a disastrous flood. The water swept through the woods, carrying trees and everything else movable with it into the Nashua River. The mills at once shut down, and 3,000 persons will be kept out of employment. . . . It will take three weeks to repair the damages caused by that one muskrat."

CRANE—"We illustrate a new all-around crane by Ransomes & Rapier, Ipswich, designed to lift a test load of 33 tons at a radius of 67 feet; the maximum radius which can be obtained with it in ordinary work being nearly 80 feet. The machine is self-propelling, being borne on a carriage which is mounted with 32 springs on 16 wheels, and has a gauge of 21 feet and sufficient height to allow a railway train to pass under it. The various motions of lifting the load, traveling, altering the radius, and turning are all performed by the steam engine."

MOLECULES—"In an exhaustive paper upon methods of measuring thin films, Otto Wiener has made certain measures of the thickness of a film of silver which can just be perceived by the eye, and arrived at the conclusion that 0.2 millionths of a millimeter is an upper limit of the diameter of a silver molecule."

TYPEWRITERS—"The typewriter is creating a revolution in methods of correspondence, and filling the country with active, competent young ladies who are establishing a distinct profession, and bringing into our business offices, lawyers' offices, editorial sanctums, etc., an element of decency, purity, and method which is working a perceptible change."

TELEPHONE PATENT—"For the second time the government has met with a reverse in its suit brought to cancel the Bell telephone patent. . . . The government, however, proposes to appeal to the U. S. Supreme Court."

AND NOW FOR THE FUTURE

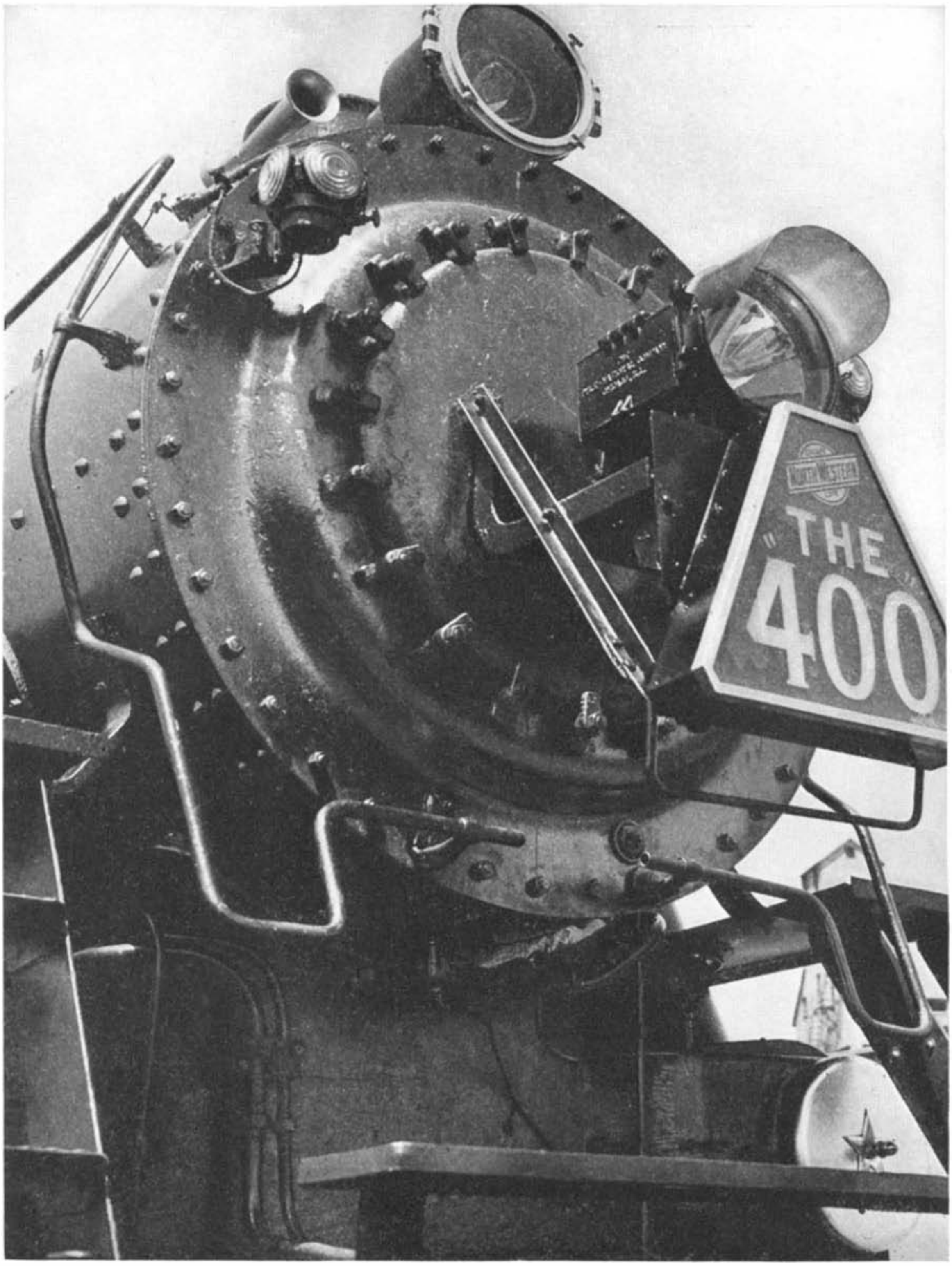
¶"Weather and Sunspots": a step toward long-range forecasting, by Harlan T. Stetson.

¶A noble metal wins its place in industry, by A. J. Wadhams.

¶An excavated tomb reveals the homely private life of a typical ancient Egyptian middle-class family.

¶New light on the subject of the speed at which ducks fly, by S. F. Aaron.

¶The existence of contagious disease is an insult to science, by G. H. Estabrooks.



A GYRATING HEADLIGHT FOR SAFETY'S SAKE

DRIVERS of automobiles only too often do not notice a train's approach to a crossing until too late. Even at night the glare of the ordinary headlight is not sufficient warning. Therefore the "400," crack passenger train of the Chicago and North Western Railway, is equipped with—besides the standard headlight—an oscillating, 3,000,000 candle-power light in front of the smoke stack. A motor operates the reflector to swing a powerful, figure-8 beam 800 feet in diameter at 1000 feet distance. It warns by its sweeping movement through the air and its flashing on roadways and against cars.

WOODROW WILSON

WARREN G. HARDING

GEORGE WASHINGTON

?

INTROVERTS OR EXTRAVERTS?
Of the six, which four are introvert types?

?

CALVIN COOLIDGE

FRANKLIN D. ROOSEVELT

HERBERT HOOVER

INTROVERTS AND EXTRAVERTS

MISUNDERSTANDINGS in business and social life frequently may be traced directly to conflicts between introverts and extraverts. Such conflicts, perfectly familiar to psychologists, are created by the cleavage between these two types of personalities, but the gap can usually be closed by a bridge of mutual understanding. To the introvert, an extravert frequently acts in an inexplicable manner. To the extravert, the mental processes of an introvert are often as mysterious. If only it were possible for extraverts and introverts to exchange personalities for even a day, it is likely that there would be much astonishment when the vastly differing mainsprings of action of the two types were disclosed, one to the other.—*The Editor*.

Most of Us are One Type or the Other and When We Understand the Wide Differences in Outlook, Some Puzzles in Business and Social Life are Resolved

By PAUL POPENOE, Sc. D.
Secretary, The Human Betterment Foundation
Director, The Institute of Family Relations

LOOK at a group of inventors, then at a parade of Shriners. Observe the people you find reading in the Science and Industry room, or in the Poetry Nook, of the public library, then attend a caucus of ward politicians.

In each case you will recognize that you are seeing different types of people—different not merely in occupation, training, and mentality, but equally in temperament and body-build.

The first group in each case is made up predominantly of introverts, the second of extraverts.

Broadly speaking, the introvert is one who, as the word suggests, has his attention turned in on himself. He is concerned with his own thoughts and feelings. The extravert has his attention turned outward. He is more concerned with what is going on around him.

Wild animals, so far as one can judge,

react in what would be considered an extravert manner; hence this is by some writers (particularly in Europe) called the primary type of personality. The introvert is then designated as the secondary type.

The two types differ radically in behavior, though with much overlapping. The introvert is more inclined to be neat, perhaps even fussy, about such personal habits as eating and dressing. He is sensitive, blushes easily, is deeply affected by either praise or blame, is conscientious to the point of worry, and enjoys a painstaking, detailed job. He does not push himself forward but speaks when he is spoken to. The emphasis of his make-up being on the processes of thought, he tends to withdraw from reality and to be concerned constantly with himself. Though he desires continually to assert himself, he often fails to do so because of some inner restraint or inhibition that results in a paralyzing condition of embarrassment. He becomes retiring and timid, and it is only when he is on the way home that he thinks of all the bright things he might have said at the party.

HUEY P. LONG
Undoubtedly he was an extravert

The extravert is the opposite of all this: he is not self-centered, because his interest is more on what is going on around him than on his own mental processes. He is always ready with a laugh and a retort, is likely to be a bit aggressive and not easily squelched. He enjoys sports and outdoor life. His tendency is to reach out and make social contacts; he is expansive and expressive; any thought that occurs to him finds ready issuance in conduct.

These differences are not associated with intelligence. They are, however, related to physique or body-build. The introvert temperament is found more frequently in the asthenic body-build, a slender physique sometimes called the linear type because the characteristic lines are vertical. The extravert is more likely to be of the lateral type, characteristic lines being horizontal. He is more thick-set and sturdy; often, though not necessarily, shorter. Calvin Coolidge and Colonel Lindbergh are good specimens of the asthenic introvert. The extravert and his body-build, commonly called pyknic, are seen to perfection in such men as David Lloyd-George, Aristide Briand and Edward Herriot, Huey Long and "T.R."

These two contrasted human types have been recognized throughout history, in mythology, and in symbolism. Don Quixote and Sancho Panza represent the classical portrayal in literature. Uncle Sam is always pictured as a lean, shrewd, laconic Yankee; Santa Claus as a short, thick-set, good-natured and generous extravert. One can not imagine a rotund Uncle Sam whose paunch "shook, when he laughed, like a bowl full of jelly"; nor a "lean and hungry" Santa Claus resembling the "yon Cassius" whose appearance annoyed Julius Caesar.

This body-build is of course associated with all sorts of internal differences. The introvert tends to have a poor circulation, while the ruddier countenance of the extravert not only suggests his better constitution, but warns that he is more likely than his opposite to suffer from high blood pressure associated with kidney defects, also with paralytic strokes, with gall-bladder disturbances and pernicious anemia. He tends to have more active glandular secretions than does the introvert. The latter has a greater liability to stomach ulcers and to tuberculosis.

As the body-build is inherited, so is also the temperament that goes with it. But, since all of us have highly mixed ancestry, both types may be found in the same family. One child may be an unmistakable introvert, his brother or sister just as definitely an extravert. In all races, both extremes are found, though perhaps in somewhat different proportions.

Just how far is temperament inborn, and how far dependent on childhood training or surroundings? Undoubtedly it can be influenced by the latter, but its association with body-build suggests that it is not a mere acquisition, a product of education.

Women are somewhat more introvert than men. This might at first sight be explained as due to differences in their upbringing and social outlook; but the fact that most of them become still more introverted during the menstrual period (only one in every 200 reported increased extraversion at that time) indicates that it may be associated with glandular balance. If so, glandular changes in the course of one's life might lead to a general shift in one's balance of temperament. Illness also tends to increase introversion.

The individual who knows his own makeup should plan his life intelligently in the light of that knowledge. The man who feels that he tends to be too introverted for his own good should keep up his physical health; then he should enlarge his interests, study other people, and try to take part in their interests. Day-dreaming must be particularly shunned, unless it is of creative character that may be expressed in profitable action.

The extravert will do well to harden his body, and then strive for independence, self-control, and the habit of reasoning. He is likely to be too responsive to those around him and when someone comes along with a new scheme, he may at once embrace it and want to see it put into execution, but is ready to drop it and take up the next one that comes along. The extravert is likely to become a yes-man (or perhaps, in the home, a yes-my-dear-man). He may always be too inclined to "go with the crowd" and accept too little responsibility.

The two types must guide themselves differently in the use of alcohol, one effect of which is to make the individual more extravert. The introvert can, generally, stand the most liquor. In fact, many introverts use it for so-called "social" purposes—in reality to increase their extraversion. The extravert is already at the edge of safety, and alcohol pushes him over the edge. In other words, he is likely to become drunk on a good deal less alcohol than the introvert can tolerate.

CHARLES A. LINDBERGH
Shy. Plans carefully. An introvert

Because the wild animal is apparently an extravert except when sick, this "primary type" has sometimes been thought to be the ideal. H. C. Link, in his recent popular book, "The Return to Religion," encourages extraversion so much as almost to make one think that it is synonymous with good mental hygiene. A broader biological perspective will show that some are born looking outward on life, others inward; that one can not greatly change his own temperament; and that each has not only its own dangers for its possessor, but its own contribution to make to civilization. *The introvert provides a large part of the creative intelligence, while the extravert makes the wheels go 'round.*

Since the type of temperament is observable from childhood, sometimes even from the cradle, it should influence the education of children. The introvert needs to be pushed out and socialized. Without wise handling, it will be too easy for him to be tied to his mother's apron strings, to shun contacts with other people, and thus to find, especially at adolescence, unnecessary difficulty in taking his place in the ranks. The extravert, on the other hand, may need to be kept within bounds and encouraged, so far as possible, in habits of industry and concentration, in order to prevent him from growing up into an irresponsible and superficial show-off.

Obviously, vocational guidance must also take account of these patterns. The inventor, working alone in his laboratory with his dreams; the poet, sitting in his garret and clothing his fantasies with the semblance of reality—such men can be thought of only as introverts, just as surely as the successful bond salesman, the affluent mortician, and the regularly re-elected district attorney will be thought of as extraverts.

With many individual exceptions, one will find actors, orators, preachers, adventurers, bluffers, squanderers, promoters, humbugs, mostly extraverts. Yet there are differences within the professions. The pastor of a wealthy and fashionable city church is likely to be an extravert, but the fanatical evangelist with fundamentalist leanings may be an introvert. Again, one could not conceive of Edgar Allan Poe as anything except an introvert, while Walt Mason and Edgar A. Guest might well be extraverts.

WILLIAM HOHENZOLLERN
Many believe he is an extravert

Extraverts are found to make the best shop foremen, while introverts are the best inspectors.

Among women, it has been found that those who choose nursing as a career seem definitely to be extraverts. The average of a group tested was more extravert than 94 percent of all women entering colleges, and the most introvert nurse in the group was only as introvert as the average college girl. Definite personality traits in which the nurses were more extravert than college girls are:

Nurses remember better the details of things to be done.
Nurses move more quickly.
Nurses prefer working with others.
Nurses are more ready to share things, even at personal sacrifice.
Nurses give less attention to personal appearance.
Nurses are less inclined to day-dream.
Nurses are not as self-conscious.
Nurses are less reserved about making acquaintances.
Nurses are less moody.
Nurses blush less.

One of the inferences to be drawn is that a girl who is an introvert should not be encouraged to consider nursing; she will probably fail at it—the greater emotional sensitivity of the introvert doubtless helps to unfit her for that career. A canvass of laboratory technicians, on the other hand, would probably show an excess of extraverts.

Women teachers are largely introverts, and the longer they have taught, the higher they average in introversion. This may be partly due to the influence of their daily life, but has also been explained as the result of a selective process. The extraverts, it is supposed, are more likely to marry and drop out of the profession; hence among those who are left after 20 years, one would find a higher proportion of introverts than in the student body of a teachers' training college.

The vocational counselor, trying to get the round pegs into round holes, makes use of all these facts. Miss A., for example, is a P.B.X. telephone operator in an apartment house. She sits behind a screen and sees no one except the postman, who unfortunately never has time to stop and talk. She is intensely unhappy because—although she does not recognize the reason—she is an extravert in an introvert's job. A counselor advises her to give up the job and demonstrate mayonnaise in a grocery store, where she can talk to every one who comes in, and can even follow them around among the shelves. She says it is simply heavenly!

Similarly, Mr. B., an extreme introvert, has been trying to make a living as a door-to-door canvasser. He is not only miserable, but is getting nearer to bankruptcy each day; retired from circulation and put into a photographer's dark-room where his painstaking attention to detail is invaluable, he makes a success.

In marriage, there is a slight tendency for the introverts to be less happy. They tend to brood more over their troubles, possibly have less of a normal social life, and are more sensitive. But the wide observations of the Institute of Family Relations indicate that this is not a major factor in marital harmony.

It has often been suggested that an introvert and an extravert would be mismated, one talking too much and the other too little. This idea is hard to reconcile with the fact that it is the wife who is more likely to be introverted, yet it is notoriously the wife who is charged by her husband with talkativeness, while a large proportion of wives complain that their husbands are not sufficiently conversable.

The Institute's studies show that almost any combination will succeed in finding conjugal happiness if husband and wife really try to do so—if they know their own weak and strong points and use that knowledge intelligently.

Mrs. C., as an illustration, is dissatisfied with her husband because he is not a social butterfly. He is "a good pro-

What About You?

If you answer most of these questions with "*Yes*," you are probably an introvert; if with "*No*," an extravert.

Do you prefer to be by yourself rather than in a crowd?

Do you plan a job in great detail before you start it?

Do you indulge a good deal in day-dreaming, in plans for the future, or in thinking what you may be doing ten years hence?

Do you keep a detailed personal diary?

Do you like cross-word puzzles?

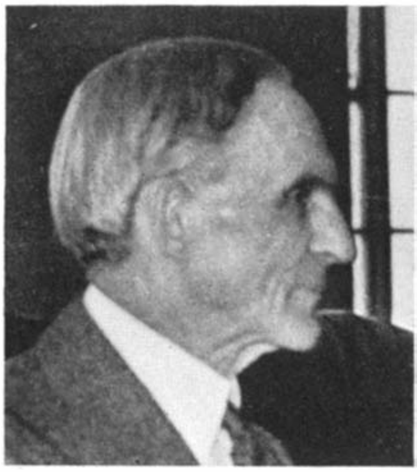
Do you go on the principle that "haste makes waste"?

Do you prefer to save money rather than to spend it?

Do you often rewrite your letters?

Do you stick to a job that has lost interest to you, just because you think anything started ought to be finished?

Do you feel that one should be very slow about giving his confidence to a friend?



HENRY FORD
Probably mainly an introvert

vider," but she thinks he ought to shine more conspicuously at bridge parties and at the monthly socials given by the Woodmen of the World. If she understands something about introversion and extraversion, and realizes that her husband belongs in the former classification, she is less likely to ascribe his reticence to "pure orneriness."

Biologically, just what is it that makes a man either introvert or extravert? Doubtless the ingredients are many, but one of the most important is supposed to be the resistance of the synapses. The synapses are the somewhat hypothetical mechanisms through which nervous impulses are transmitted at each point where two neurones come together. One may form a crude mechanical picture, for the present purpose, by considering the wiring of a radio or any other electrical circuit. If the joints are well soldered, the resistance is low at these junctions, and a current will flow through easily. If, on the contrary, the joints are loose, there will be a high resistance at each of them, with a greater likelihood that the current will be stopped, or will flow off at a tangent.

IN the introvert, it is supposed that the resistance of the synapses is low and that a nervous impulse therefore travels around easily. To speak very diagrammatically, the introvert's ideas circulate 'round and 'round in his mind and stay there, because that is the line of least resistance. The extravert's synapses, on the other hand, offer a high resistance to the circulation of an idea, hence it tends to branch off and express itself in action, instead of remaining in the closed circuit of thought processes.

The introvert's emotional life, as a whole, is different in quality from that of the extravert. His emotional states are complex and play on each other. Conflicts are met by repression, and can be dealt with by psychoanalysis.

The extravert's emotional states are more simple. Each tends to be expressed immediately, without interference by others. Severe conflicts are met by dissociation—they are "split off" in the personality. Hence the extravert lends himself well to being hypnotized, since that is a process of dissociation. It is virtually impossible to hypnotize some introverts—their minds are not built that way. But the attempt to psychoanalyze the extravert is equally difficult, because his emotional life is not built up on the repressed complexes which the psychoanalyst seeks to uncover and release. A study of some of the patients who became insane during the process of psychoanalysis showed that they were predominantly extraverts. The psychoanalyst should not have attempted to work on them, for there was nothing to work on.

WILL ROGERS
An extravert—he liked people

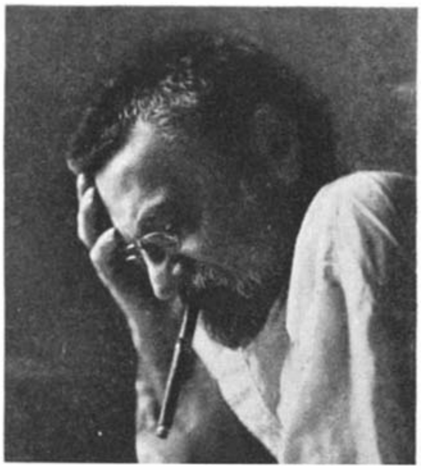
If the emotional difficulties increase to the point of a neurosis, it will be of radically different type in the two cases. The introvert's conflicts, being repressed, will result in the tension and confusion of neurasthenia. The extravert's conflicts, being split off for the protection of the rest of his personality, will end in hysteria with its bizarre symptoms of dissociation—one part of the body, or one part of the daily life, seeming to exist quite independently of the rest.

