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SEE CAPTION PAGE 1

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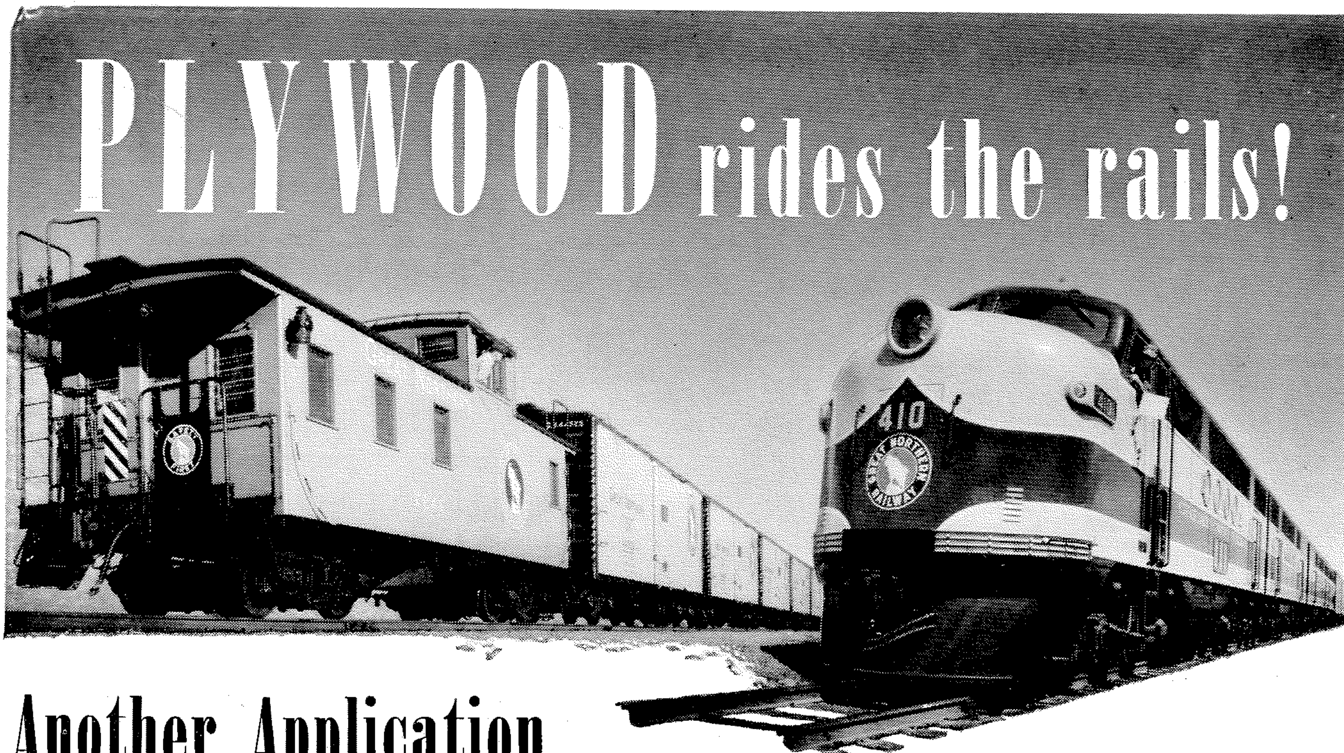

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BY-LINES

WILLIAM DOUGLAS SELLERS

Mr. Sellers was graduated from California Institute of Technology in 1925, studied law at George Washington University and De Pauw University. He holds degrees of Bachelor of Science in Electrical Engineering, Master of Patent Law and Doctor of Jurisprudence. He is now engaged in the field of patent law with the Hoover Company of Chicago, Illinois.

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Dr. Brighouse received his B.S. in 1930 and M.S. in 1934 from University of Chicago; his Ph.D. in 1936 from University of Iowa. He is the author of many articles in both professional and general magazines. At present he is associate professor of psychology at Occidental College and is a visiting lecturer at California Institute of Technology.