The same far-reaching difference is found if the patient actually becomes insane. The introvert will end up as a victim of dementia praecox. His personality becomes more and more shut in, his daily life more and more cut off from contact with the world around him. He "crawls into his shell," in extreme cases, until he appears to lead a sort of vegetative existence. He has been likened to a larva spinning a cocoon around itself. He may give no sign of recognizing what is going on around him; one would say that he had almost lost consciousness; yet an occasional rift in the cocoon reveals an active mental life going on inside. But it is a perpetual sort of waking dream-life. It does not issue into action.

The extravert, in the extreme case, will break down with manic-depressive insanity, in which a period of despondency or melancholia typically alternates with a manic period of intense, sometimes frantic activity. In the latter stage he may commit a crime of violence, or merely wear himself out. In the depressed phase, suicide is a common termination.

However, the mere fact of being an extreme introvert or extravert, as the case may be, does not at all mean that one is destined to break down with the appropriate mental disease. I am merely trying to point out that the two types of personality are so distinct as, in abnormal cases, to end in quite different ways.

INTROVERSION and extraversion themselves must be considered normal aspects of the personality. Most of us represent a balance between the two tendencies. We are ambiverts—we can react in either way, according to circumstances. Similarly, most of us are of medium height or weight, by definition. But, just as we recognize in a crowd some unusually tall or short, fat or thin, so we shall recognize among our friends some who are unusually introverted or extraverted. We shall probably recognize that the tendency runs in their families as well; and that it influences their daily lives in sickness and health, from infancy to old age.



CHARLES P. STEINMETZ
Creative intelligence—introvert

One can not change his make-up radically, but in ordinary circumstances he can keep it within bounds and use it effectively instead of inefficiently.

The first thing, then, is to recognize one's own temperament; the second, to recognize that of others. In the light of this knowledge, one will not expect an introvert to behave like an extravert; and he will find an explanation for things that have formerly seemed obscure, in business, politics, religion, or social life. A wider acquaintance with these facts of personality would do much to make human relationships more harmonious and promote personal welfare.

OUR POINT OF VIEW

Precaution

DISREGARDING for the time our feeling that stunt flying should be curbed—we have made our position in this respect clear in past issues—there are other aspects of long-distance flight over water that warrant careful consideration. Although the tragic Earhart-Noonan flight has long since passed from the front pages of the newspapers, it has left a bad taste in the mouths of those directly concerned with the future of aviation. Particularly is this true of technicians who have placed so much faith in radio as the mainstay of those who fly over the sea in ships.

The anxious days and nights of waiting for word of the courageous if somewhat foolhardy fliers, the valiant efforts of the United States Navy and Coast Guard, the vague whisperings variously reported, all are now history, history that we sincerely hope will not be repeated. From a study of the conditions surrounding the Earhart-Noonan flight come questions that, answered by technical advances, will do much to forward safety of life in transoceanic flight. Radio compasses on board ship are available only on the 500-kilocycle ship band. Reception on this band demands 500-kilocycle transmitters on airplanes, and such transmitters require trailing wire antennas for efficient operation. These antennas are usable only when the plane is in flight; forced down, the wire may, first, cause a crash if it is not wound up, and, second, become useless if the plane lands on water. Short-wave radio compasses are technical possibilities; their use in airplane service is strongly indicated; their range would be greater per watt input in the transmitter than when operation is carried out on the ship wave band. The radio homing device, which requires only tuning to broadcasting station signals, also offers possibilities that should not be overlooked.

At the present time, the 500-kilocycle band is the only one on which it may be said that anything approaching a 24-hour-a-day watch is maintained by commercial and naval ship and shore stations. With the increase in aircraft traffic, it would seem logical to develop, at least on board naval vessels and in naval land stations, a similar schedule on one or more of the airplane frequencies. If this is not possible, the alternative is to compel all airplanes flying over oceans or other dangerous territory to carry equipment that can be used in the 500-kilocycle ship band—and to carry operators who know how to use it.

Commercial operation of airplanes in the South American and transpacific service shows what can be done by large organizations working on carefully thought out schedules, with the best equipment for the purpose and with highly-trained personnel. The Bermuda route now in operation and the projected transatlantic service will place more and more of the public in positions where every contingency must be foreseen and provided for. Radio is the only link which man has forged that can bridge the gap between planes at sea and the safety of dry land. No possibility should be overlooked in forging the girders of this bridge, that it may be so strong as to be infallible.

Science or Sonorousness?

THE title of a paper—"Influence of Sulfhydryl and Sulfoxide on Chromosome and Aster Dimensions in Regenerating Tissues of Clymenella Torquata" —delivered by a physiological chemist, has been the subject of merriment because it sounds sonorous. Nevertheless this is all good, legitimate, and really *compact* descriptive language. Unlike it is a sentence from a paper delivered by an entomologist: "It would appear from what evidence is available that the act of oviposition is immediately stimulated by the crepuscular diminution in the intensity of illumination and the rise in relative humidity as the diurnal temperature increases," meaning that twilight and evening dampness stimulate egg-laying, and reminding one of the old-style professor who exclaimed, "Dear me, I fear I have excoriated the cuticle of my digit." He had cut his finger.

Science properly aims toward simplicity.

Predictions

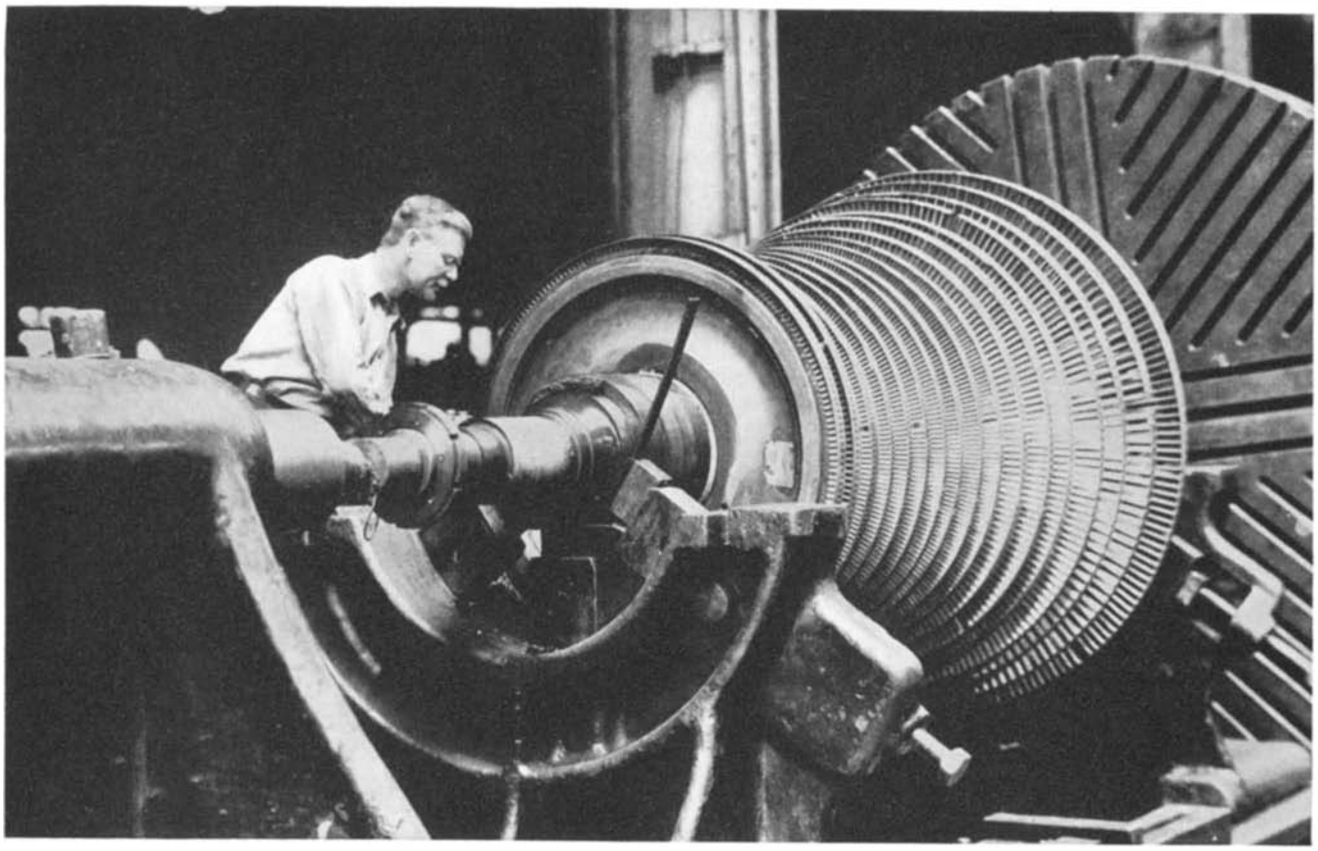
LET'S assume that man is a perspicacious animal. He must be; consider his mighty works, his scientific achievements, his multitudinous plans and programs for future happiness, welfare, riches. A glimpse at a part of his record should tell us something.

A few years before the day in 1903 made famous by the Wright brothers at Kitty Hawk, a noted scientist stated positively that man would never fly. In the vernacular: "What a bust!" Another came at the time Roentgen first announced the X ray. One world authority said: "Interesting, but it can never be more than a laboratory curiosity." Radio was opportunity knocking on Edison's door; he had it within reach at one time but he turned to something else. This journal reported in 1853 a doctor's description of an air conditioning system essentially as we have it today, yet we had to wait more than half a century before an industry was built upon it.

Perhaps, after all, man is not so keen as we assumed, for these few examples might be multiplied by the score. Bear in mind that experts were concerned in the above-mentioned failures to read the future rightly. Nowadays even the man in the street knows better than to say "It can't be done," for he believes science can work any miracle. But that is not prescience. If man were clairvoyant, he might have foreseen the social and economic implications of the incandescent lamp, the automobile, radio, aircraft; might not have said as David Starr Jordan did early in 1914: "This inevitable war people have so long discussed won't come because it can't come"; might have avoided the world economic collapse of 1929! If man were so clever as that, we would not have been treated recently to the glorious sight of billowing sails in races (?) off Newport for the honor of winning or holding a silver mug. The contestants knew how much their yachts cost, the distance around the course, all the factual details. Why not call off the races, predict results by theories or mathematical calculations, let it go at that? Why not? Because there were too many uncertainties!

Life and work, all human endeavor is like that—influenced, assisted or handicapped, encouraged or defeated by wind and weather and the vagaries of unstandardized human nature. Uncertainty is the rule, not the exception.

Why, then, a group of impractical professors of the National Resources Committee can expect other committees (which they urge) to predict future inventions or the social and economic implications of existing ones is a puzzle to us. This group spent months studying the question and submitted to the President a report of something like 450,000 words. One might say, offhand, that the committees suggested would really do no harm and that their appointment would elicit some amusing theories to put a smile on our faces. But then, they would be using taxpayers' money, as the reporting committee did! Who wants to extend our tax burden to pay for the highly dubious activities of groups that can never be as expert specialists as those who failed in the examples quoted above? Not we! The uncertainties of droughts and hurricanes and the stupidities of man in an era cursed with the existence of numerous megalomaniacs are *too certain* and unpredictable!



Thousands of blades, or buckets, radiate, row on row, from the shaft of a steam turbine rotor

Mass Power

Steam Turbines Most Efficient Power . . . Run Red Hot . . . Higher Pressures . . . New Bucket Construction . . . Metal Technology Brings Improvements

By PHILIP H. SMITH

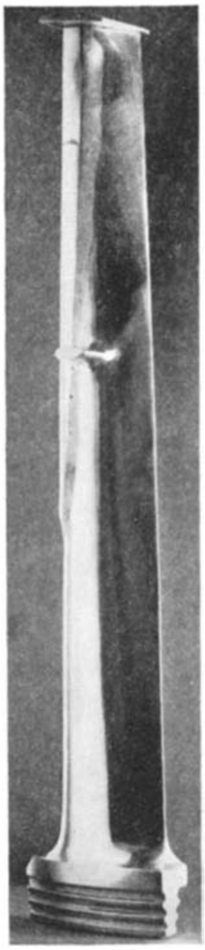
DESPITE great projects for harnessing water power for the generation of electric current, and the millions of kilowatts being made available by the simple process of making water work as it runs down hill, steam remains the principal generative force for the production of mass power.

In the year ending March 31, steam turbines produced about 70 percent of the 109 billion kilowatt-hours consumed in this country, and if the struggle of turbine manufacturers to fill orders for central station equipment is any criterion, this percentage is going to endure or become even larger in the coming years.

There is no mystery in this predominance of steam-produced power. The turbine is the most efficient generator yet devised, when both prime and operating costs are considered. It dominates because it has become steadily more efficient as demands for cheaper power have driven engineers to improve its qualities. Since the turn of the century, turbine capacity has grown from 500 kilowatts to 75,000 kilowatts for the single case machine and to 200,000 kilowatts for the compound type. At the same time, the power station rates of energy consumed for current produced have been reduced from 30,000 B.t.u./Kw.hr. to less than 12,000 B.t.u./Kw.hr. This means a reduction of more than one-half in fuel consumption so that today's turbine gives forth the equivalent of the work of 13 men for one hour for every 12 ounces of coal burned.

A MODERN commercial turbine does things which were physically impossible 30 years ago; perhaps its functioning was not even dreamed by the most radical of engineers of that time. For example, a turbine can take in steam at 1200 pounds pressure and 900 degrees, Fahrenheit, temperature and one-thirtieth of a second later, after the steam has expanded a thousand-fold, the machine will expel it 821 degrees cooler and down to absolute pressure of one inch of mercury. The rotor of a complete expansion type machine, which may weigh as much as 60 tons and rotate at near red heat, attains so high a velocity that the blade tips reach the amazing speed of 14 miles a minute! Such a turbine must pass a terrific volume of steam. One machine of 165,000 kilowatt capacity, recently put into operation, passes over 12,000,000 cubic feet of steam per minute to the condenser at full load. That's enough to form a sphere of steam 284 feet in diameter every minute of operation.

Performance of this magnitude has been achieved by slow and painstaking steps, rather than by startling discoveries. It is fruitless to search for a simple explanation which will reveal how present efficiencies have been obtained and what the future holds in store for the turbine. The basic principles were laid down centuries ago, first in the Hero



A typical large, reaction blade such as is used in the last rotating row of a condensing turbine. Lower end fits into slot in rotor; upper is free end

engine of 130 B.C. and later by the Branca wheel of the Seventeenth Century. These inventions gave the "impulse" and "reaction" principles in use in varying combinations today. Then, after Sir Charles Parsons, the British engineer, began his work in 1884 to give the turbine commercial practicability, many contributed to make improvements by a process of slow accretion.

The outstanding feature of the modern turbine is the high steam pressures and temperatures at which it operates, and if we keep our eyes focused upon this fact and discover how it came about, we will find all noteworthy developments passing in review.

Elevating both pressures and temperatures has long been the goal of turbine engineers because of the higher efficiencies it makes possible. Their success may be measured by the fact that pressures have been raised from 150 pounds per square inch to 1400, while temperatures at the throttle have been increased from 360 degrees, Fahrenheit, to 950.

Higher pressure raises a serious problem. It results in greater deposition of moisture during expansion, which in turn causes a pitting of the blades when they strike the moisture particles in an atmosphere of extremely low pressure, and it otherwise affects efficiency of the elements. To solve the problem, engineers, in some cases, have employed re-heating of the steam; that is, steam is extracted from the turbine after partial expansion, is re-heated, and is returned to the turbine to finish its work. This practice reduces the moisture content, but it has not been looked upon as a wholly satisfactory solution because it involves large piping. A more recent practice has been to raise temperatures so that re-heating can be avoided and still keep the moisture content below 12 percent, which is considered the maximum permissible.

A satisfactory solution to the blade problem has been found by using the most recent advances in metallurgy. But pitting at the low pressure end was not the only trouble to be overcome. The higher velocities necessitated stronger blade construction and use of materials that would maintain form. From non-ferrous alloys, to steel, to low carbon steel containing nickel, and finally to stainless steel, traces one path of blade or bucket development. Now we find the wearing-away action being checked by silver-soldering thin strips of Stellite to the stainless steel body of each blade.

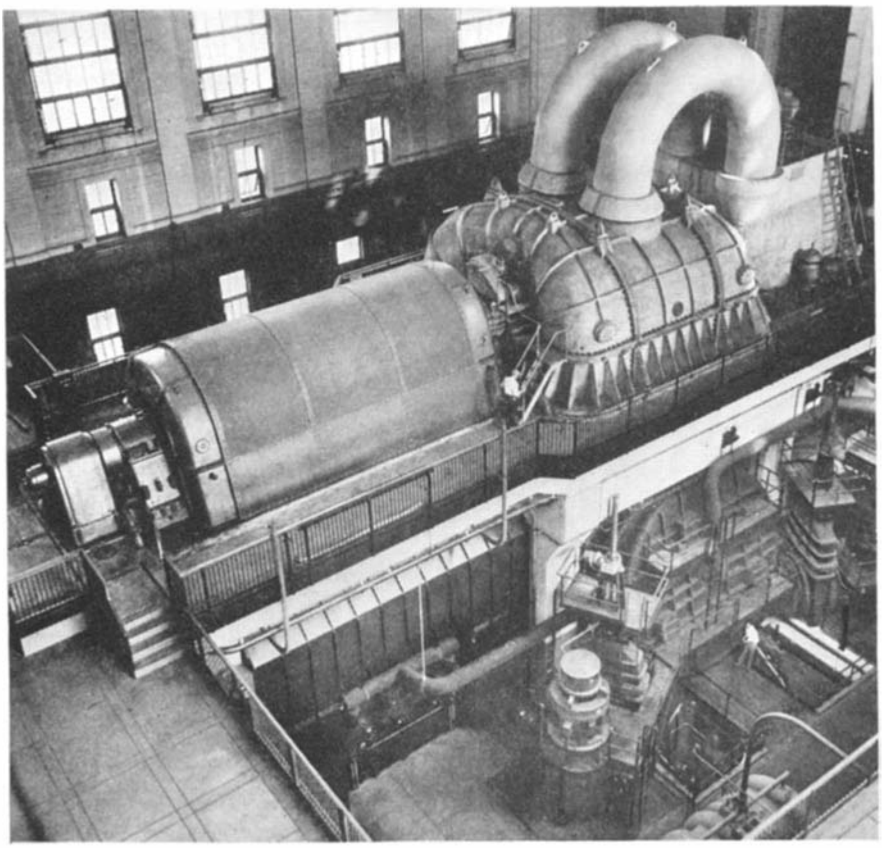
Higher steam temperatures, while reducing moisture content, raise problems of their own. Steam consumption is reduced about 1 percent for every 10 degrees Fahrenheit of superheat, and such reductions are desired; but with the advent of superheat came the phenomenon of "growth," or warping, in the cast iron pipe fittings and turbine casing. Then, as the temperatures were pushed higher, there followed the phenomenon of "creep," which is the tendency of metals to stretch more or less continuously.

Once again metallurgy came to the turbine engineers' assistance. Cast iron was abandoned in favor of alloys containing such metals as molybdenum, which has resistance to corrosion and embrittlement, nickel, and chromium. One of the most satisfactory alloys in use is a chromium-molybdenum-steel.

Metallurgy has played a dominant role in the last 10 years of turbine development and it should be given full credit. Without knowledge of the newer alloys, the present turbine would be impossible. Stability of metals is an essential to proper functioning as one instance alone will show.

Any one conversant with the turbine knows that there must be minute and accurate clearance between blade tips and the rotor housing, because if steam leaks past there will be loss of efficiency. Much has been written about this phase of turbine construction because it rouses a feeling of amazement to think of the blades whirling around at 14 miles a minute with less than a visiting card thickness separating them from the stationary housing; less has been written about what happens if for any reason the clearance is not maintained and there is contact. The older methods of trusting to proper clearance were wholly inadequate when high heat and pressures came in and so there had to come a three-fold solution to the problem—making the blades better, improving the housing casting, both of which have been touched upon, and, finally, in the reaction type of turbine, by increasing the blade clearance and spanning the gaps with strips of stainless steel containing molybdenum, thin enough to wear away without damage if there should be contact.

NEXT to high temperatures in importance as means for achieving greater efficiency, comes feed-water heating by extraction. This practice involves extracting partially expanded



Installation view of a 165,000 kilowatt turbo-generator

steam from various stages of a turbine and condensing it in a series of feed-water heaters. A high thermal efficiency is obtained because the heat of evaporation goes back into the system instead of being lost in the condenser cooling water.

Much of the progress in turbine efficiency has come from developments external to the turbine itself. Electric generator design has been a very important contributor, and so have condensers. Early turbines could not operate at maximum efficiency because rotative speeds were low and these speeds could not be raised until generator capacities at any given speed could be stepped up. While turbine designers were at work on their own problems, the electrical engineer got busy on his and soon generator speeds were raised so that they now meet the turbine on even terms. Higher permissible turbine speeds have enabled the designer to increase velocity ratios (the ratio of blade speed to steam jet speed) from 60 to 85 percent with a consequent decrease in turbine diameters and reduction of leakage and losses.

The condensers used in conjunction with the newest type of turbine may create a vacuum higher than 29 inches, whereas the earlier type was limited to 25 or 26 inches. This marks another important advance in turbine efficiency. Steam in a turbine can be made to expand to any low limit of exhaust pressure and the lower this limit the greater the amount of work obtained from the steam.

Not all turbines make full use of condensers. There are machines in which partial condensing is employed and others where there is no condensing, albeit, in this last group condensation does take place before the steam cycle is completed. Here we refer to the superposition turbine, which represents about 30 percent of current production.

The superposition machine, sometimes called a topping turbine, is designed to exhaust steam at pressures of 200 to 300 pounds per square inch for re-use in existing lower pressure turbines. In practice, the new turbine is placed ahead of an older one, and its purpose is to raise the efficiency of a power plant without scrapping existing equipment. Were it not for the fact that higher initial temperatures are now possible, this rejuvenation could not be accomplished. As it is, engineers are convinced of its practicability, and 1936 might be designated as a superposition year because of the many installations.

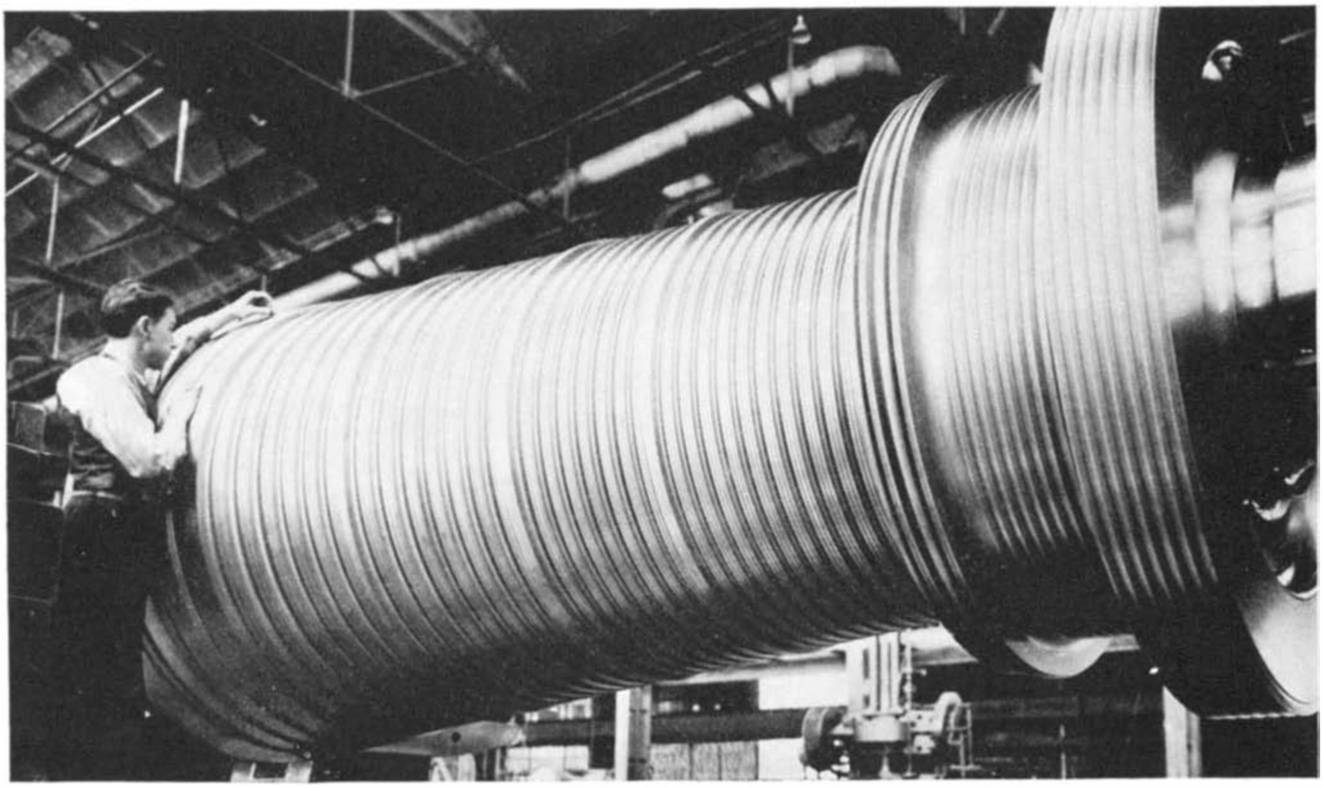
At first thought, the superposition machine might seem a makeshift, but it is not. Extremely reliable and efficient installations can be had by this simple expedient provided the older, low pressure equipment is in good condition. Some designers believe a system which embraces a high pressure unit and a lower pressure one comes near to approximating the ideal.

It is interesting to note that there was a similar practice pursued in 1908. It had to do with using exhaust steam at the low pressure end of the cycle rather than at the high end. The cry was then for equipment to utilize the exhaust steam from reciprocating engines, and to meet this demand low pressure turbines were built. The combination of reciprocating engines and low pressure turbines served to prolong the useful life of the former until inescapable economics forced replacement with more efficient and up-to-date power producing machines.

Turbines which condense only a part of the exhaust steam are those which enter into industrial use as contrasted to central power stations. In this case, a part of the steam is extracted from the turbine for heating or process work incident to manufacturing operations and these latter requirements tend to govern the inlet temperature and pressure of the steam.

If one were to take the significant factors about turbines, such as pressures, temperatures, capacities, and so on, and plot them back to, say, 1900, the graphic presentation would reveal steadily ascending curves for every item save those of weight and kilowatts per pound of fuel consumed. In certain instances there would be sharp upward ascents followed by a leveling off and then another push upward. You couldn't study this picture long without being convinced that turbines had been undergoing long and steady development and the idea might easily be conceived that we are on the eve of another great surge forward. We would then ask: is something new about to break and what about competition from hydro-electric sources and the Diesel engine?

Let us consider competition first and stick to facts that are not controversial.



An unbladed rotor of carbon steel for a 30,000 kilowatt turbine, slotted ready for blades

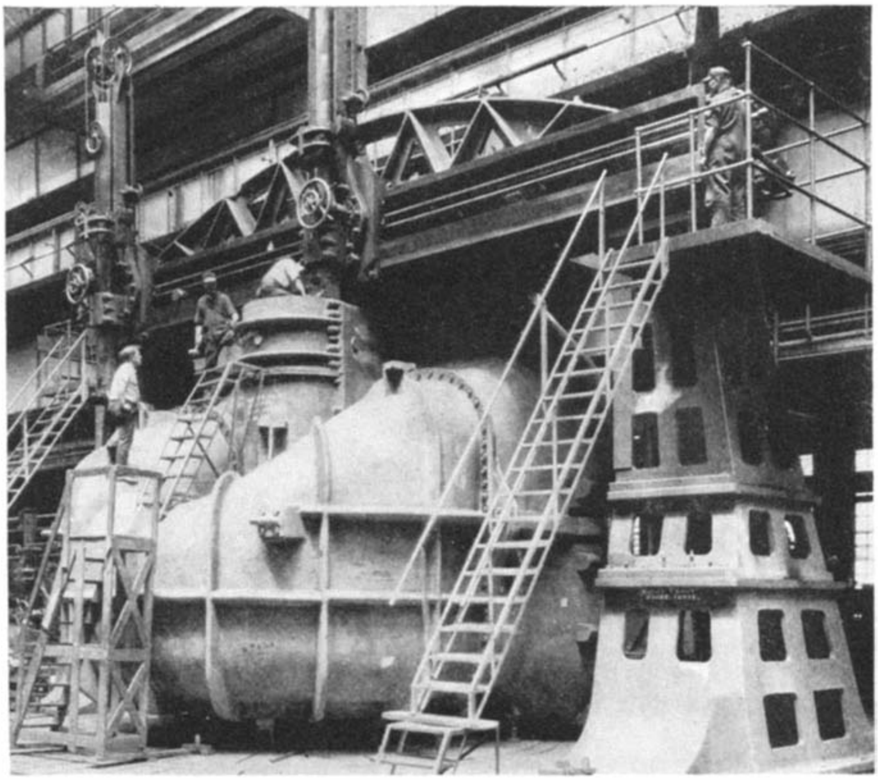
Competition from hydro-electric projects does not offer any serious threat to turbine supremacy when the overall costs of power production are the determining factor. At the moment, water power generation must be subsidized to make it competitive because of the enormous outlay which must precede the first turning of a wheel. Water power is not "something for nothing" as the public is so apt to regard it. A fair estimation of water power cost must include the expenditures made for dams, penstocks, and transmission lines to points of power consumption. Francis Hodgkinson, engineer, whom George Westinghouse brought from England with the first Parsons turbine, has stated that a modern steam power station erected at Niagara Falls, if operated with a good load factor, could probably produce power cheaper than the falls themselves.

THE fact that turbines are the most efficient producers of power does not, of course, eliminate hydro-electric power production from consideration. When one is through arguing the merits and demerits of both systems, the fact remains that water running down hill and doing no work is an economic loss to the community; and, furthermore, coal is a capital resource.

Diesel engines have figured lately in power station news and the proponents of this productive agent foresee further developments of no mean proportions. At the moment, however, Diesels are not headlining mass power production; their forte seems to be as auxiliaries or as boosters for central power stations.

The immediate outlook for development of the turbine promises no such stepping up of temperatures, pressures, and capacities as has been witnessed during the past 15 years. An engine efficiency of 87 percent has been obtained and further operating efficiency is not impossible, but a point of diminishing returns has been reached. The engineer who spends his time designing turbines must keep his eye upon fixed charges quite as much as upon heat efficiency. It has been figured, for example, that a reduction of 10 percent in fuel cost will justify no more than a 7½ percent increase in prime cost.

Perhaps due emphasis can be given to this matter of fixed charges by declaring that a fuelless power station would come up against the obstacle of prime cost. Engineers say that a station using no fuel and having no supervision costs, ideal as it might be, would nevertheless be uneconomical if the prime cost exceeded 160 dollars per kilowatt of capacity. (Present cost is around 100 dollars.) If, at the same time, rates to the consumer had to be dropped, the limit of prime costs would have to be even lower. By so much, therefore, has fuel become secondary to prime costs in the problem of the turbine's future.



Machining a large turbine case casting on a giant lathe

The immediate outlook is for wider use of the superposition turbine because it has proved eminently satisfactory. But industry demands higher pressures and higher temperatures and demands bring action. Improvements are certain to come.

Use of a binary-fluid cycle has been suggested as one method of achieving greater efficiency. This cycle calls for two fluids, one of which will have a temperature at exhaust pressure adequate to evaporate a second fluid. Such cycles are sound and mercury has demonstrated practicability for the higher temperature fluid, but again fixed charges interpose.

Still higher pressures are being projected and there is much promise of success. This calls for a new development in boilers. The existing drum type is inadequate to do the job because of the difficulty of steam and water separation. One suggestion has been to use a boiler in which the water is forced through a continuous tube system to emerge as high-pressure, superheated steam. It is thought that greater safety can be had with this system because it employs small tubes. While no greater temperature or heat would be imparted to the steam, there would be more available energy. A boiler of this type would require a return to re-heating, but since the system promises high thermal efficiencies at practically no increase in prime costs, it affords an attractive problem for engineers to work upon.

Before turbine engineers adopt temperatures higher than 950 degrees, Fahrenheit, some time must elapse for experience to be recorded. As recently as 1931 a temperature of 800 degrees, Fahrenheit, was the maximum employed and not until 1936 did designers venture into the new high range. Turbines are virtually custom made; each one charts a little newer path, and there must be every assurance that improvements will really improve before they are adopted as standard. When a turbine once gets into motion it is expected to stay in continuous motion and give dependable service until inspection time comes around—usually a two-year interval. There can be no time spent in modifying or overhauling it because idleness means loss of revenue.

THERE is much more to steam than James Watt discovered when he observed his mother's tea kettle. The higher ranges of superheat create problems which were unsuspected when turbine engineers began intensive study some 30 years ago. When and if turbines go to much higher pressure and temperature there will be problems of metallurgy again; there may arise difficulties in the lubrication of journals because of the higher heat. There may even be new heat cycles discovered which will raise new problems of their own. Whatever difficulties arise will probably be met, however, because turbine engineers have demonstrated a singular capacity for making this power producer forge steadily ahead.

Photographs courtesy The General Electric Company and Westinghouse Electric and Manufacturing Company.

PEACE-TIME PREPAREDNESS

Every Resource Employed in Modern War . . . "Industrial Mobilization Plan" . . . The Part Played by Radio . . . Army-Amateur Radio System

By GENERAL J. G. HARBORD
Chairman of the Board, Radio Corporation of America
Former Deputy Chief of Staff, United States Army

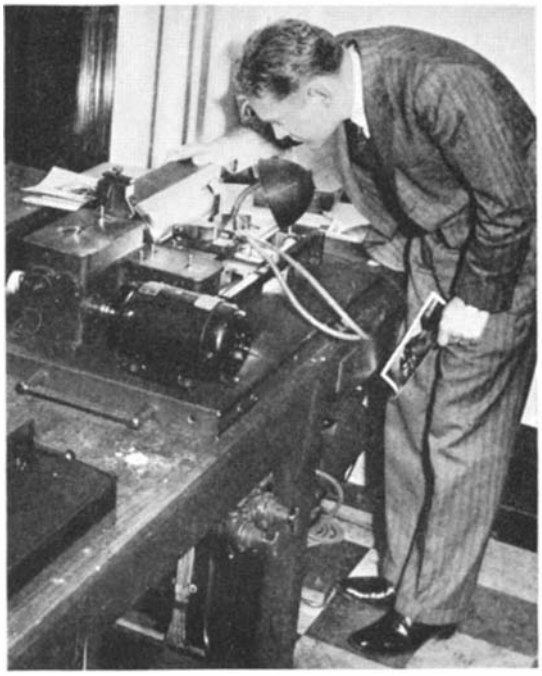
EVERY patriotic American hopes that the United States will never be engaged in another war. Every sensible American, however, looking at the troubled state of Europe today—"a game in which every nation is playing according to its own rules," according to Dorothy Thompson—must refuse to take the ostrich-like attitude that as a nation we are surely done with war forever.

The time is past when wars are fought solely by professional soldiers, or nations defended by "embattled farmers" leaving their fields to seize their squirrel rifles and assemble in the village square. Modern wars are wars of populations in which every industrial and economic resource of a nation is employed.

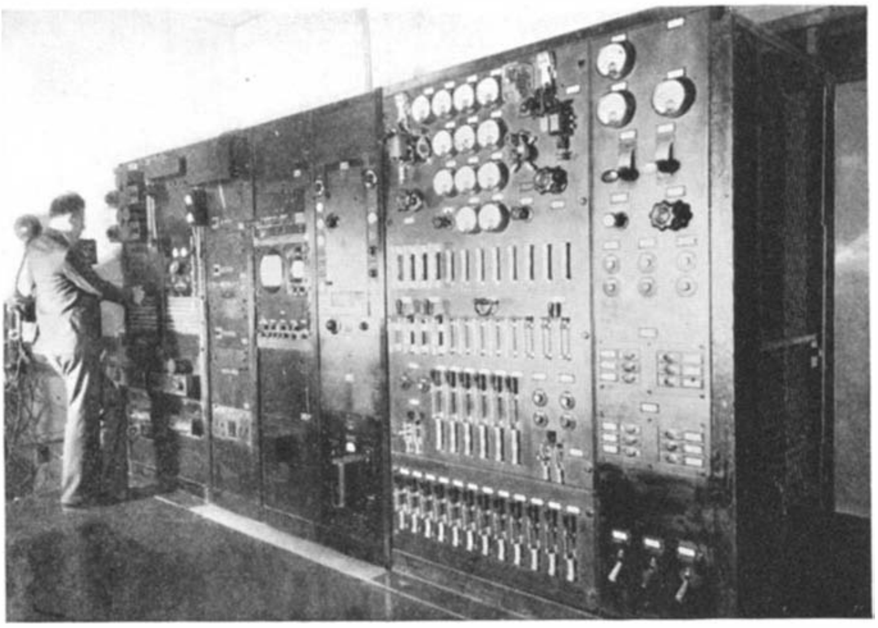
Requirements for national defense fall into three classifications: Trained man-power; munitions and supplies; organization.

The War and Navy Departments have co-operated to prepare a comprehensive "Industrial Mobilization Plan" to insure our industrial preparedness in any possible war emergency. The plan was first announced in 1933 and revised in the autumn of 1936. It establishes a joint Army and Navy Munitions Board to classify and provide for the procurement of the thousands of items of munitions, food, clothing, transport, communication, and other necessities that constitute a national shopping list for war. Huge though the list is, it actually represents an enormous simplification compared with our military inventory of 1917-18. The list of 20 years ago, which comprised approximately 700,000 different articles, is said to have been cut, through scientific planning, to 200,000. Press estimates state that 20,000 factories have been surveyed, of which 12,000 have been selected as potential sources of supply. To describe the war procurement plans of the Army and Navy Munitions Board in all the various fields of American industry would require a book of several volumes. A partial idea of the whole plan may be gained, however, if we take a glimpse at its application to a single industry; for example, that of radio.

Radio was an infant industry when the Armistice was signed. Since then, it has grown to full stature. Feeble radio signals of pre-war days have now been superseded by powerful transoceanic and marine radio-telegraphy linking this nation with every land and with vessels on the farthest of the seven seas. Two thousand and twenty radio stations are now licensed on ships of American registry.



Examining an incoming picture on an RCA facsimile recorder. Military possibilities here



Control panel in NBC's television station in the Empire State Building, New York City. Television developments may play an important part in the next war

Broadcasting was unknown when the World War ended. Today more than 24,000,000 homes and 4,500,000 automobiles in the United States have radio receivers. Six hundred and ninety broadcasting stations compete for attention in this country. Our radio industry sold 8,250,000 radio receivers and 98,000,000 tubes in 1936—receivers and tubes capable of a performance never dreamed of in 1918.

Radio facsimile, practically unknown during the World War, now flashes pictures and maps through the ether and reproduces them exactly, even across oceans. Engineering field tests of tele-

Photos above and below courtesy *All-Wave Radio*

Amateur operators at W8FIC did meritorious work during the last Ohio Valley floods, proving again the value of amateur radio to the country at large

vision are bringing that art closer to introduction as a practical public service. Research in all branches of radio day by day pushes the horizon farther out. Such industrial radio attainments offer military possibilities that did not exist in the dim pre-war days. Radio will be a vital factor in the next war.

The war procurement plans of the Army and the Navy differ in detail, but conform in principle. We can understand the story by following it through in the Army—remembering always that the Navy has a comparable narrative.

After sources of radio equipment have been tentatively selected, the Signal Corps makes detailed surveys. Ownership and management are studied, as well as quality and quantity capacity. Under the Industrial Mobilization Plan the Signal Corps has surveyed approximately 1400 manufacturers of electrical communication equipment—including all principal radio plants—and selected about 400 as sources of supply. The Navy has conducted similar extensive surveys. Data has been obtained not only from individual companies, but also from the Radio Manufacturers' Association.

Part of our "radio reserves": National Guard Station W8MGD, Corp. George Dively at key

Selected manufacturers are requested to sign a statement—though not a contract—expressing willingness in emergency to enter into an agreement with the authorities to produce certain items within a certain time. The procedure culminates in written plans, a separate one for each item, containing concise shipping information.

To avoid the raw-material scramble of the early days of the World War, commodity studies coördinated by the Joint Munitions Board are an important part of Army and Navy Planning. As an illustration of the thoroughness of this phase of our industrial mobilization plans, take what would appear to be a relatively insignificant material—mica. Mica is a "strategic" material, largely imported. Radio tubes, aviation spark plugs, and some ordnance items require it. An officer of the Signal Corps is Chairman of a special Committee on Mica, and the membership includes officers from the Air Corps and Ordnance. It is the function of this committee to be thoroughly familiar with diversified sources of supply outside the United States, with potential new sources within our own borders, with the development of possible substitutes, with our current industrial inventory, and with both our peace-time and war-time requirements. In case of war the committee would be in a position to build up our national stock of mica with a minimum of delay.

In a rapidly developing industry such as radio, with laboratories constantly making new inventions, plans for full industrial preparedness would be lax indeed if they assumed that progress and invention in the industry had ceased, and if they stopped with equipment now available. If in an approaching day television becomes a practical, far-seeing military eye, as well as a keen ear, plans should be ready to take full advantage of the newest developments. Both the Army and the Navy maintain constant liaison with radio's industrial laboratories and with the Radio Manufacturers' Association. Every advance is studied for possible military application.