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Mr. Wiegand received a degree in electrical engineering from California Institute of Technology in 1927. Upon graduation, he was employed by the Southern California Telephone Company. He is now an engineer in the Traffic Department. In his present capacity, he makes studies to determine the amount and type of equipment required in the central offices and schedules equipment additions and replacements.

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WARREN FURRY

Mr. Furry attended the School of Architecture at Georgia School of Technology for two years. In 1931 he obtained a degree of Bachelor of Science in Civil Engineering at the University of Arkansas. He was county surveyor of Van Buren, Arkansas, until 1933 when he was engaged by the National Park Service. In 1940 he joined the Lockheed Aircraft Corp., at present holding the position as supervisor of engineering training.

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ENGINEERING AND SCIENCE *Monthly*

The Truth Shall Make You Free

CONTENTS FOR NOVEMBER, 1944

Cover Photo: Testing perceptual skills. The University of Minnesota spatial relations test makes possible accurate scoring on speed, and precision of perception of two-dimensional shapes. It aids in the prediction of success in all sorts of mechanical operations. (See article pages 5-8)

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THE FLASH OF GENIUS DOCTRINE
Approaches the Patent Office

By WILLIAM DOUGLAS SELLERS*

ENGINEERS and scientists are rather closely associated with inventions and patents. It seems appropriate that the views of William D. Sellers should be presented to the readers of *Engineering and Science.* In many cases the interest in patents of highly trained technical men is not paramount to but incidental to and the result of their work in their particular field. As a matter of fact, the trained engineer or scientist probably is not as prolific in the procurement of patents as those who have not had as much formal training.

Charles F. Kettering of General Motors has written a very interesting article on "How Can We Develop Inventors" which appeared in "Mechanical Engineering," April, 1944. His remark about engineers in the field of invention is worth quoting.

"Some years ago a survey was made in which it was shown that if a person had an engineering or scientific education, the probability of his making an invention was only about half as great as if he did not have that specialized training.

"Now that is very interesting, and I have spent a great deal of time wondering why it is so. As a result, I have arrived at a definition of what an inventor is. An inventor is simply a fellow who doesn't take his education too seriously.

"You see, from the time a boy is six years old until he graduates from college he has to take three or four examinations a year. If he flunks once, he is out. But an inventor is almost always failing. He tries and fails maybe a thousand times. If he succeeds once, he is in. These two things are diametrically opposite.

"We often say that the biggest job we have is to teach a newly-hired boy how to fail intelligently. We have to train him to experiment over and over and to keep on trying and failing until he finally learns what will work.

"We also have to teach him that everything is not in the books. In his education he invariably gets the idea that this is so because his textbook is always the last word and final authority on whatever he is studying. If we fail to do this, sooner or later he will say, 'There is no sense trying this experiment because page 284 of this book says it won't work'."

The technical men should have a little insight into the patent picture. Mr. Sellers' article should provoke a little thought along these lines.—EDITOR.

THE recent decision by the United States Court of Appeals for the District of Columbia in the case of *Potts et al v. Coe* will give pause to all interested in the future of patents in this country. Decided January 18, 1944, and to be found at *60 U.S.P.Q. 226,* the decision was written by Justices Arnold and Miller with Justice Edgerton concurring. The influence of Justice Arnold's background stands out clearly. The doctrine of the "flash of genius" has taken a big stride toward the Patent Office.

The "flash of genius" test for invention has been received by the patent bar with irreverence, considering its high sponsorship. So long as it remained a fiction on Mt. Olympus it was not intolerable. That it would filter down to lesser courts was recognized as probable but the hope remained that it would be modified, restricted, or abandoned before the danger went too far. Proposed legislation to effect the removal of this unwelcome and unnecessary growth has been and is being discussed. The case here referred to makes it clear that the need for early action is urgent.

In the case *Potts et al v. Coe* appellant Potts brought a 4915 action in the District Court seeking the grant of a patent covering an automatic stock quotation board. The Patent Office had rejected certain of the claims as a simple combination not involving invention of ideas disclosed in the prior art. The District Court agreed with the Patent Office.