Radio personnel is really a phase of its industrial mobilization. Quite aside from the supply of excellent apparatus and services which the growth of American radio has created, is the great body of expert technicians. The Naval Communication Reserve and the Signal Corps Reserve are proud of the proportion of men they have who are employed in the radio industry or are outstanding licensed amateurs.

The latest FCC report shows 46,850 licensed radio amateurs in the United States—amateurs whose ability and response to civic duty have become traditional in storm, fire, and high water.

THE Navy, working closely with civilian operators, estimates that in a national disaster it could mobilize a network of 2500 amateur stations within two hours. The Army enlarges its contact through the Army-Amateur Radio System, which includes 1394 operators selected for proficiency. Supervision is exercised by the Chief Signal Officer. Membership is by invitation, without physical examination, pay, or gift of equipment, but with no agreement to serve in war. Members are actuated by eagerness to be ready for disaster relief work, and by their ambition to improve by weekly training in Army methods of operation.

The spirit of civilian radio technicians who are available in case of a national emergency is undoubtedly typical of many thousands of other workers in all branches of American industry.

The United States is a peace-loving nation. If the cruel necessity arises, however, I am confident that we shall be able to demonstrate that love of peace is not necessarily a military handicap. The arts of peace reach their highest perfection when directed by the private initiative of a free people. Those arts, and that initiative—if they can be quickly and efficiently mobilized—should become the most powerful support that any nation in the world is capable of putting behind its armed forces.

As Others Would See Us

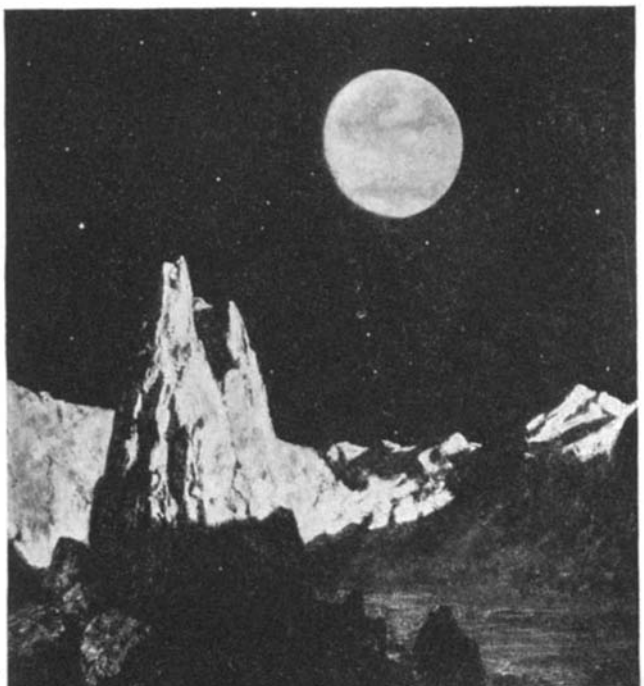
Just as Mars, when Seen from the Earth, is Called the "Ruddy" Planet, so the Earth from Mars or Other Planets Would be Called the "Azure" Object

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society

THOUGH there is little enough reason to suppose that any intelligent life exists on other planets of our system, yet the question how our world would look to the inhabitants of another planet remains a tempting one. Parts of the answer are very simple. It is easy to calculate just how large the earth would look, as viewed from another planet, whether it would appear like a crescent, a half- or a full moon, at any given time, and so on. But it is far from easy to figure out, on general principles, how bright it would appear. Since our atmosphere—alone among the planets—is partly cloudy and partly clear down to the surface, we might expect a reflecting power for sunlight—an albedo, as it is technically called—intermediate between the 10 or 15 percent shown by cloudless or almost cloudless bodies, such as the moon and Mars, and the 50 percent or thereabouts which is found for permanently cloudy surfaces like Jupiter's. We might expect, too, that our clouds, seen from above, would give the earth a whitish color.

We could have no hope of supplementing these theoretical estimates with the more solid evidence of observation, were it not that nature has provided us with a photometric screen, situated in exactly the right place to catch the light reflected by the earth, and send it back to us. This screen, of course, is the moon.



The earth seen from the moon, as painted by Howard Russell Butler, N. A., an artist who investigated the scientific aspects of his work. He shows equatorial clouds, a storm over the North Atlantic and a smaller one west of Africa, also clouds around the poles—the whole *not* "like a map"

LONG before the earliest recorded astronomical observations, alert watchers of the skies must have noticed that the thin crescent of the new moon is attended by a faint luminosity of the rest of the disk—called in our own tongue, by old tradition, "the old moon in the new moon's arms." As soon as it was realized that the earth was a planet and, like the others, must reflect the sun's light, the origin of this faint illumination was obvious. But, for any accurate measures of this earth-light upon the moon, science has had to wait until our own times.

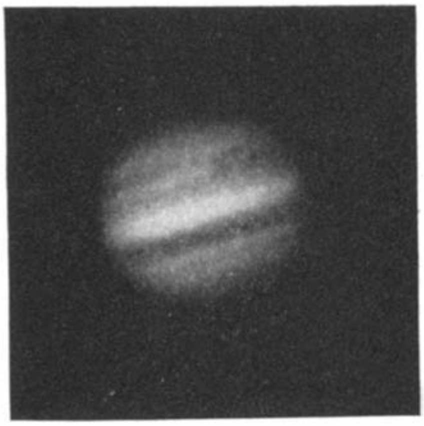
To measure the brightness of this light is by no means easy, for we see it through a foreground of moonlit sky, and allowance for this is hard to make. The first serious attempt is due to an American, F. W. Very, in 1911, but his observations were few and of no high accuracy. For a long series of precise observations, astronomers are indebted to a French astronomer, Dr. Danjon of the Strasbourg Observatory, who has recently published a discussion of ten years' work and established his results on a firm basis.

By an ingenious "cat's eye photometer" of his own design, Danjon secures images, side by side and practically touching, of the bright limb of the moon, lit by the sun, and the faint opposite limb, illuminated by the earth. Adjustment of an aperture of variable area reduces these two images to the same apparent brightness and permits the calculation of their real difference in intensity. A great advantage of this method is that the illuminated sky foreground extends over the whole field of view. So long as it is not so strong as to drown out the faint earthshine altogether, its presence makes little or no difference in the accuracy of the observations, since the image of the bright side of the moon has been reduced instrumentally to the same faintness, and the judgment of the equality of the two faint images is little disturbed by the foreground. Dr. Danjon has also obtained excellent observing conditions by taking his instruments to stations in the south of France, where the skies are notably transparent—especially when the famous wind called the *mistral* blows.

THESE observations give an accurate determination of the relative brightness of the earth-lit and sunlit edges of the moon; but a complication ensues. We are always looking at the earth-lit side right down the path of the rays which light it up; it is fully illuminated. But the sun's rays strike the surface at very different angles. At full moon, they come from behind the earth, and illuminate the moon fully, but near new moon they come, at an oblique angle, from behind the moon, and every roughness on the moon's surface, whether mountain or pebble, has its shadowed side toward us. Though the separate shadows are too small to see, they greatly diminish the average brightness of the surface. This effect has long been known, and its influence on the total brightness of the moon's light determined by observation. But the effect on a particular region near the moon's limb should be different for the average all over its sunlit surface. To make sure of it, Danjon constructed another ingenious photometer, with which he was able to compare directly, during the day time, the brightness of the edge of the moon with that of the sun (cut down by dark glass screens of carefully determined absorbing power).

THE effect of the shadows is very great. Even with the moon only 30 degrees from the full phase, the brightness drops to about half that at the full. At half moon, it is down to a quarter, and, for the new moon 30 degrees from the sun, to 1/15 of the value for full illumination. This helps to explain a familiar fact. The earth-shine is very conspicuous when the moon is a thin crescent, hard to see at half-moon, and visible, at phases beyond, only in a very transparent sky. Part of this effect comes from the fact that the sunlit part of the moon increases in apparent size as the phase advances, another part from the increase, just described, in its surface brightness. But, when this has been allowed for, Danjon's observations show that a large change remains.

The earth-shine at half-moon is only one third as bright as that observed when the thin crescent is 30 degrees from the sun. Extension of the observed curve to exact new moon (when, of course, no observations can be made) shows that, at this time, the earth-shine would be five times brighter than at the half-phase. The reason again is not far to seek. At new moon, the earth, seen from the moon, is at the full phase, at half moon at the half. We should naturally expect its light, reflected to the moon, to be fainter. The difference between the "geometrical expectation" of half-brightness and the observed 20 percent arises largely from oblique illumination of the earth's surface at the half phase, and partly from the effect of shadows cast by clouds, and so on. For the moon the shadow effect is so great that the half-moon is less than 1/10 as bright as the full. The earth's reflecting surface is therefore, on the average, much smoother than the moon's, but not so smooth as that of Venus, which shows a smaller phase effect.



Jupiter, taken by Gustavus Wynne Cook, with a 28½-inch reflector. Jupiter is chronically beclouded

Danjon's final conclusion is that the earth, as seen from the moon, would at the full phase send it 1/9000 part as much light as the sun itself.

From this he finds that the earth, as a whole, reflects 39 percent of the light which falls upon it. This value, as might have been expected, is intermediate between those for the cloudy and cloudless planets. These values hold good for visual light as a whole.

Observations made through glass screens of various colors show that there is less red light in the earth-shine, and more blue light, than in direct sunlight. The albedo of the earth for violet light, such as is effective photographically, appears to be 0.59 and the color index of the reflected light 0.33. This is more than half way from the color of a yellow star like the sun, to that of such a white star as Vega. In comparison with the other planets, even with Venus, the earth would therefore appear quite decidedly blue.

This is not surprising. The blue sky above our heads, if seen from far above the limits of the atmosphere, would look just about as bright, and as blue as it does to us. That is, the molecules of the air, which scatter blue light more than red, do so impartially, upward and downward. This is not a mere prediction of theory. All high-flying aviators are familiar with it—and the writer has not forgotten the look of the world from 14,000 feet on a clear day, with a luminous blue veil over the land, even directly below.

We might expect, too, that the brightness of the earth-light would vary from time to time according as there were more or fewer clouds on the reflecting area. Danjon has confirmed this—finding that the earth-shine is about 30 percent higher in February than in August. On certain days, when the sunlit part of the earth appeared from the moon as a thin crescent, and this region lay over the Atlantic Ocean, the reflected light was much brighter than usual—which may safely be attributed to stormy weather seen from a quarter of a million miles above the storm.

This very complete and satisfactory clearing up of an old problem makes it possible to describe the earth's appearance from the other planets with precision.

From Jupiter, for example, our planet would never appear to be more than 12° from the sun. At elongation it would look like a star of magnitude 1.5—about equal to Castor, and almost as white. It would be hard to see after sunset—at least through an atmosphere like ours—but would be conspicuous when the sun was totally eclipsed by one of Jupiter's satellites.

From Mars the earth would be seen as we see Venus, as a morning or evening star. At elongation, it would look about as bright as Jupiter does to us, and be a conspicuous object—although it would be far inferior to Venus as we see her.

The old moon in the new moon's arms, as photographed by Harold A. Lower. The earth shine or earth-light is clearly reflected from the part not directly illuminated by the sun. The ragged edge of the terminator is caused by the sun's incidence on the lunar mountains

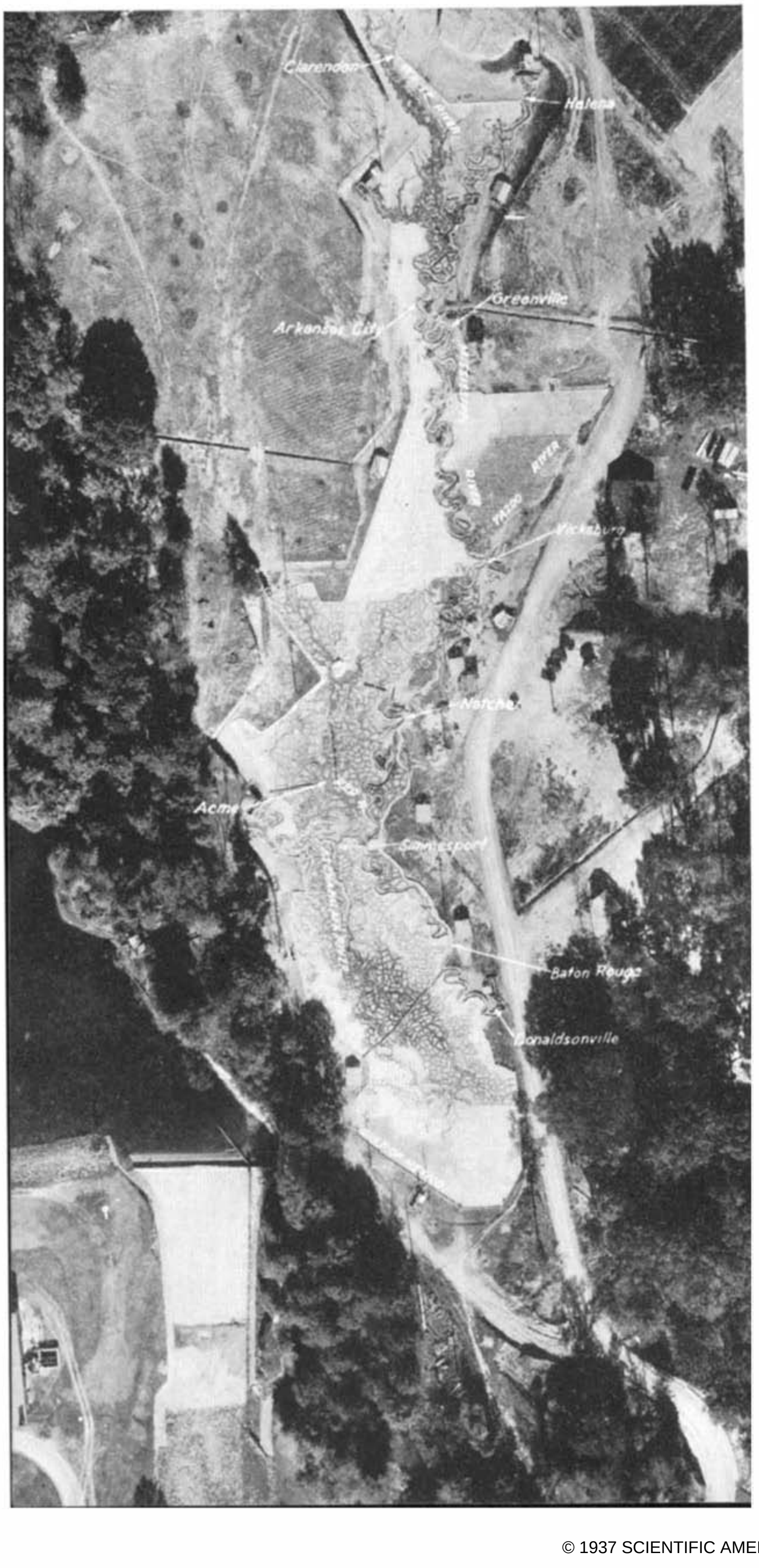
But it is from Venus that the earth would be most impressive. At opposition, it would have the apparent magnitude –6.5; that is, it would appear some six times brighter than Venus at her best does to us. No other planet in our system would be as conspicuous, seen from any other (except from a few asteroids with peculiar orbits). Moreover, the moon at the same time would appear from Venus as bright as Jupiter at his best does to us, and conspicuously yellow, while the earth would be bluish. The maximum distance separating the two bodies would be half a degree, so that they could fairly be described as a "double planet"—as Young suggested many years ago. The motion of the moon about the earth could be followed readily without telescopic aid.

AS the distance increased after opposition, the two brilliant objects would lose in brightness and draw closer together; but, even on the far side of the sun, the moon when farthest from the earth could still be seen separately by eyes like ours.

Could Copernicus—or, for that matter, Ptolemy or Thales—have had such an object lesson before his eyes, human understanding of the heavens would have advanced faster.—*Jamestown, R. I., July 29, 1937.*

Rivers In Exact Miniature

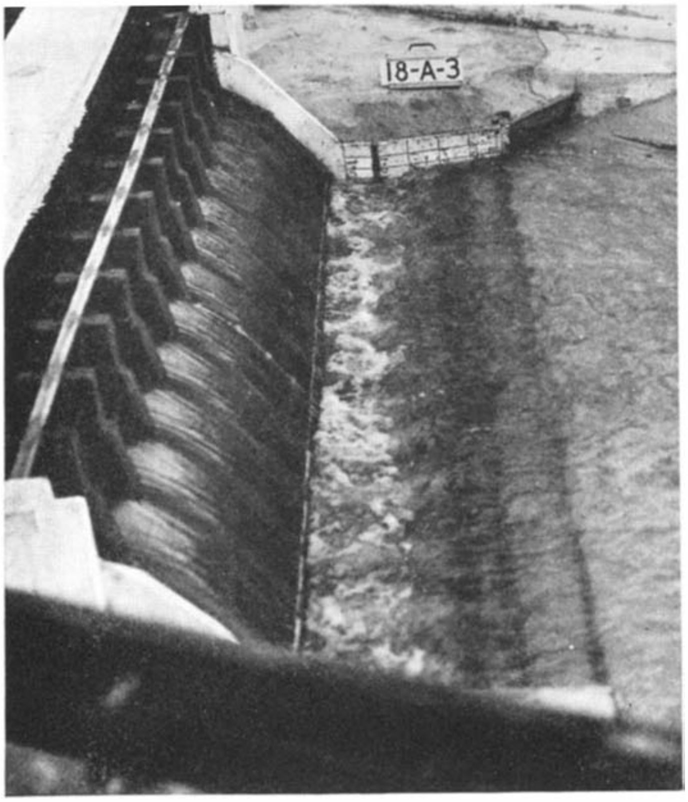
This aerial view of the 1100-foot scale model of the Mississippi strikingly illustrates the magnitude of the project. Location of various cities on the river itself are shown on this view of the model which duplicates every curve and feature of Ol' Man River. The highways and trees help to give a size comparison of the model features



Laborers raise levees along the model river channel. These levees, constructed in concrete, are often molded in removable units for testing various alignments

DOWN in Mississippi, Army engineers are learning many things about waterways in the U. S. Waterways Experiment Station, a federal reservation near Vicksburg containing 245 acres. At this station miniature models of sections of important rivers are constructed, and studied with the purpose of determining the best flood-control measures. To date more than 170 studies of this kind have been conducted on models of such rivers as the Ohio, Missouri, Kansas, and Savannah, and several harbors and tidal estuaries. The model of the Mississippi River at this station is the largest of its kind in the world. It reproduces the entire overflow area of the alluvial plain of the Mississippi south of Helena, Arkansas, and it includes 602 miles of main river, its principal tributaries, backwater areas, and the Atchafalaya Basin, a total area of 16,000 square miles.

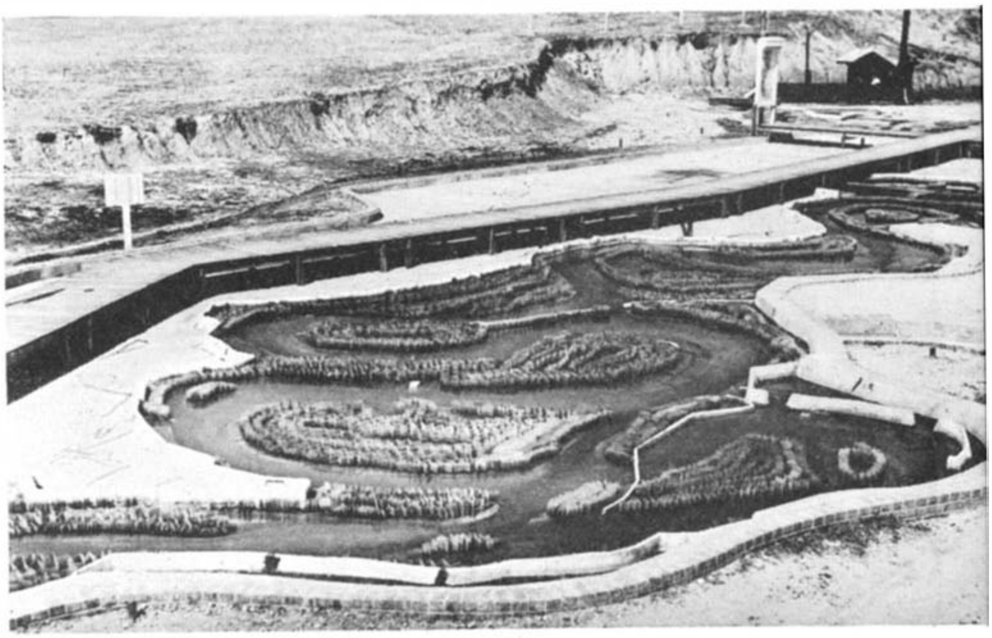
One of the control houses where form, height, and time of travel of flood waves are recorded. A day in nature requires only five minutes 24 seconds of research time in the model



Aerial photographs courtesy U. S. Army Air Corps; others U. S. Army Corps of Engineers

The complete waterways station where from 200 to 400 persons are employed. From 20 to 25 active hydraulic model studies may be carried on simultaneously. Most of the work is done on outdoor models but much is conducted in the main laboratory building at left center of picture near lake from which water for models is pumped. It makes a compact unit

Above: **Use of many dams and spillways on headwaters of the Mississippi may be one means of controlling floods. Hence the engineers study models of such dams and their spillways, a spillway model being shown here**



Right: **Model of a section near Greenville. Wooded areas are simulated with folded wire mesh which offers resistance to water flow like that of trees in nature**

Lower Right: **Tortuous meanderings of the Mississippi during the 1936 high water. Note shortening effected by three cut-offs constructed between curves by the Army engineers**

Below: **The Atchafalaya Basin, looking north, with the Gulf of Mexico in the foreground. This model provides the engineers with data regarding the routing of rushing flood waters through the basin**

RADIUM—
NATURE'S ODDEST CHILD

(*In Four Parts—Part Four*)

Its Place in Medicine . . . Radium Water and Death . . . Behind Modern Atomic Physics Lay Radium . . . Its Uses in Geology . . . Radium in Bed of the Ocean

By JOHN A. MALONEY
The Museum of Science and Industry, Chicago

THE medical profession was quick to realize the possibilities of radium rays in the treatment of cancer and fibroid tumors, tubercular glands of the neck and certain non-malignant conditions. Its place in medicine is assured, and progress in this field will keep pace with the progress made by the chemist and the physicist.