The decision of the Appellate Court, written by Judges Thurman Arnold and Miller, affirmed the decision of the lower court without a reference in the decision to the prior art structures, the Court instead relying upon an "inference" of non-invention under the circumstances. The Court stated the following:

> In this case we have before us a complicated improvement in electrical communication made by an employee of and assigned to a research group that has long dominated and raised to a new level the application of science to communication. These circumstances in the absence of evidence of individual achievement, create at least an inference that the machine is a step by step improvement, the result of skill and experimentation in the use of existing knowledge, and not an invention. That inference, which is not rebutted in the record, supports the findings of the court below that there is no invention in this case.

The inventor Potts was an employee of the Teletype Corporation and the invention was assigned to that corporation. The Court referred to public records such as the Report of the Federal Communications Commission on the Investigation of the Telephone Industry in the United States and pointed out that the Teletype Corporation is a wholly owned subsidiary of Western Electric which in turn is a manufacturing subsidiary owned and controlled by the A. T. and T. Company. The Court pointed out that the appellant was a member of the research staff of a subsidiary of the Bell System, comprising an interlocking group of companies controlled

*Reprint from the Journal of the Patent Office Society, April, 1944, by permission.

by A. T. and T., which dominates the telephone services in the United States and which has spent vast sums on engineering research, some $242,000,000 between 1916 and 1935. The Court also pointed out that the Bell System owns or controls some 9,000 United States patents and has licenses under nearly 7,000 more; that its research laboratories employ about 4,500 people in various scientific fields.

In considering the appellant's right to a patent on his application the Court made it clear that a mere consideration of the objective advance which the claimed invention represented over the prior art known to the Patent Office would not be sufficient. Such a consideration would not evaluate the individual achievement as required by the "flash of genius" doctrine. The Court stated the following:

> In determining whether invention has been made the character of the article or process, its novelty, and its advance over the prior art are merely evidentiary. The ultimate question is the character of the contribution made by the inventor. There is no invention without inventive genius. The objective advance does not identify or evaluate the individual achievement, ... And so the trend of the recent decisions has been to emphasize more and more the character of the individual achievement rather than the qualities of the product in determining patentability.

Recognizing that in order to determine the individual achievement it would be necessary to know the inventor's background and surroundings the Court stated:

> The burden of proof of patentability is on the applicant. Prior to the development of corporate research the circumstances under which the alleged invention was made were ordinarily not examined. The oath of the applicant was considered as a sufficient *prima facie* showing of intention provided the article itself was sufficiently novel but today where the record shows that the real party in interest is a vast research organization possessing advantages not available to the outside scientist it would be contrary to modern experience to assume that the burden of proving the presence of inventive genius has been met without evidence disclosing the level of the art in that research organization at the time the application is made. This principle simply emphasizes the importance of individual achievement which is the aim of the patent law.
>
> In order to evaluate the contribution of the inventor the court must reconstruct the conditions under which he worked, with emphasis on the contribution of others.

There appeared to be considerable doubt in the mind of the Court that patents are a suitable reward for developments by research organizations as evidenced by the following:

> In other words, patents are not intended as a reward for a highly skilled scientist who completes the final step in a technique, standing on the shoulders of others who have gone before him. By the same token they are not intended as a reward for the collective achievement of a corporate research organization.

This viewpoint was justified in the following words:

> Today routine experimentation in the great corporate laboratories can produce results beyond the imagination of 20 years ago. But such contributions to industrial art are more often than not the step by step progress of an entire group, not the achievement of an individual. Such an advance is the product not of inventive ability but of financial resources and organizing ability of those who operate the laboratories.
>
> The corporate research laboratory of today has given us the greatest invention of modern times, the knowledge of how to invent. Under a disorganized system of invention a hundred men would hunt for the needle in the haystack, the prize going to the successful finder while the efforts of the others served only to scatter the hay in all directions. Organized invention has changed the entire process. Each man is given a section of the hay to search. The man who finds the needle shows no more "genius" and no more ability than the others who are searching different portions of the haystack.

The decision attempted to answer the argument that patents should be viewed as a means to protect investments in research and in the following words:

> It is sometimes argued that the investments in research by dominant corporate groups should be protected by law in order to encourage them to spend more money for research and thus extend that domination. The reading of such a principle into the patent law should require an act of Congress.

In the prosecution before the Patent Office the applicant Potts had apparently made no showing as to the advance his individual contribution represented over the personal or private prior art of his assignee. He was content to argue, as have millions of applicants before him, that his contribution represented a patentable advance over the public prior art as evidenced by the references developed by the Examiner in the Patent Office. The Court, however, found that under these circumstances, and particularly in view of the vast research organization of the assignee, that there was an "inference" that the inventor's contribution was merely a "step by step improvement" and not an invention. The "absence of evidence of individual achievement" with respect to this private prior art created this "inference" and the holding was as set forth in the paragraph first quoted in this paper.

From this decision, which is a clear case of the filtering down to the lower courts of the Supreme Court's "flash of genius" doctrine, it is clear that the Patent Office will have to change its method of handling applications if the directions of this Court are to be followed. The level of invention has now become an individual thing differing with each inventor. That which is a patentable invention for one man with one background is not at all a patentable invention for a second man with a different background. To comply with requirements of this Court, which is in the nature of an appellate tribunal as to the Patent Office by virtue of the existence of 4915 actions, the Patent Office should require, and the applicant is under a burden to provide, data showing the state of his own personal prior art at the time he made his invention. Failure to do this, at least in the case of an inventor with a large research organization, as in the instant case, gives rise to an "inference," according to the decision, that no invention is present.

Let us consider an assumed case. Inventor *A* is a poor uneducated cotton picker with no library and with no knowledge of mechanics. He invents an improved article having at the time no knowledge of the prior art. Inventor *B*, working as an engineer for a manufacturer making articles in the field of this new invention, makes the identical invention as did Inventor *A*. Admittedly the mental effort which the uneducated cotton picker displayed is more astonishing and less to be expected than that displayed by Inventor *B*. Because of Inventor *A's* lack of education and knowledge of the field relative to his invention his mental effort may be considered a "flash of genius." Inventor *B* with an engineering education, with a knowledge of his company's field, and also its private and secret files, would hardly be called a genius and his effort could hardly be called for him a "flash of genius." The net advance over the public prior art is identical in each case, however.

In the proposed case, applying the doctrine of *Potts v. Coe,* Inventor *A* would be entitled to a valid patent while Inventor *B* would not. Inventor *A* disclosed the "flash of genius" that Inventor *B* did not display. This fact remains despite the identity of the inventions and the equality of the advance over the public prior art.

If the doctrine of *Potts v. Coe* is to be recognized and given effect it is doubtful that many patents owned by corporations having research organizations are of any validity. If this doctrine is to be given effect in the

(Continued on Page 16)

New Frontiers of the Mind

By GILBERT BRIGHOUSE

PSYCHOLOGY is a young science, perhaps the youngest. Born about 1860, it has the lusty enthusiasm of youth, and youth's proneness to error; yet in its short life psychology already has had to meet three obstacles to progress. First are the barriers imposed by the enemies of psychology: a small but articulate group who find something indecent or frightening in investigations of mental life. They feel, with Immanuel Kant, that consciousness is so personal that it should not be probed. Perhaps they fear what insight might reveal. Second are the handicaps of the would-be friends of psychology; a larger and much more menacing species which includes those who have read a book on abnormal psychology and then proceed to diagnose the defense and escape mechanisms of their friends and relations: those pseudo-scientists who prey on the gullible with astrology, numerology, palmistry, phrenology, and other schemes. As the term "psychologist" is not legally recognized, any of these "friends" can call themselves psychologists with impunity.

The third obstacle to the development of psychology has been the personalities of the psychologists. There is something about the discipline which attracts peculiar individuals. My readers will recognize that psychology is not unique in this respect; even the hallowed laboratories of physics and chemistry are not completely free from eccentrics. Psychology, however, seems to have more than its share.

Despite its conspicuous lunatic fringe, experimental psychology has established itself as a true scientific discipline with carefully controlled methods and an increasing body of established data. Our insight into the human mind is far richer, our appreciation of its beauty and complexity far keener, and our control over its irregularities far more effective than in 1860.