Probably no other subject has such value to the newspapers of our day as that hardy perennial, "Death Caused by Radium." Whether the story emanates from a watch dial factory where deaths have occurred among the workers who paint the luminous figures on the dials, and who take radioactive material into their bodies by pointing the brushes with their lips and tongues; or whether the death occurs from drinking a radioactive water supposed to be a veritable fountain of youth, the amount of public reaction measured in increased circulation for the newspaper makes such a story well loved by the sensation-seeking kind of editor. It is invariably followed by many letters-to-the-editor, written by cranks on both sides of the argument, and these are each time well aired in the public forum until interest begins to lag and the whole case is forgotten. Industry has apparently learned its lesson and helpless women are no longer being allowed to ingest poisonous material in watch dial factories and then spend a few horrible years awaiting sure death.

RECENTLY a well known business executive died and the newspaper reports of his death carried the statement that he had been drinking "radium water" sold in bottles as a commercial product. The daily press immediately swung into action and was followed closely by the "popular" scientific magazines. Invariably the editors will ask medical men for expressions of opinion, and just as invariably the answers will contradict each other. The editors do not realize that the average medical practitioner knows very little about radium.

Since the number of manufacturers offering water, which has supposedly been treated with radium, for sale to the public will increase in direct proportion to the unfortunates who will ever seek a fountain of youth, or until the government prohibits its manufacture and sale, it may be well to state the truth about quack radium devices in the light of common sense and in the opinion of men who have lived their lives with radium. Radium contains one of the most powerful energies known to man, hence it can be either an agent for great good when it is harnessed by the hands of competent specialists, or an agent for awful destruction in the hands of the ignorant.

Photo Associated Screen News, for Eldorado Gold Mines

Barium-radium crystals in a pail, one step in the long process of reducing the extraneous content

Any substance known to contain radium should not be taken into the body through the digestive tract, since it will induce necrosis, or death, of the tissues with which it comes in contact. In treating a patient with radium the physician never allows the radium to come in contact with the tissues, but introduces tubes filled with radium or radon (radium emanation) into the area to be treated and withdraws the tube after a predetermined interval of time.

It is now well known that a part of the dials for watches and other gages, bottled elixirs and the so-called "radium" pads have been treated, not with radium but with the cheaper mesothorium. With radium selling in the world market at somewhere in the vicinity of 30,000 dollars a gram, it can scarcely be expected that the modern descendant of the snake-oil salesman would forego the possibility of doing a little "cutting" and use a less expensive substance than radium. Sometimes, however, good, wholesome, unadulterated tap water has been sold to a gullible public, adorned with a label that explains in great detail its marvelous powers as a remedy for everything from falling hair to falling arches. To the addict who feels that he must have his radium highball or cocktail, let the simple statement suffice that all of the bottled preparations of this kind on the market are either as harmless and ineffectual as ordinary water or else they are highly injurious and dangerous to life itself. There are, however, many excellent natural springs in the world where water that has been irradiated by nature is available. The "radio-pad" is about as energetic as the ordinary watch dial; the fact that these pads shine in the dark is no assurance that they will cure ailments and it is a waste of money to buy them in hope that they will be beneficial. As in the case of the water, if they were strong enough in their radioactivity to affect the body, they would also be strong enough to do untold damage. Beware, therefore, of patented radium preparations, for they fail on every count.

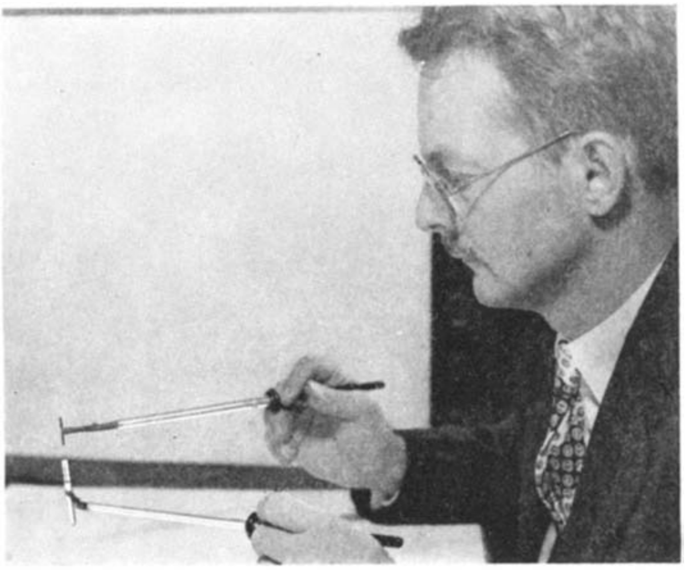
Radium has played a very important rôle in medicine but its influence in changing the course of physics directly, and chemistry indirectly, has been all-important. Viewed with the naked eye, radium is not singular in its appearance, but its radioactivity would have become apparent sooner or later from its effects if the photographic plate incident had not led Becquerel to set Marie Curie to the task of tracing its family tree. So little was known of this new energy source that its action became known as "rays" and, just as Roentgen had called his discovery X rays, so the emanations of radium were temporarily to be known as "alpha," "beta," and "gamma" rays respectively, to distinguish them. Popular usage, rather than logic, often determines such matters and these terms have become so widely used that scientists have never attempted to change them, although subsequent investigation proved that only "gamma" was a ray in the sense that light is spoken of as a ray, and that it alone, of the radium emanations, has a place in the spectrum. The so-called "alpha" and "beta" rays are in reality charged particles.

The "gamma" ray of radium is quite similar to the "X ray" of the cathode-ray tube. Rays of this kind have strange powers. They have been turned on fruit flies and have caused monstrosities to result from their propagation. They have caused grapefruit to flower in five weeks instead of five years. The biologist is beginning to apply the experiments of the physicist and, where the latter batters away at the nucleus of the atom to tear it apart and learn its secrets, the former bombards the genes of living tissue and secures another kind of transmutation. These two sciences have gone on divergent paths, but it is interesting to see that this odd child of nature, radioactivity, may yet bring them together in a common cause.

TALK to a physicist about radioactivity and in a few minutes he will have you talking about atoms, nuclei, electrons, protons, neutrons, and deuterons. To the layman all of this business about atoms sometimes seems most bewildering and he is tempted to give up in despair. It may be well to remember that, until the discovery of radium, the physicist knew about as much concerning the nature of the atom as our friend Democritus, who takes the credit for propounding the atomic theory in the 5th Century B.C. Dalton revived the atomic theory, which had lain dormant for centuries, but his explanations, given at the beginning of the 19th Century, are scarcely recognizable today.

The members of the family of radioactive elements are not social climbers, but rather the opposite. They are constantly degenerating into lower strata of their society and in this act of degenerating they give off energy. Alpha, the first type of energy which is given off, is an atom and, while it is not actually seen in its flight through space, it has been made to tell its story by landing on a substance which scintillates as a result of the impact. Beta, in turn, is an electron—a negatively charged particle which travels at about the speed of light. A thin sheet of paper will stop the alpha particle dead in its tracks, where it gives up the ghost by the simple procedure of turning into helium gas. It takes a few sheets of paper to stop beta. Gamma, which is a true ray, will penetrate solid material in much the same manner as the X ray.

C. T. R. Wilson, an eminent British physicist, was the inventor of an ingenious device, known as the Wilson cloud chamber, which made it possible to study these emanations with comparative ease. Its operation depends upon fundamental principles contained in every high school textbook of physics. Push a piston into a cylinder and you compress the air and heat it at the same time. Wilson reversed this procedure and devised a glass cylinder with a piston that can be pulled out so quickly that a fog of water vapor enshrouds the tell-tale footprints of the rays dashing across the chamber.



Science Service photo

Dr. L. F. Curtiss demonstrating a pair of new forceps used at the National Bureau of Standards for handling radium. Dr. Curtiss designed the forceps, which keep the hands as far removed from the radium as possible, thus preventing injuries

The historian of the next century will write more about our wars on the atom than about our wars with our fellow men. Scarcely an issue of periodicals devoted to science today appears without some news of progress in "bombarding the atom." The poor atom has been set up as a target and the heavy artillery of radiation from a radioactive material or from an artificial generator of radiation begins to hurl projectiles at the nucleus of the atom in an effort to tear it apart. Announcement follows announcement from the physical laboratories of the world, and a friendly race is constantly being run to see who can first succeed in breaking down the last-line trenches of matter itself. A few years ago some scientists predicted that when man succeeded in blowing the atom to bits he would wreck the world. Today nearly all physicists believe that man will never wrest enough atomic energy in this way to keep the whistle of a peanut wagon in operation. Consider that the gunners in this artillery regiment have about only one chance in 10,000,000 of hitting their target and you see why it has taken years to chip off even the outer layers of the atom.

The modern atom dates from Dalton's conception of its nature—a conception that was eminently satisfactory until the year 1897. Since then, styles in atoms have changed with almost the fickle rapidity of Paris fashions. The Dalton atom was altogether too simple to explain radioactivity, X rays, and similar phenomena. Sir Ernest Rutherford proposed the now famous "solar system atom," in which a nucleus is surrounded by revolving electrons, the electrons agreeing with the numerical equivalent of any given element in the table of the elements prepared by Dmitri Ivanovich Mendeléev. (It's a small world, for here we meet this great Russian again, having left him in Part I as he watched Marie Curie in the laboratory. Little did he dream that this blushing girl whom he had complimented was to play such an important part in proving his own theories about the elements.)

The Rutherford atom did very well, also, until the meddling mathematician began to put it to the test that is always the final word in science—the test of measurement. Measurement determines our progress. Lord Kelvin and many other great minds have pointed out that we always make an advance when the mathematician has pushed forward one decimal place. Look over the history of modern science and the truth of that statement will be more forcibly impressed as you turn each page. And so, when the mathematicians proved that electrons, as they revolved, radiated energy and therefore should, in the natural course of events, fall into the nucleus, things began to look bad for Dalton, Rutherford and Company. The universe should have collapsed as soon as it was born, it seemed. But the atom has ever had its own staunch crusaders and Niels Bohr, a Danish pupil of Rutherford's, and, like him, a Nobel prize winner, applied the quantum theory of Max Planck to the Rutherford atom and saved the day. Bohr made the electrons jump from one orbit to another, emitting radiation as they did so. This was the first attempt made by science to explain why light is emitted by atoms in the sun or in a lamp filament, and for that reason alone the Bohr atom was very popular among physicists. Sommerfeld gave elliptical orbits to the Bohr atom and made a few minor changes in its features. At this stage physicist after physicist took hold of the atom and each gave it a new property. The process is still going on, each new foster father leaving to his atomic brain-child a heritage of greater value than his predecessor.

UP to this point this atom business is not very complicated, but it just seems that you cannot let anyone with a flare for mathematics alone with anything very long and come back expecting to find it as simple as it was when you left. The handy man can put two boards together and make a gadget, but the mathematician will start with two theoretical boards on a drafting table, and when he is finished he may have a gadget—but he will have a mathematical treatise about it in addition. And so it was with the atom. Mathematics, in the person of de Broglie, decided that the atom was much too simple and remedied this evil by proving that the electrons were accompanied by waves, and that, although these electrons might well be infinitesimal bits of something or other, they behave as if they were mere wraiths. Thus was born a new branch of physical science known as "wave mechanics"—a branch at once a mathematical paradise for the scientist and the utter despair to the layman. Next comes an Austrian physicist, Schrödinger by name, who improved on de Broglie. He decided that, if the atom seemed to be composed partly of electrons and partly of waves, it might be well to dispose of the electrons and keep the waves. His atom became a nucleus surrounded by a kind of electrical halo—a diffused cloud that completely obliterated the old solar system atom of Rutherford.

The plot continues to thicken with the advent of Heisenberg, a brilliant young mathematical physicist of Germany, upon the cosmic stage. He restored the electron to some of its old glory and declared that the mystery consisted in not being able to determine where the electron was located at any particular time. Its presence could be detected only when it was disturbed, but by the time it is disturbed it is no longer in the same place, so that you cannot identify it from one moment to the next. It was but a step from this conclusion to the conclusion that science would proceed along less stony paths by considering the atom as a statistical average of electrons. In a word, the mathematicians had won the day, leaving the more philosophical scientists to sit back in amazement and murmur, "'Tis a strange world, my masters!" The more we learn the less we know.

Admittedly this is a rather superficial and brief narration of man's attempt to wreck the atom. However, it has a place in this discussion because, until very recently, it was hoped that radium would serve as the dynamite which would blow the atom apart. But the physicist has found it a stubborn tool. Powerless to aim it at a target, he has had to trust to luck, with only varying degrees of success. The time was coming when he could lay aside this unwieldy weapon and substitute for it a man-made bombardment of high-voltage electricity. The nucleus of the atom is walled in by what the scientist calls a "high potential," and only a higher potential can penetrate that wall. Today huge machines have been built with which protons can be shot at atoms at pressures as high as 15,000,000 volts. Some of these electric guns consist of two huge metal spheres in which the experimenters sit, safe from harm. Static electricity is built up in a reservoir about one sphere and when it can hold no more it spills over into the other sphere in a terrific flash of artificial lightning which is directed against the atom. Another apparatus, the cyclotron, has been still more widely used in the bombardment of the atom. All of these works of man came about through the discovery of radium.

A visitor at the Port Hope, Ontario, plant of the Eldorado Gold Mines, inspecting one of the final stages in the refining of radium

The physicist is by no means the only member of the scientific family who has taken a keen interest in this odd stuff called radium. The geologist, too, finds radium helpful in arriving at the solution of some of his problems. First of all, the emission of alpha particles which immediately turn into helium gas has afforded the geologist a rather accurate time-clock for measuring the age of rocks and hence of the earth itself. Minute amounts of helium gas are captured from the disintegration of radium within a rock. The geologist measures this helium and thus computes the time required for its generation from the radioactive material which gave birth to it, and so arrives at a conclusion about the age of the rock itself. It was by this method that Lord Rayleigh determined the age of many rocks and was able to place a lower limit on the age of the earth as not less than 400,000,000 years. This conclusion, in turn, gave the biologist a wider latitude in explaining some of the seeming discrepancies in evolution. The generally accepted figure for the earth's age is now about 2,000,000,000 years.

Again, the discovery of radium has raised another interesting question in geology; namely, what effect does the heat generated by radium have on the interior of the earth? We have recently constructed at the Museum of Science and Industry in Chicago a device known as a pressure box, which is descended from an invention of Professor Bailey Willis, an eminent American geologist now at Stanford University in California. Two steel pistons representing horizontal pressures within the earth, when squeezed together, cause vari-colored layers of wax, representing the various strata within the earth, to simulate in a very realistic manner the folding and faulting of igneous rocks, the formation of mountains and valleys and other phenomena—all in a few seconds—which actually take thousands of years to occur in the earth itself. This same Bailey Willis has done much to bring the problem of the effect of radioactivity on the heat of the earth out of the realm of contradictory theory and conjecture, and to prepare it for the findings that must inevitably come as man's knowledge of the nature and origin of radioactive substances increases.

THERE is a group of American geologists who are devoting much of their lives to furthering our knowledge of this problem, by examining radioactive deposits over the entire earth, laboriously collecting small samples. This is a problem that is integrally connected with the phenomenon of radioactivity. Like the pioneers of the history of radium itself, these men are not satisfied to take the path of least resistance. The romance of radium is not a thing of the past. Our knowledge of this curious substance is still in its infancy and the men who are advancing that knowledge are encountering as many difficulties as those which faced the others. Consider for a moment the work that is being done by such men as Dr. Charles Snowden Piggott of the Geophysical Laboratory of the Carnegie Institution of Washington. We have noted previously that radium occurs throughout the earth's crust and probably throughout its interior as well. Dr. Piggott has examined countless samples of rocks from the eastern coast of North America, from Georgia to Greenland.

Dr. Piggott has found that Stone Mountain in Georgia, for example, projects a mass of rock above the earth which weighs about 500,000,000 tons, and that in this mass there are about 1727 grams of radium. Since radium gives off about 100 calories of heat per gram each hour, the amount of heat that is being generated within Stone Mountain is about 172,780 calories every hour. If the interior of that rock were strung with electric light bulbs, it would take about 3000 of them to generate the same amount of heat per hour as is being generated day in and day out, now and for centuries to come, by the radium in that rock. For the statistician who delights in such figures, Dr. Piggott estimates that a block of granite the size of the Woolworth Building in New York would contain about 15 grams of radium and the pyramid of Cheops about 22 grams.

PERHAPS of more interest to the layman is the work that Dr. Piggott and others have done in determining the radium content of the floor of the ocean. Few such measurements have been made, and only the most general conclusions have been reached about the why and how of these radium deposits. In striking contrast to the ordinary rocks of the earth's surface, the samples from the ocean bed reveal an extraordinarily high concentration of radium—the latter being about ten times as active as the former. One sample was separated by suspension in distilled water and the part which settled to the bottom consisted of coarse skeletal remains, small clay balls resembling excreta, and specks resembling finely ground pepper. Other samples resembled tree rings, with clay separating the deposits of manganese. Just how these ocean sediments acquire their radioactive properties has been the subject of much discussion. The suggestion was first made that the innumerable living organisms which inhabit the sea extract the salts of uranium from the sea water, store them in their tiny skeletons and take them to Davy Jones' locker when death removes them from circulation. To show that this theory is untenable—plausible though it appears on first inspection—Dr. Piggott quotes the findings of Bischof, that an oyster requires the lime from 76,000 times its own weight of sea water, and if the uranium salts from this great quantity of water were stored in the skeleton shell of the oyster, the amount of radioactivity would have to be much more than it actually is. Again, if these skeletons were responsible for radium deposits, other types of sediment on the ocean floor would be free from radioactivity. Yet the red clays, which are largely mineral in their composition, are even more radioactive.

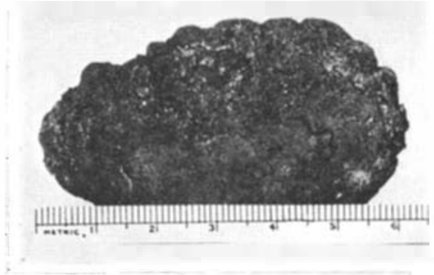
Trace the uranium in sea water back far enough and you will find that it leads you to igneous rocks on the land. The rocks give forth uranium to the water in a form of colloidal solution and, by some mysterious process, it collects in the sediments of the ocean in a form more highly concentrated than in the original rocks from which it sprang. The theory that radium is deposited in the sea by being washed down from the earth's crust and forming what the geologist calls detrital accumulations has also proved untenable, for the nearer one comes to the shore the less radium concentration is apparent, the activity falling off to a point about equal to that of the surface rocks on the shore. Another explanation which has been put forward to show the manner in which this radium gets into these sediments is that it results from a volcanic and hydrolytic action at the point where the molten rock and sea water meet.

Dr. Piggott believes that none of these explanations will prove correct and offers one that, while it must be regarded as theoretical until man bestirs himself to the extent that a representative number of samples of cores can be gathered from the ocean beds and sufficient money and time can be expended for a more thorough examination, certainly has merit as a logical explanation. In a paper which he published in the *American Journal of Science*, he said:

"There are probably several factors aiding in its (uranium's) separation and concentration in those places where it is found to be most abundant. Skeletal remains may take down some; also dust particles of volcanic or other origin absorb some and sweep it to the bottom; but probably the greater proportion comes out as a result of oxidation. Water which is near enough to continents or shallow enough to have sufficient organic material at the bottom to maintain a slightly reducing environment tends to keep its uranium in solution, whereas the very deep bottom waters, far from land, do not contain organic material either washed from the land or as undestroyed organisms. Consequently, they afford an oxidizing environment. That these waters are oxidizing is borne out by the direct measurements of the oxygen content with depth made by the *Carnegie* .... This shows that the environment at the bottom of the ocean is of an oxidizing rather than a reducing nature. In the deeper parts of the ocean where there is little movement, the water at the bottom must be at saturation with respect to the oxides of uranium. There is, therefore, a tendency for them to separate out just as iron and manganese do. Volcanic dust, detrital material, and skeletons of organisms modify the possible concentration by diluting it."