The confluence of three streams of thought—philosophical, biological, and social—made a new science necessary. The ratiocinations of philosophy had carried knowledge of mental phenomena perhaps as far as uncontrolled methods could go. Physiological experiments on the functions of cells and organs demanded study of the total organism. Increasing interest in economics, political science, and history called for an understanding of the individual at the root of all social phenomena. The confluence showed the need; two books showed methods with which to begin. Darwin's "Origin of Species" (1859) gave a rational approach to the study of mental phenomena; Fechner's "Elements of Psychophysics" (1860) posed a series of problems and described experimental techniques for their solution.

RESEARCH AND APPLICATIONS

The first great psychological experiment grew out of an incident at the Royal Observatory at Greenwich in the eighteenth century. Maskelyne, the astronomer royal, had to discharge from his employ a promising assistant named Kinnebrook, because the latter, though conscientious, was unable to observe the transits of stars with sufficient accuracy. Maskelyne made a brief note of the incident in the transactions of the observatory and Kinnebrook passed into oblivion. In the early 1880's, however, the incident was revived when a young American, James McKeen Cattell, doing graduate work in the new psychological laboratory at Leipzig, demonstrated that abnormally slow reaction times had accounted for Kinnebrook's failure. Cattell conducted a series of investigations into reaction times for different sense organs, differences among children and adults, among men and women, normal and abnormal persons, and the intelligent and the feebleminded.

Out of these experiments, techniques have been developed for studying the effects of fatigue, emotion, alcohol, drugs and other influences. Out of these also has come better selection of streetcar motormen, turret-lathe operators, job-printers, hundred-yard-dash men, and combat pilots. Some day we may choose better automobile drivers with reaction time tests.

In the early 1890's the great William James, of Harvard, gave one of his graduate students, Edward Lee Thorndike, the privilege of keeping chickens in the basement of the James' home, since referred to as the first psychological laboratory in America. From Thorndike's pioneering experiments on the learning curves of chick-

Based on a talk at the 1944 Alumni Seminar.

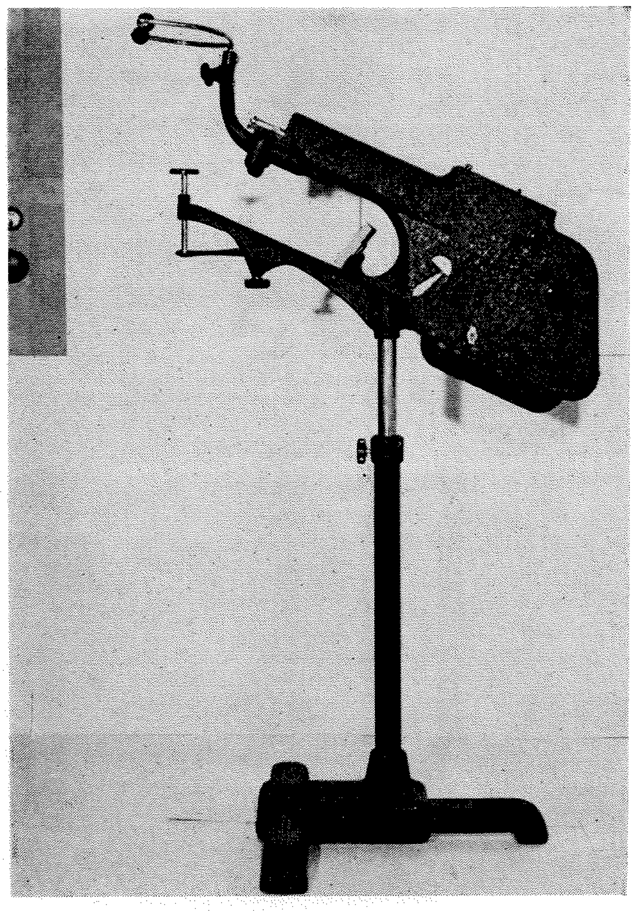


Illustration showing the eye-movement camera. With this equipment accurate photographs of the behavior of the eyes during reading enable the psychologist to determine the exact efficiency of reading and the causes for any bad habits. The subject, who sits at the left of the instrument, reads a standardized test card while light, projected onto his eyes, is reflected back and focused upon a moving 35-millimeter film.

ens, a vast amount of research has given us intimate knowledge of human learning and memory, and practical information on efficiency.