Of all of the 28 samples of ocean sediment which have been examined, 27 have come from the Pacific Ocean. Perhaps tests in the future from the other seas where vulcanism does not run rampant, as it does in the Pacific, may reveal the truth of these conclusions. At all events, man may yet find it more economical to secure his radium from the denizens of the deep than from the deposits which are nearer at hand. Will he dredge the deeps for precious bits of that odd stuff called radium? Who knows? Strange things have happened since radium was discovered. Things stranger still would not be quite unexpected.

(The End)



A magnesium nodule taken from the ocean floor. After it was sawn in two, the sawdust contained one part in 12,000,000,000,000 of radium

©Radium Luminous Materials

An old photograph, showing girl painters applying radium luminous material to the numerals on watch dials. Today this kind of work is handled safely

For Floodless Stores

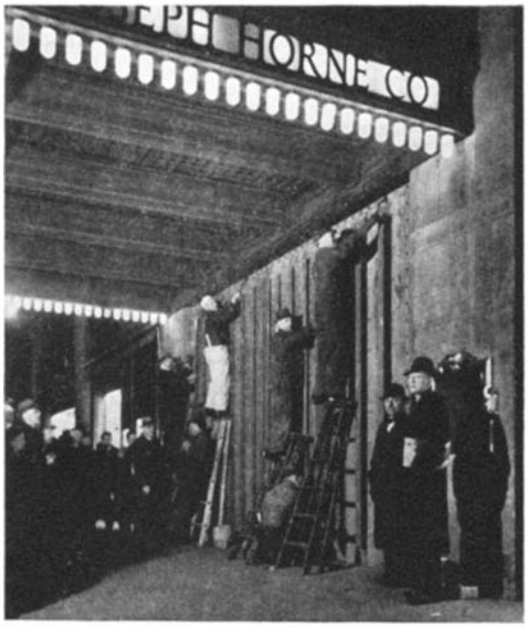
Bulkheads for Stores in Flood Districts . . . Prevent Damage to Valuable Stock . . . Made of Aluminum . . . Swung on Trolleys . . . Quickly Placed

By R. T. GRIEBLING

THE success of any proposal to safeguard large buildings from the ravages of flood waters is assured if it can answer one question affirmatively:

Will it work?

This is the question which bothered Pittsburghers considerably after the St. Patrick's Day flood of 1936. Those who were interested in protecting their buildings from future flood disaster didn't quite know how to go about it. They were familiar with the plans that *didn't* work; now they wanted something better. Whatever that scheme was, it had to be decided upon quickly, because the city records show that past floods have descended upon the Golden Triangle in every month of the year except October.



The Horne flood emergency brigade had a chance to go into action this year. Bolting down the main entrance door bulkheads

Such reasoning was wise, for less than 10 months later the city saw a flood crest of 34.5 feet, and only last April damage to the extent of more than 10,000,000 dollars was done by rivers which rose to 35.1 feet. But quite a number of business concerns were ready.

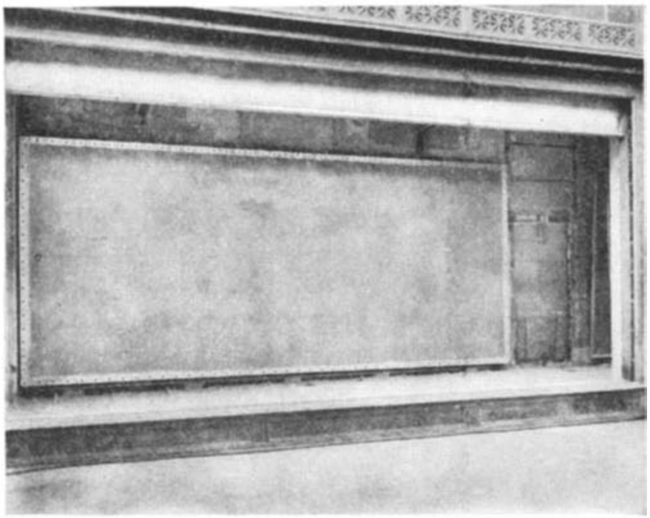
The most obvious thing to do in case of a flood is to place valuables out of reach, either by moving them to a different location or by keeping them at such a height that they are indubitably safe. Since relocation of a city the size of Pittsburgh is out of the question because of prohibitive cost, the next best thing to do was to place the city on stilts wherever possible.

The Farmers Deposit National Bank and the Pitt National Bank took to stilts, the former by constructing a new 300,000-dollar vault on the second floor, 14 feet above the water's 1936 crest; the latter by relocating its vault on the first floor. The old vaults had been in the banks' basements.

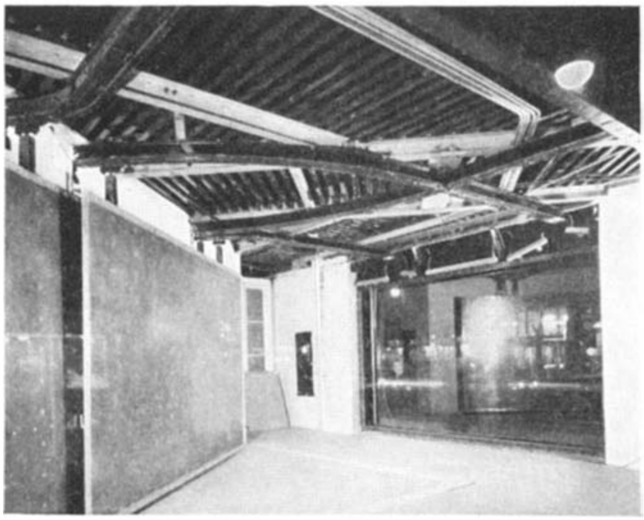
The Weirton Steel Company built a new boiler house higher than the highest stage of water experienced previously, and the correspondence and blue print files of the Westinghouse Electric and Manufacturing Company were moved from the basement to the upper floors. Other concerns took similar measures.

A LEAF was next taken from the book of Portsmouth, Ohio. That city's concrete flood wall has held back much high water, even though it was inadequate last January. The Pennsylvania Railroad built a number of retaining walls along its right-of-way on the Conemaugh River near Johnstown; the West Penn Power Company erected a 215-foot concrete barrier to protect its Springdale plant; and the Aluminum Company of America spent 400,000 dollars for a sea wall 1787-feet long in order to shield its New Kensington works.

But what plan should be adopted when measures such as these are not practical? What, for example, should a department store do—an establishment which depends on its ground floor for its principal display space? It would be folly to


As seen from the street: One of the aluminum bulkheads being swung into place in a window on overhead trolleys

The intricate system of trolley tracks that had to be built to handle the various bulkhead sections in a corner window



abandon this floor and to confine business to the upper stories. Similarly, it would be madness to surround the building with a 10-foot sea wall and thus to exclude the show windows from the view of pedestrians.

The Joseph Horne Company solved this problem in a most satisfactory manner. It devised a way by which the store could be made watertight for a sufficient length of time to enable employes to move all merchandise and fixtures from the basement and first floor to the upper stories. The care with which the Horne plan was conceived and executed prompted the Bell Telephone Company and the Duquesne Light Company to follow suit.

Horne executives are pre-eminently qualified to discuss floods. This large department store has been at its present location in the Golden Triangle for 43 years, and was one of the worst sufferers in the 1907 flood, when the water reached a height of 30 inches on the building's outside walls. Last year the water climbed 91 inches higher. After the 1907 flood. the executives were determined never to suffer such damage again. They ordered the construction of huge steel panels which were to be fitted into windows and doors at the next threat of flood. Calking would make them waterproof, and an elaborate pump and sump system in the sub-basement would take care of seepage.

When these panels were built, two errors in judgment were made, but no one knew about them for 29 years. It took the St. Patrick's Day flood to point them out.

The first concerned the panels, or bulkheads as they are called in engineering parlance. These were stored in the Horne warehouse across the river. When they were finally ordered out, the water was rising so fast that they could not all be brought across in time. Because of this fact, panels that had been erected were perfectly useless.

The second error lay in making the weight of each bulkhead so great that a crew of no less than 15 to 20 men was needed to handle it. Speed of erection was out of the question.

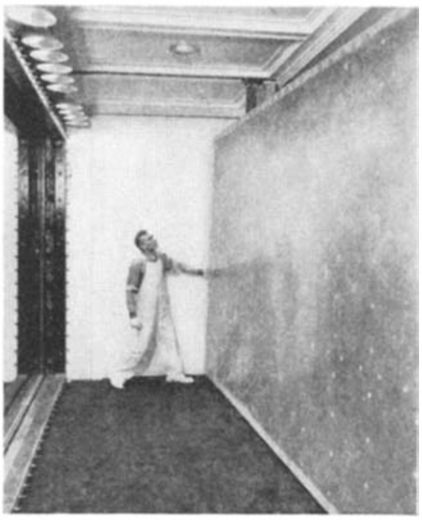
While the idea of having bulkheads was basically sound, the inefficiency of the old bulkheads was amply demonstrated. Horne executives felt that if new ones were to be built, they must be without their predecessors' shortcomings. For one thing, there was to be no more of this business of storing bulkheads in the warehouse and then having the river cover the bridge approaches. The new bulkheads were to be "on location." Secondly, they should be constructed in such a manner that they could be easily handled.

To C. B. Shea, a Horne vice president, goes the credit for first suggesting the ingenious manner in which the bulkheads were finally built. He suggested the hanging of movable partitions at the rear of the show windows, concealed by show window paneling. In time of danger, the paneling would be taken down and the bulkheads rolled forward on trolley tracks toward the windows, where they could be securely bolted down. Small openings between window glass and bulkheads would allow the water to rise inside the space so that outside water pressure would not crush the glass.

In order to lighten their weight as much as possible, the bulkheads were made of aluminum. Only two men are needed to swing each window bulkhead forward smoothly and easily. The entrance door bulkheads are made in sections, each of which can be handled with speed. A crew has been trained to erect the bulkheads in the shortest possible time. A chance to watch the procedure was given to passing Pittsburghers last January, when the Allegheny River, along the left bank of which the store is situated, almost came into the store through the first floor entrances. The bulkheads were in place in short order.

The idea of using flood bulkheads is not new, for most buildings in downtown Pittsburgh have emergency sets, made of some material or other. The real contribution to flood bulkhead architecture and engineering is their fabrication from a light metal. The idea appealed so well to engineers of the Bell Telephone Company that they decided to use aluminum for the bulkheads of the Sterling exchange, where eight feet of water last year succeeded in crippling the branch for months. These bulkheads were not ready for the January flood, but luckily they were not needed, either then or last April. A similar application was made at the 13th Street substation of the Duquesne Light Company, which suffered heavy flood losses last year.

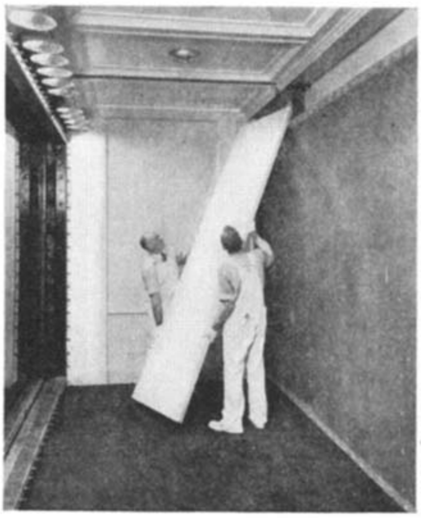
Still another kind of bulkhead is the stationary one, such as the special windows which were installed on the first floor of the *Pittsburgh Press*. These were made of steel, concrete, and thick glass, strong enough to resist the tremendous hydrostatic pressure of a flood.



Photographs Courtesy Aluminum Co. of America

With all obstructions removed, the light metal panel is swung forward

Removing the merchandise from a show window as high water threatens



Decorative paneling, normally secured by dowels, is then taken down

With socket wrenches, a trained crew bolts bulkheads into position

THE MYSTERY OF THE

Why Must Man Have Fifteen Chemical Elements, but Does not Utilize the Other Seventy-seven? Secrets that Nature has Thus Far Withheld from Us

ARSENIC, though highly poisonous to most forms of life, is food for some microbes. Other microbes eat selenium, an element with which the soil sometimes plays Borgia. Thus, quite recently, the selenium present in shale lands of Wyoming and the Dakotas has been shown to be slowly poisoning domestic animals and, in some instances, human beings, causing stunted growth and premature aging. Wheat from this region bears its toxic selenium into other parts of the country.

Here, therefore, are two elements which contribute to the vitality of some live beings and to the early death of others. Indeed, it is one of the great mysteries of bio-science why a living mechanism can use only certain elements, and finds either useless or toxic the rest of the ninety-odd known to chemists. Even an element very closely related chemically to one of the life elements cannot replace it in the architecture or in the bio-chemical activities of a given creature. Iron, indispensable to man's blood, cannot be replaced by the chemically very similar nickel—which is discovered in vital tissues only every now and then, seemingly as a chance ingredient. Perhaps more strangely, a life activity may be undertaken by one element in one organism and by another life element in another organism. For example, in many lower forms, such as lobsters, copper plays the same rôle as iron in human blood; that is, it forms part of a respiratory substance which transports oxygen from the breathing organs to the cells.

IT is remarkable, too, that by sheer chance or by grand design, the abundance of the different elements on the earth's surface is extraordinarily close to the ideal distribution for life's needs. The composition of man is strikingly like that of the waters and the soil out of which he has emerged. The saltness of seawater is so like the saltness of blood that the solutions best adapted for keeping tissues alive in the laboratory are, in every case, but modified seawater. In a real sense, the fluid from an ancient ocean flows through our veins.

Could life have originated on the earth if the distribution of the elements had been far different? Could living creatures have fashioned themselves largely out of arsenic and selenium, for example, instead of phosphorus and sulfur? These are questions which biologists today despair of answering: the secrets of the relationship of the elements to the construction of life's uncountable varieties remain altogether obscure.

Rats used in experiments at the Bureau of Home Economics of the United States Department of Agriculture. Upper rat received adequate phosphorus; lower rat, low phosphorus diet

Much valuable scientific knowledge, however, is steadily being accumulated concerning the life elements in the chemistry of man. These discoveries have come out of the extensive and highly refined researches of nutritional science, and out of the application, to man, of the findings made with domestic and laboratory animals.

Such knowledge has been eminently practical. Goiter, endemic over vast regions, including important sections of this country, is much less common—because the element iodine is being added to water supplies, or to table salt. Once, it was accepted that a mother, at the time of childbirth, must probably lose a tooth or two, and that her child might helplessly be deformed by rickets. Now, thanks to the influence of the newer science of nutrition, the chances are that both obtain adequate calcium and phosphorus, and under the proper conditions for the healthy assimilation of these life elements.

Also, thanks again to nutritional science and its practical use, our population has been able to endure, with an amazing minimum of deficiency diseases, the recent years of economic stress. A balanced diet, with suitable proportions of the life elements and their compounds, had become popular. Thus diminished means were put to increased advantage. Thank science for this gain.

How many chemical elements are required to make a man? At least 15, perhaps more. So, man would perish from the earth if some strange catastrophe were to make any one of at least 15 elements unavailable to his diet. African tribesmen barter cattle and even wives to get the sodium of table salt. And over a great part of interior India, the thyroid gland, overworking because of the drinking water's poverty in iodine, swells to distort the neck. Inland America knows this poverty too: iodine does not travel far from the sea. Hence, mention of such a catastrophe should not seem wholly fantastic.

Since the human body is, of course, largely water—approximately two-thirds water by weight—and since almost all of the myriads of other essential compounds contain them both, the elements hydrogen and oxygen are present in quantity.

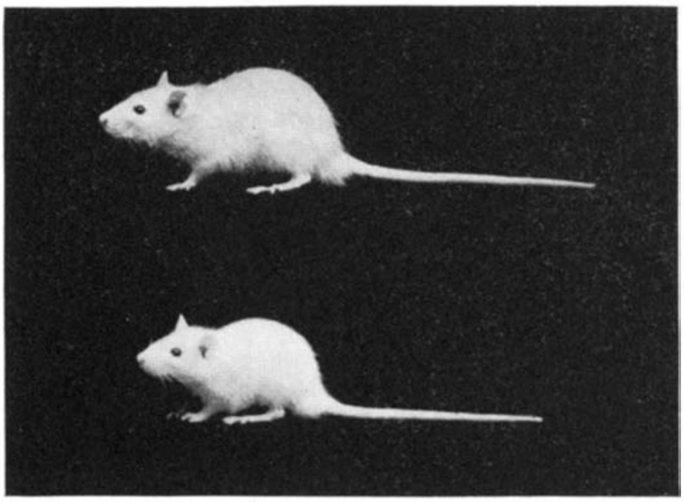
Then, carbon and nitrogen, invaluable for their extreme tendency to form great chains and webs of atoms, must be on hand, that the living structures and the physico-chemical processes may have the molecules without whose high complexity and remarkable delicacy of reaction no life is possible. The elements sulfur and phosphorus also aid in the construction of these huge molecules, which include the proteins—such as hemoglobin, the pigment of red blood cells; casein of milk; and albumin of egg white.

The metallic elements calcium and magnesium are indispensable for the formation of bones and teeth—and, as is less commonly known, are required

Life Elements

By BARCLAY MOON NEWMAN

with two other metals, sodium and potassium, for the normal activity of nerve, brain, and muscle, including the heart—and for the appropriate alkalinity and saltness of the blood and tissue fluids. In fact, these four metals constitute an intricate system of balanced antagonisms. If too much sodium is present, and insufficient calcium, the heart becomes completely relaxed—and ceases beating. If, however, calcium is suitably balanced by sodium, the heart muscle suffers the opposite extreme, that is, becomes completely contracted. Potassium acts similarly to sodium, and magnesium similarly to calcium. Nevertheless, each metal has its precise rôle. Neither is potassium entirely interchangeable with sodium, nor calcium with magnesium. All four must be supplied if the heart is to beat normally—and, in general, if any organ or tissue is to carry on its functions harmoniously.



Other rats used in experiments at the Bureau of Home Economics in Washington. The upper animal received adequate calcium but the lower one was fed on a diet low in calcium

Chlorine is essential to the activity of these four metallic elements, and helps to transport them and to neutralize their electric charges and balance their effects. That is, chlorine gives rise to negative ions, or electrically charged atoms, while the metals give rise to positive ions. Furthermore, this non-metal is a part of many physiologically valuable compounds; with hydrogen, it forms the hydrochloric acid used in the stomach in the digestion of proteins.

Iron is the star of prime magnitude in the protein constellation hemoglobin, which pigment in the red corpuscles carries oxygen from the lungs to the tissues. It also is an atom of certain molecules which take part in oxidation (respiration) within the cells. And it is thought to be a necessary stimulant, or catalyst, for certain intricate bio-chemical reactions.

THESE 12 elements make up over 99 percent of the body, and the whole account of their workings in the apparently infinitely diverse and ineffably elaborate physical chemistry of life may never be set forth. None can be called more important than any other in the making of the living man, because no human life-reaction is possible unless all of them are present in proper proportion and appropriate chemical combination. These are the "Big Twelve."

The remaining three elements are needed in traces alone. And their rôles in the human physiological drama appear to be comparatively restricted. But these special, minor rôles—these apparently insignificant traces—each mean the significant difference between life and death.

Iodine is of irreplaceable value specifically in the synthesis of thyroxin by the thyroid gland. Thus, as a part of the thyroxin molecule, it assists in the regulation of metabolism, or rate of the body's chemical reactions. When the thyroid is producing too little thyroxin, the individual has too low a rate of metabolism, hence suffers from obesity, and physical as well as mental sluggishness. Cretins are dwarfs who are remarkably benefited by the administration of adequate thyroxin.

Manganese, formerly considered merely a fortuitous though constant ingredient of the human body, has recently been proved definitely necessary in reproduction—and, as well, perhaps as a catalyst in certain chemical syntheses which occur within the cells. In the case of rats, upon which animals most of the experimentation has been done, there is a high mortality in the young born from mother rats that have been fed a diet excessively low in content of manganese.

Still more recent researches have shown that copper is, though in the minutest quantities, needed in the making of a man. This element is required to assist in the utilization of iron in the manufacture of hemoglobin. Seemingly, this explains why minute doses of copper compounds are beneficial in certain types of anemia.

Will later investigations demonstrate that the proper formation and healthy operation of the human machine, generation after generation, call for more than these 15 elements already clearly determined to be essential? We can be sure that, if other elements are discovered to be needed, they are needed only in almost immeasurably small amounts—12 elements invariably constitute all but a tiniest fraction of a man.

ANALYSES indicate that, besides these 15 bio-elements, other elements are of constant occurrence within the body. And at one time or another, according to the delicacy of the analysis, almost every one of the known chemical elements has been turned up. Exposure to the hazards of industrial poisoning makes for a host of walking reservoirs of chromium, selenium, tellurium, radium, and many other elements—which nature may not have intended man to lavish upon his system. In fact, probably any one of us could by sufficiently refined technique be found to contain at least a few atoms of every element on the chemist's list.

Cobalt is one of the elements which are invariably present, but which are thought to be adventitious impurities. Now, however, some investigators have come forward with evidence that this element must co-operate with copper and with iron in the normal manufacture of hemoglobin—and for the prevention of anemia, characterized by insufficient hemoglobin.

It is a tremendously difficult task to prepare a diet from which either copper or manganese is absent. Such is also the case with cobalt. Therefore, few persons would seem to be in danger of suffering from cobalt deficiency—should this element actually be indispensable. Of course, it would be possible, however, for cobalt to be present in the diet, though not in a chemical form which the body could use. In addition, it is conceivable that some individuals would be unable to assimilate cobalt as it ordinarily occurs in the food, and would thus require the administration of some special combination of the element.

Zinc also seems to be characteristically a human constituent, and certain authorities point significantly to the increasing realization of the importance of this element in both plant and animal physiology. Many lower organisms make use of it—bread mold, for example.

Strangely, no analysis fails to discover arsenic, and even this violently toxic element has its proponents, however few in number. Yet, every one of even the 15 known human bio-elements is toxic in some special instance or another—such as carbon in carbon monoxide; oxygen in the form of ozone; and especially iodine, manganese, copper, in almost any one of their compounds which are absorbed in more than bare traces.

The case of fluorine is interesting. Once it was believed essential in the formation of the enamel of teeth—although this belief was based solely upon the constant occurrence of fluorine within the body. But now, the prevalence, in 300 areas of 23 states, of mottled teeth—teeth marred with ugly, permanent brown spots—has been proved to be caused by drinking water in which there is as little as one part of fluorine to 1,000,000 of water. Here we have the unusual case of an element formerly thought a life element, now shown harmful—even in quite high dilution.

THIS example serves to bring out the exceedingly great difficulty of researches into the problem of what elements are actually bio-elements but ones needed in excessively small quantity. Discoveries are derived primarily from experiments involving the rationing of animals, chiefly rats—whose nutritional requirements are very like those of man. To prepare synthetic food of definite composition and extreme chemical purity is one really mighty labor. To prevent contamination after preparation is another. Even the walls of the containers yield up impurities whose effects may be disastrous to the investigation. Glass may send forth sodium, potassium, iron, copper, zinc, and perhaps many other elements to the substance within the glass vessel—depending upon the composition of the glass and that of its contents.

Distilled water takes up atoms from the distillation apparatus itself, and from whatever the container used for storage. Contamination is therefore not only a matter of technique, but also of time. The rat cages have to be carefully constructed, of just the appropriate ("safe") materials for the experiments. The rats must be kept from obtaining nutrient substance from the walls of the cages—and from eating one another, or the wastes. Controls have to be maintained, for the sake of comparison, as checks upon the determinations. Finally, the laboratory animals must be bred through generations, since one generation may have a reservoir of a given element, and this supply may conceivably last a lifetime and may even be shared with the offspring. And the symptoms of deficiency may not be observable—an added difficulty—until the store of our given element has been almost entirely depleted.

Photo San-Carlo Studios, New York

Prof. Henry C. Sherman of Columbia University, noted authority on the chemistry of foods and author of "Food Products," "The Chemistry of Food and Nutrition"

Thus it is possible—though not generally accepted as probable—that some hitherto unsuspected element or elements may turn out to play an almost imperceptible part, though a life-giving, absolutely essential part, in man's vital activities. Indeed, in the case of plants, where the experimentation has been far more extensive than with animals (because it is far simpler to work with plants), elements as unfamiliar as boron have of late come to be recognized as bio-elements—irreplaceable in the nutrition of certain crop plants. Now, where plants are being experimentally grown in water culture, and where no soil is used, but instead, coarse, chemically clean sand to which the appropriate salt solutions have been added, as many as 30 different elements have been found simultaneously useful.

Photo Pictures Incorporated

White rats kept in glass "log cabins," used by the Food and Drug Administration in experiments on the tolerance for lead arsenic in spray residues on fruits and vegetables sold in interstate commerce

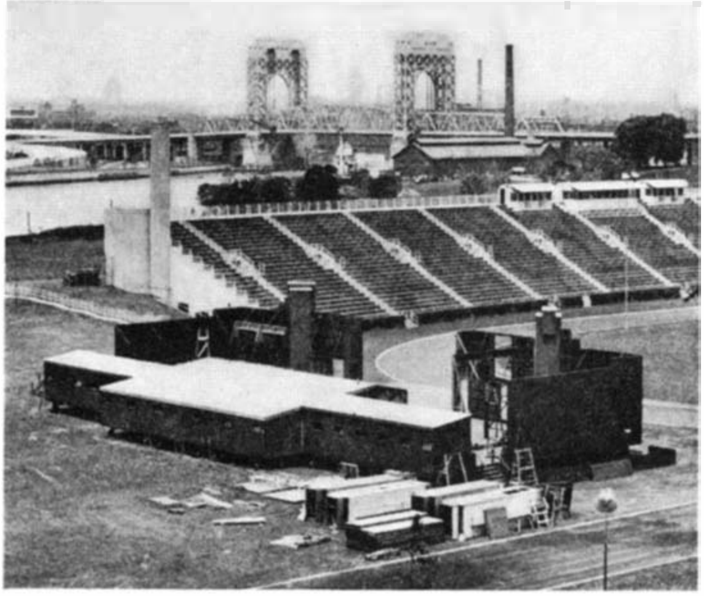
CONSEQUENTLY, we may wonder if man really gets along, with a mere 15 elements, as famously as he might with a number of additional ones. Are there stimulating elements for man as well as for the tomato plant? We must wait upon the rat, the cow, and the pig for the first experimental hints. The fascinating history of the vitamins may be repeated with the chemical elements—part of whose significance may be so slight as to be undiscoverable for generations. Meanwhile, the fact that an ordinary balanced diet contains so many elements, and the fact that it is so difficult to devise a synthetic diet "pure" of unknown "contaminations," may entirely relieve our minds as to the outcome of such research. We may be thankful also that the outcome of such delicate investigations must be afar off—for that means the indefinite postponement of what we used to hear so glibly prophesied: food pills instead of luscious steaks and tasty puddings.

Furthermore, there remains the stupendous problem of isotopes: varieties of the same chemical element, like light and heavy hydrogen. Is heavy water—water made with heavy hydrogen—poisonous? Tadpoles and other lesser organisms succumb to it. Would it be harmful or beneficial to man? What proportion of light and heavy hydrogen in his water and his food is the ideal for health? Such are the intricacies of the human physico-chemical mechanism that many people would be liable to the gravest doubts of our ever being able to answer such questions.

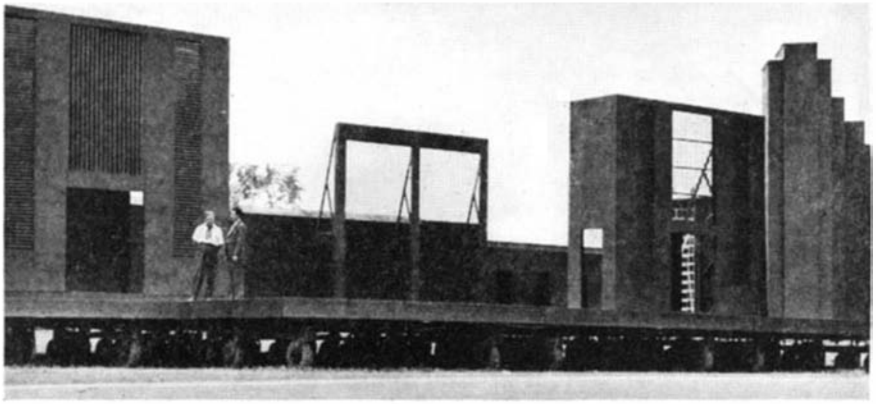
Indeed, the chemistry and physics of earthly man remain on the whole such a baffling mystery that even the biochemist most sanguinely hopeful for his young science must hesitate—unlike a number of organic chemists—before he speculates upon the chemical possibilities of liquid ammonia and ammonia vapor upon the planet Jupiter: and upon the problem of whether or not an ammono instead of an aquo chemistry has given rise to a race of ammono men, inferior or superior to our watery selves.

A STAGE ON WHEELS

A PORTABLE stage that can be moved to the center of a baseball field, for example, used to present a play, and then moved off to the side when not in use, has been built by the New York City Department of Parks and Improvements. The stage is so constructed that it can be taken apart into 53 sections and hauled to any park or playground in the city. Fifty thousand square feet of lumber, it is reported, were required for the construction of this 150-ton stage.

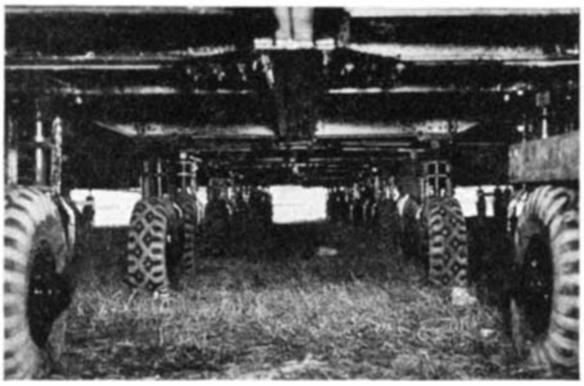


Upper right: **A general view of the portable stage "on the sidelines" at Randall's Island after construction was completed**



Above: **Front of the stage. Note the wheels, which are also shown in the illustration at left, taken with the camera at ground level and pointed lengthwise of the huge stage**

Close-up of the balloon truck tires and the leveling mechanism that makes it possible for the weight of the stage to be evenly distributed on its 224 tires



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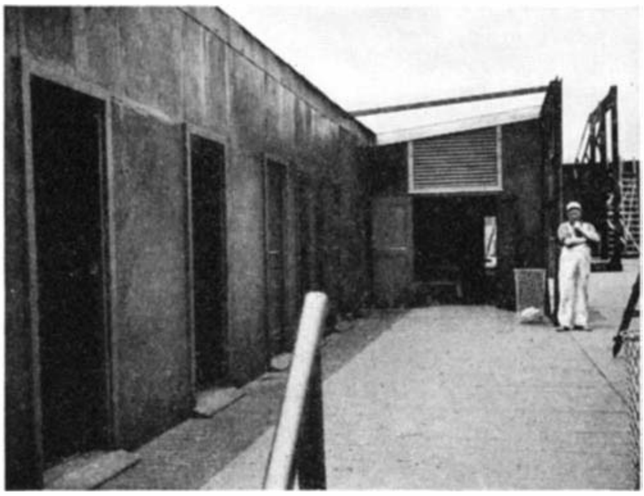
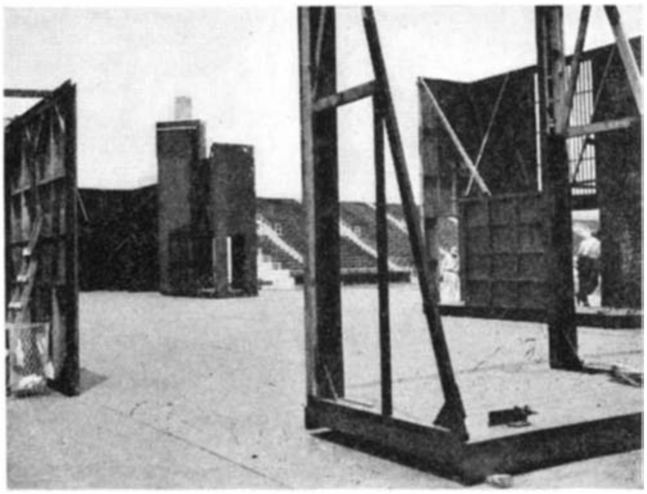
Below: **The dressing rooms back-stage. The composition walls can readily be taken apart and assembled as necessary**



Below: **The side wings. Every part of the stage is so designed that it permits maximum flexibility and portability**



A PURGATION OF PURGATIVES

Laxative Fallacies . . . Most Liberally Purged People on Earth . . . Autointoxication . . . Spastic Colon . . . Irrigation . . . Let Nature Set Her Normal Pace

By T. SWANN HARDING

THINGS have almost reached such a point in these United States of America that it is impossible to look anywhere without seeing an advertisement for a laxative. It is also impossible to listen to the radio more than a few minutes without being implored to attend your bowels. Much of this advertising is disgusting, yet it seems to be effective, for we are the most liberally purged people on the globe.

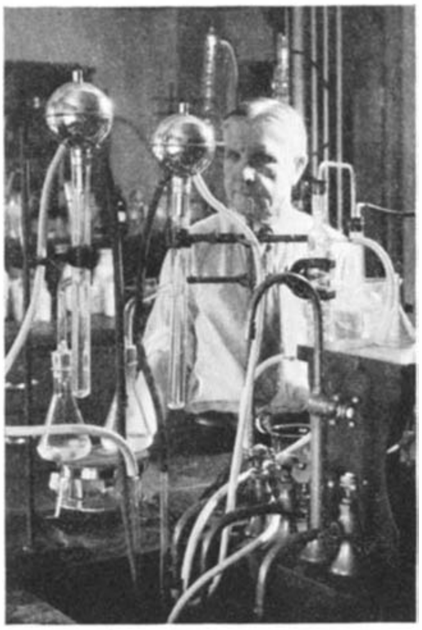
It is often stated that constipation is a relatively new complaint caused by the hurry and pressure of modern life, or by the use of too concentrated foods, or by other dietetic errors. This is to be doubted. For one thing, individuals differ enormously, as Dr. Walter C. Alvarez of Mayo Clinic has shown, in the speed with which nutriment passes through their digestive tracts—those curious tubes around which we each one live.

Many people imagine that they are constipated when they are not at all. They merely have naturally slow intestinal systems. Except for the psychic disturbance they have set up by worrying about their condition, they are absolutely all right, but they can scarcely believe this when advertisers are always dinning into them the necessity for using purgatives.

Furthermore, any who study the old Ebers Papyrus on which is written the medical lore of ancient Egypt, soon discover that constipation is not relatively new but was rampant thousands of years ago. This old record contains formula after formula for the sure cure of constipation, and castor oil enters into most of the formulas. In one case it is the sole constituent of a prescription that doubtless worked. One delightful remedy consisted of half an onion mixed with the broth of beer. It was claimed that this was not only a purgative but would infallibly dismiss all diseases from the body. It was described as "a delightful remedy against death." Today, according to some reports, there are purgatives that can more likely cause death than ward it off.

CONSIDER the coal-tar derivative, the organic substance called phenolphthalein, which is widely used as a self-administered candy or wafer cathartic. The Federal Food and Drug Administration issued a careful warning concerning the use of this drug several years ago, a warning that was repeated and further emphasized in the *Journal of the American Medical Association* (April 29, 1933).

The substance occurs in a large number of laxative preparations, many of which resemble candy, chewing gum, or wafers. Children have even mistakenly eaten these preparations in quantity and to their death. Skin eruptions and other minor symptoms from the use of phenolphthalein are common in medical literature. The drug has a legitimate place in pharmacy when properly prescribed by a physician, but its use in self medication is dangerous, especially when manufacturers urge the repeated and frequent use of their products containing it. There is no excuse for peddling candy and chewing gum laxatives among a race so addicted to cathartics anyway that they imagine that taking a purge does not constitute drugging oneself.



Analyzing remedies at the Federal Food and Drug Administration

The promiscuous use of laxatives is blamed by many physicians for our increased death rate from appendicitis and other abdominal troubles. The first thing the average person does when ill is to take a laxative, but even if the illness is a mere cold or minor infection this may be dangerous. The bowels can not be cleaned out in such manner, nor is it advisable for the patient to weaken his resistance further by purging.

Before the American Medical Association, Dr. John O. Bower of Philadelphia reported that, in a study of appendicitis patients, one in 14 died when they took one laxative; one in seven died if they took more than one laxative; but only one in 80 died when they took no laxative. The variety of laxatives these patients took was almost incredible, 37 of them being listed! About 47 percent of those who were attacked by appendicitis had taken laxatives of one sort or another. What is more, 55 physicians had actually prescribed the laxative in that many cases, and they thus lost four patients. Yet, as early as 400 B.C. the father of medicine, Hippocrates, warned doctors against giving purges in the beginning of "sharp disease" which, from his description, was probably appendicitis!

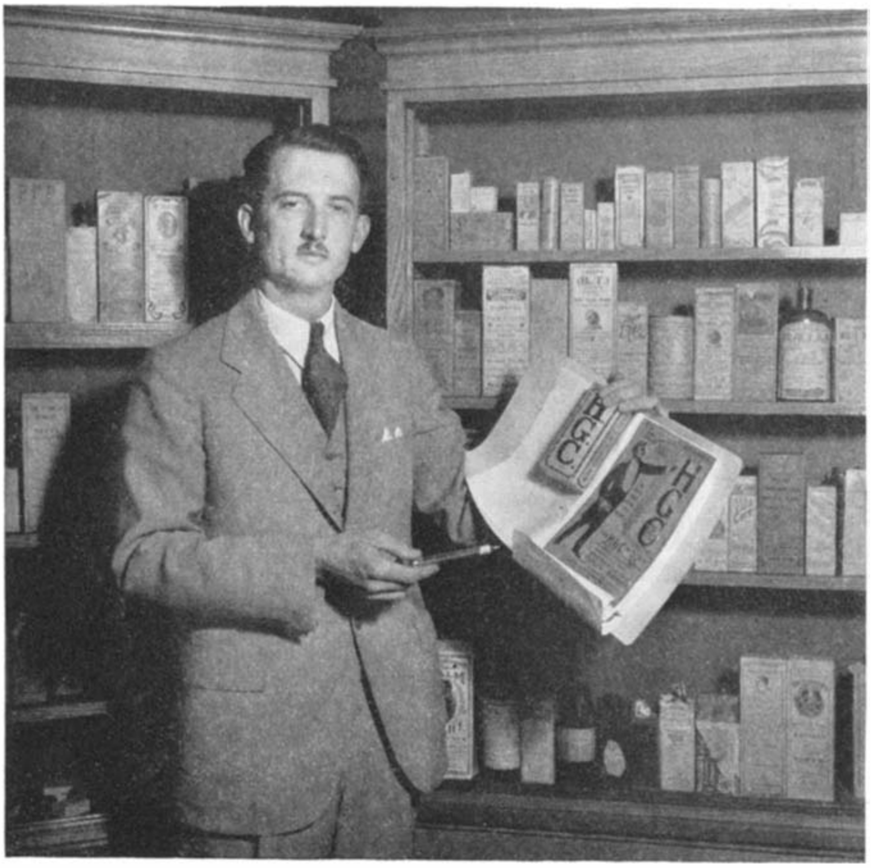
ONE of the things the advertisements teach us to dread is "intestinal toxemia." In its issue for June 22, 1935, the *Journal of the American Medical Association* said, in reply to a doctor's question: "There is no well-defined disease entity of 'intestinal toxemia' or autointoxication. Even the concept of 'biliousness', so definitely and eloquently described by our forefathers in medicine, has been abandoned."

There is no carefully controlled, reliable research work to show that the state of intestinal intoxication ever exists. All sorts of germs flourish in the bowels, and often they are the same in those in health as in those who complain of illness. Constipation rarely if ever produces chemical injury; it can not "poison" us. Even patients with infections get along better without the customary "cleanout."

Neither cathartics nor purges make the colon contents less toxic. High colonic irrigations are usually unnecessary, and may be harmful. They can not possibly render the bowel germ free. They are rarely indicated for use by careful medical men. They can neither change the nature of the bacteria in the intestines nor sensibly reduce their numbers.

In January, 1936, Dr. Frank H. Krusen reviewed colonic irrigation for the Council of Physical Therapy of the American Medical Association, saying that unfortunately the claims of quacks and charlatans were often no more absurd than those made by regular doctors who should know better. He added that there are many opinions about such high colonics, but that they all center around the removal of toxins, clean alimentary tracts, and elimination treatments for a variety of ills. However, such irrigations often do much harm and are seldom resorted to in careful hospital practice. They often cause bad, untoward results, and but four out of 500 patients receive them in a carefully regulated hospital. The famous *streptococcus* is as often contained in the feces if the person is in good health as it is in illness. Antiseptic solutions used in such irrigations are valueless and the lower bowel can not truly be sterilized. Elaborate devices used by most quacks and some others for irrigation are worthless, even though many of them have won U. S. A. patents.

What, then, of that "spastic colon" we hear so much about? There was an article on this subject in the *British Medical Journal* (April 7, 1934). Dr. Thomas Hunt then said that, whereas bowel displacements are often extreme, such organs just as often function as well as "normally" placed bowels. The bacteria in the bowel varies enormously, he pointed out, but offer no clues to assist the doctor, for the healthy have the same bugs as the ill.



George P. Larrick, Chief Inspector of the Food and Drug Administration, with some of the patent medicines that have been put out under misleading labels

NERVOUS factors are most prominent in causing the ills usually attributed to constipation, Dr. Hunt continued, and psychic treatment is usually the best to restore a normal eliminative habit to the bowel. While many take purgatives regularly for years without injury, it is a useless and can be a dangerous procedure. A faithless husband causes worse constipation than hosts of bacteria, and the calm of Marcus Aurelius is better than a dozen colonic baths.

An interesting recent theory is that of Robert and Doyle, published in the *Journal of Nutrition* (May, 1935). These men worked on rats, it is true, but their results are suggestive. When young rats are fed diets low in minerals they have marked intestinal stasis, becoming badly constipated. Rats on high mineral diets do not show this symptom. Vitamin B does not aid the rats on low-mineral diets, but if calcium and potassium carbonates are added to their diets they get relief.

Now, since constipation is most prevalent among civilized peoples who eat minerally deficient foods such as highly processed sugar and white flour, the theory holds that their minerals may be out of kilter. In fact the water in which vegetables are boiled is usually thrown away, the minerals going with it; potassium especially. Perhaps, then, the potassium-to-calcium ratio in the diet is an important factor in preventing constipation, these workers say.

Dr. Irving A. Frisch, New York pediatrician, reassures us still further. He produced artificial constipation in 12 perfectly well and normal children, and in five with fevers, for periods of from 6 to 68 days. He did this by giving them a weak opium tincture. Each child had but one small stool per 11 days, on the average. They continued at their usual habits and diet. They remained happy and comfortable. They had no headache or lassitude. They gained one pound each in weight during the test. Few had pains or discomforts of any sort from accumulated feces, though some did. Their temperature, pulse, red blood count, hemoglobin, white blood count, and urine remained normal and unchanged. Other findings were negative.

These constipated children had no vertigo, frontal headache, neuritis, insomnia, bad dreams, lack of concentration, hysteria, convulsions, fever, furred tongue, bad taste, foul breath, gas, poor appetite, colicky pains, cold extremities, sallow complexions, skin affections, anemia, palpitation of the heart—not one of these hallowed symptoms of constipation that advertisers tell us to watch turned up. So avoid needless cathartics.

Very broadly speaking, the present generation of Americans has been reared in the traditional belief that the bowels must move daily and that, if they do not do so, something is radically wrong. But, strange as it may appear, there are cases recorded in the medical literature where individuals went not only weeks but even months without intestinal evacuation. Stranger still, many of them complained relatively little. Such a condition is not normal but that is not the point. The point is that relative good health may be maintained by individuals who do not by any means follow the daily schedule. On the other hand, increasing constipation and actual ill-health may follow persistent worrying about the intestinal functions and the use of drugs to goad the bowel into action.

JUST as some of us eat rapidly and some slowly, so the intestinal tracts of some of us handle food rapidly and others slowly. If individuals with a naturally slow bowel persist in using cathartics they undermine their own nourishment by ridding themselves of food from which their organs have not yet extracted the nutriment. Many maintain excellent health on three, two, or even one bowel movement weekly. The moral seems to be, let Nature set her own pace, for she usually knows much better what she is about than we do.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

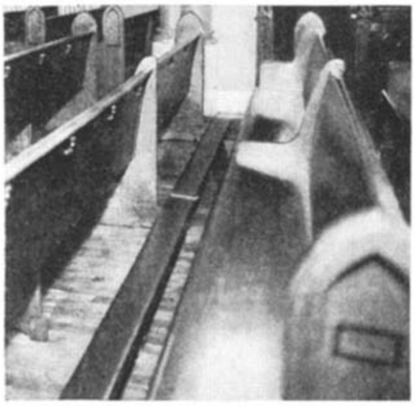
Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER
Chemical Engineer

Comfort to Kneeling Church-Goers

THE latest innovation in modern and comfortable church equipment is a kneeling bench which features sponge rubber upholstery. The bench itself is no different in design from the old bone-bruising type except that it is covered with a one-inch-thick slab of sponge rubber which in turn is covered with leather or high-grade Fabricoid.



Comfort in prayer

Man's Insignificance

DESPITE the activities of civilization and the changes wrought by man in his environment, which to him have seemed colossal, the total effect on nature, according to Robert E. Wilson writing in *Industrial & Engineering Chemistry*, has been negligible. The 50 billion tons of carbon contained in fuels mined during the last 50 years would, on burning, produce approximately 180 billion tons of carbon dioxide. This apparently tremendous quantity might be expected to be sufficient to snuff out most of the animal life in the world, Dr. Wilson says, but actually this stupendous total is so small as compared with the volume of the atmosphere that if all of it were dumped in the air and none removed it would increase its carbon dioxide content from 30 parts per 100,000 to only 32 parts, an insignificant change. The water of the oceans contains some 30 to 40 times as much carbon dioxide as does the atmosphere, and it is the absorbing capacity of the sea which maintains the composition of our atmosphere constant. Since man's inroads into fuel have been greater than any other of his alterations of nature, Dr. Wilson believes man has no right to puff himself up.—*D. H. K.*

Building from the Roof Down

CONCRETE walls that hang clear of the ground, and steel framework that rolls with the wind are embodied in the design of two huge airplane hangars being built on the site of the 1939 Golden Gate International Exposition on San Francisco Bay.

These two hangars, 287 by 335 feet in dimension, ranking among the largest ever constructed, are of three-hinged arch construction designed by Exposition engineers under the supervision of John J. Gould.

Walls are cantilevered outside the lower arch pins, counterbalancing the weight of the roof and reducing arch thrusts to a minimum. With this design, the tension on horizontal ties is computed at 18,000 pounds as against 74,000 pounds without cantilevering the walls. This results in a substantial saving in concrete foundations and steel. At the bottom of the walls, between the wall and the foundation trench, flexible joints of copper sheeting are provided to permit movement due to wind pressure and temperature changes. Flexible joints are also provided at the ridge of the roof.

Main columns of the arches rise from lower hinge pins 6½ inches in diameter and 24 inches long, supported by an all-welded steel base bolted to concrete piers. Foundations for the 10 arches of each hangar are concrete piers 11 feet deep resting upon 70-foot timber piles. Central arches rest upon 18 piles and the two end arches are jointly supported by 45 piles.

The two hangars that have been built from the roof down. See text

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

Hamburger Castles

THOSE white roadside lunch rooms, designed like miniature castles, which specialize in Hamburger sandwiches, have recently been the center of litigation based upon unfair competition. The proprietors of two competing chains of lunch rooms of this character filed cross suits charging that the names, types of buildings, and advertising slogans were so similar as to mislead and deceive the public. The stands of one of the proprietors were known by the name "White Castle" and the slogan was "Buy 'em by the Sack." The stands of the other proprietor were known by the name "White Tower" and the slogan was "Take Home a Bagful." The "White Castle" lunch rooms began business prior to the "White Tower," the former having started in Wichita, Kansas, in 1921, and the latter being organized in Milwaukee, Wisconsin, in 1926. The storm center of the controversy was Detroit, and it appeared that even though the "White Tower" lunch rooms were the last to organize they were the first in the Detroit market. The "White Tower" lunch rooms commenced business in Detroit in 1928, while the "White Castle" lunch rooms entered Detroit in 1929.

It was contended by the proprietor of the "White Tower" lunch rooms that since they were the first to operate in Detroit the "White Castle" lunch rooms should be enjoined at least in that territory. The proprietor of the "White Castle" chain, on the other hand, contended that since the "White Castle" lunch rooms were the first to operate in any territory they were entitled to injunctive relief against the "White Tower" lunch rooms. The court rejected the contention of the proprietor of the "White Tower" lunch rooms and sustained the contention of the proprietor of the "White Castle" chain, granting an injunction against the acts of unfair competition which the proprietor of the "White Castle" chain complained of.

Some very fundamental questions of the law of unfair competition were discussed in this case. Thus, it was contended by the proprietor of the "White Tower" chain that where a second party has innocently adopted a name which has already been used by another and builds up a business in a market remote from that of the first user, the second party may not be restrained in his use of the name in that market. Based upon this principle of law, it was contended that since the "White Tower" lunch rooms were the first to do business in Detroit, their rights, at least in Detroit, were paramount. The court found, in the first place, that the "White Castle" lunch rooms were already known in Detroit at that time, due to the fact that they were located on arterial highways and the general public was familiar with them. The court also rejected the contention that the "White Tower" lunch rooms had innocently adopted their name, slogan, and system of doing business but on the contrary found that the peculiar characteristics of the "White Castle" lunch rooms were deliberately imitated.

Scientific Discoveries

A SCIENTIFIC discovery as distinguished from an invention, generally speaking, is not patentable. Thus, where a scientist, as a result of research, discovers the scientific explanation of certain natural phenomena, he cannot protect his discovery by means of a patent. In a recent case before the United States Court of Customs and Patent Appeals involving a patent application on a motor fuel and the process for making the same, the Court found that the applicant for the patent had merely discovered the explanation for certain natural reactions, and sustained the refusal of the Examiner to grant a patent. The Court stated:

"As a result of the researches of the applicant, an explanation has been made of certain natural reactions which have been known to the art to occur, but which were imperfectly understood. This does not, however, amount to invention."

Alien Enemy

THE patent laws provide that a patent cannot be obtained on an invention which has been in public use in the United States more than two years prior to the filing of a patent application. A patent which is granted on an invention which has been in public use for more than two years in the United States is invalid.

In a recent case a patentee claimed exemption from this provision of the patent laws on a rather novel theory. The patentee found himself between the horns of a dilemma. He had brought a suit charging patent infringement and the defendant in the suit claimed that the patent was invalid because of an earlier patent disclosing the same invention. The patentee then introduced evidence purporting to show that he actually made the invention prior to the earlier patent and his evidence made it appear that he had placed the invention in public use more than two years prior to the filing of his application. The patentee sought to avoid the provisions of the statute referred to above by stating that he was an alien enemy of the country at the time and that his delay should be excused. Since the statute makes no exceptions the court rejected the patentee's contention, stating:

"The plaintiff also seems to have in mind that some of his own difficulties might change the law in that regard and let him wait more than the two years. He mentions in that connection that he was in law an alien enemy of the country, and that this explains in some way his delay.*** I don't know of anything in the law that would treat those things as excuses or justification for any setting aside of the two-year rule."

Restricted Name

WE pointed out on this page in the February, 1937, issue of Scientific American, under the heading "Whose Name?", that your right to use your own name in business is not free from restrictions where there is danger of confusion between your name and a competitor of the same name who had used his name in his business at an earlier date. Under the restrictions imposed by this principle of the law of unfair competition an individual may use his name in business in one neighborhood and may be barred from using it in another neighborhood. Thus, in a recent case in New York a woman was engaged in the millinery business on Broadway. Another woman bearing the same surname subsequently opened a millinery store in the same neighborhood. The newcomer was enjoined by the court from using her name in connection with the retail millinery business on Broadway in New York City between 80th and 102nd Streets.

Foreign Patents

A DISTINGUISHED correspondent from abroad has sent us a suggestion which we think is worthy of the serious consideration of our readers.

The patent laws of many foreign countries contain so-called "working" requirements. Under these requirements it is necessary for a patentee to manufacture the patented device in the country in which the patent is granted, within a period of two or three years. Failure to comply with the working requirements might result either in the cancellation of the patent or the granting of a compulsory license for the manufacture of the device.

It will be readily appreciated that where a manufacturer has obtained a patent in a foreign country having a very small population it would be impractical, due to the limited size of the market, to establish a factory for the purpose of manufacturing the patented device in that country. In many instances the principal advantage received by an American manufacturer from foreign patents is found in the enlarged protected market which he obtains for the patented products of his American factory. If under the working provisions of foreign patent laws he is deprived of the enlarged protected market, the advantage obtained from the foreign patent is destroyed.

Our correspondent has suggested that by treaty between the United States and those countries having working requirements, American citizens could be protected by providing that manufacturing in the United States within the prescribed time was sufficient compliance with the working requirements. That such a treaty is practical is evidenced by the fact that one already exists between the United States and Germany.

Books SELECTED BY THE EDITORS

EVERY MAN A MILLIONAIRE

By David Dunham

A GENIUS (or a crazy man) by the name of David Dunham is the hero of this crazy-quilt of inventions which revolutionize the entire world and give to David Dunham dividends amounting to a great many billions of dollars per year. David Dunham serves an ultimatum on Europe that if the second World War is not immediately stopped and seven billion dollars paid to the United States, the United States will forthwith use David Dunham's scheme of diverting the Gulf Stream so that Europe will freeze. David Dunham invents a new rotary razor, the touch of which feels so much like velvet on the face that men begin shaving three or four times a day, and all wars are immediately forgotten, for men have no time to stop the pleasure of shaving for such petty things as wars. Men use hair tonic on their faces so that they may shave oftener! David Dunham builds, in the Sahara, high towers which become snow-capped like mountains, cool the atmosphere, and do a lot of other things meteorologically, so that the desert is made to bloom and David Dunham takes a mere 64 billion dollars profit per year from the scheme. David Dunham has, in fact, written in this small volume of just under 100 pages, the details of 37 gigantic David Dunham schemes, developed by David Dunham to make a David Dunham world scientifically most perfect and financially most profitable to David Dunham. In fact, we believe that David Dunham likes David Dunham in this David Dunham balloon trip in the mathematical stratosphere of social relations.—$1.10 postpaid.—*F. D. M.*

SHADOW ON THE LAND

By Thomas Parran, M. D.

SYPHILIS is the "shadow" on our land, and the nation's people have this disease on its list as the enemy in the next great battle to be fought by the aid of science. Preparation for the fight has consisted of first making the nation conscious of the need for such a fight. The first objective—breaking down the old prudishness which was preventing public discussion—fell more quickly than was hoped: it was found that the anticipated objection to the public discussion of syphilis did not materialize. Now it is being publicized and talked about nearly everywhere. In this book, the Surgeon General of the United States tells what syphilis is and how it behaves, but his book is mainly a non-technical and readable discussion, not of the disease from a medical point of view but as a public health problem. It contains just the information intelligent persons would be likely to ask for about existing conditions in our nation, both among whites and negroes, what Scandinavia, England, and Europe have accomplished, the platform for action, and other pertinent matter of general significance.—$2.65 postpaid.—*A. G. I.*

SOUND WAVES—THEIR SHAPE AND SPEED

By Dayton C. Miller, Prof. of Physics, Case School of Applied Science

PART I of this book contains an account of researches with an apparatus for recording sound waves, on the shapes of such waves, and a chapter on photographing bullets in flight by means of electric spark photography. Part II describes wartime research at Sandy Hook Proving Ground on pressure effects of air near large guns in action, the wave form of the sounds from large guns, and the propagation of sound waves from the muzzles of large guns; also the determination of the velocity of sound. The treatment is semi-popular. The author is a leading and noted authority on sound.—$2.90 postpaid.—*A. G. I.*

THE CANNING PRACTICAL HANDBOOK ON ELECTRO-PLATING

PRACTICAL workers will find this volume complete in every detail of electro-plating from the preparation of the work to the finished job. It includes information on plating with the commoner metals and most of the precious metals, and gives information on lacquer finishes, enamelling, and so on.—$2.65 postpaid.—*F. D. M.*

WORKING WITH TOOLS FOR FUN AND PROFIT

By A. Frederick Collins

SUPPOSE that you had never before seen a hammer, a saw, or a plane: you could read the present book and straight away go to work on making simple things out of wood. The author takes for granted no previous knowledge of wood-working tools and has accordingly started from scratch. His descriptions are clear, simple, and concise, and are helpfully illustrated with a large number of drawings. This is a book that will be welcomed by many a growing boy; it will be equally welcomed by the man who wants to do things around the home, yet lacks the fundamental knowledge that smooths the way.—$2.15 postpaid.—*A. P. P.*

A STORY OUTLINE OF EVOLUTION

By Charles W. Grimes

A SIMPLE, direct, non-illustrated presentation of evolution, written by a Tulsa, Oklahoma, lawyer who has obviously studied his subject a great deal. Part I deals with cultural evolution—morals, writing, art, music and so on; Part II with organic evolution. The book is pervaded with theism and a teleological point of view, and is in part inspirational.—$2.15 postpaid.—*A. G. I.*

COMPOSITION FOR PHOTOGRAPHERS

By Richard N. Haile

BY reducing the elements of composition to tone, line, and the "frame," it is possible to produce perfectly composed photographs with a minimum of effort and trial. The "frame," incidentally, refers to picture space limited by the borders of the photograph itself—that is, the rectangle or containing shape. Based upon the above elements, the present book gives the amateur photographer all he needs to know about good composition—if he is willing to use his eyes in translating to the photographic negative the knowledge gained by reading.—$3.65 postpaid.—*A. P. P.*

THE MAKING AND MOULDING OF PLASTICS

By L. M. T. Bell, Lecturer in Plastics, Borough Polytechnic, London

WITH plastics daily finding new uses in all manner of commercial products, this is indeed a most important study for it gives the history, the present-day essentials, and the probable future developments of plastic molding. For the benefit of the more advanced chemists, the field of study in this book has been exended to include discussions of the processes of resinification, and information is provided that will be of value to those with considerable experience in plastics. Much information is provided that has hitherto not been disclosed in any literature.—$5.20 postpaid.—*F. D. M.*

CULTURE METHODS FOR INVERTEBRATE ANIMALS

By Galtsoff, Lutz, Welch, Needham, and dozens of other specialists

A 590-page book containing the experience of scientists who are expert in rearing protozoans, hydrozoans, trematode worms, rotifers, bryozoans, spiders, insects, snails, and a host of other invertebrates for studies that require a continuous supply, as in teaching or research in genetics, parisitology, zoology, entomology, and so on; also in aviaries, aquaria, and fish culture stations. A thoroughly practical compendium, chock full of specific directions and recipes.—$4.20 postpaid.—*A. G. I.*

THE DAILY NEWSPAPER IN AMERICA

By Alfred M. Lee

IN the space of 797 compact text pages is carefully traced the influence of the newspaper on American life. The history of newspapers serves as a foundation upon which is built a solid structure of fact. Here the student of sociology will find much of value; the general reader will, if he can concentrate long enough, absorb a vast amount of information regarding newspapers—what they stand for, how and why they are edited, and how and why certain newspapers can and do wield such a strong influence in their own localities.—$4.95 postpaid.—*A. P. P.*

DIESEL HANDBOOK (Fourth Edition)

By Julius Rosbloom

TO those who know their Diesels, it is only necessary to mention that this is the fourth edition of a practical book of instruction for engineers and students on modern Diesel engineering for all types of installations. It is officially endorsed by engineering organizations.—$5.25 postpaid—*F. D. M.*

EVERYDAY FIRST AID

By Walter Frank Cobb, M. D.

ONE neither looks for trouble nor anticipates it. It is important, however, that everyone know the simplest first aid measures to take when an accident happens. If such a book as this is read beforehand, one can be surer of doing the right thing at the right time. After the accident has happened, there is usually too much frantic haste, too much excitement for anyone but the man with the coolest head to do the things which will help the victim before the doctor arrives. Dr. Cobb's book can be highly recommended for this reason as it covers with text and pictures the thing to be done in case of all types of accidents such as broken bones, cuts, drownings, poisonings, and electrocutions.—$1.65 postpaid.—*F. D. M.*

THE LITTLE THINGS IN LIFE

By Barnett Sure, Ph.D., Prof. Agricultural Chemistry, University of Arkansas

VITAMINS, hormones, and other minute essentials for health are the "little things" concerning which this well known scientist tells the story in non-technical language. Vitamins in connection with dental disorders, colds, and other ailments, infant nutrition and foodstuffs, together with discussions of minerals, anemia and goiter, foods, hay-fever and asthma, ferments and indigestion, give the scope of this book which presents a review of the work done by science up to today.—$2.65 postpaid.—*A. G. I.*

THE TRAILER FOR PLEASURE AND BUSINESS

By W. A. Kimball and W. L. Larned

TRAILER travelers, still increasing apace, may be divided into two general groups: those who use a trailer for vacationing, and those who use it as a perambulating office or showroom. The authors had both of these groups in mind in preparing the present book and they have done much to smooth the way for them if they will but read and profit thereby. The book is crammed with practical advice on the selection of the trailer, its equipment, operation, and upkeep. 236 pages, well illustrated.—$2.65 postpaid.—*A. P. P.*

LIFE AND DEATH

By Andrea Majocchi

THE autobiography, vivid and dramatic, of Italy's foremost surgeon. Despite one fault—the author's excessive self-esteem even for an autobiography—this account is difficult to put down before about 2 A.M. with the reading of its last line. It gives, in addition to a well-told, lively narrative of emergency calls to rich and poor, in palaces and reeking slums and houses of prostitution of Milan, an insight into the workings of a physician's mind, which is seldom so frankly revealed to the layman as here.—$2.90 postpaid.—*A. G. I.*