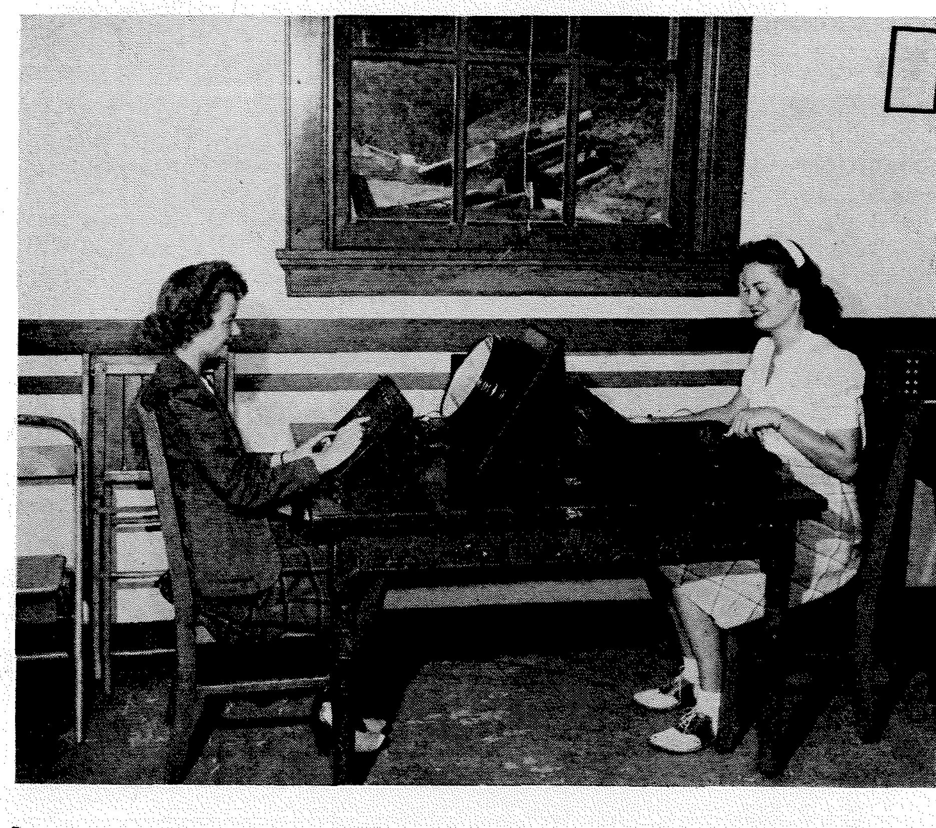
A highly important part of this research has attacked the question: "Do we inherit our emotions or learn them?" Results show that the mechanism for the release of emotion is innate, but we have to learn to perceive emotional stimuli. In other words we are born knowing how to emote, but not why to emote. At birth we respond with a generalized excitement and it is only with the passage of many months that we learn specific emotional patterns. This observation is highly important for our understanding of mental hygiene. For example, if fears are learned, can they be unlearned? Mrs. Mary Cover Jones, of Berkeley, has shown that acquired fears can be eradicated by reversing the process of fear formation. A little boy was conditioned to fear rabbits by having an unpleasant experience (a startling sound) occur whenever rabbits were present. The fear was later removed by having only pleasant experiences (ice-cream or games) when the rabbit was near. The removal process takes much longer than the original fear conditioning and requires expert direction, but in competent hands it is positive and effective.

Another application concerns the eradication of bad habits. Professor Knight Dunlap, of the University of California at Los Angeles, finding that practice often fails to make perfect, has developed the intriguing technique called "negative practice," which consists of intentional practice of the wrong kind of behavior in order to control it. The technique obviously cannot be applied to all habits (chronic alcoholism, for example), but Dunlap has been successful with cases of stagefright and some kinds of stuttering, as well as with such minor bad habits as typing *"hte"* for *"the."*

BRAIN FUNCTIONS

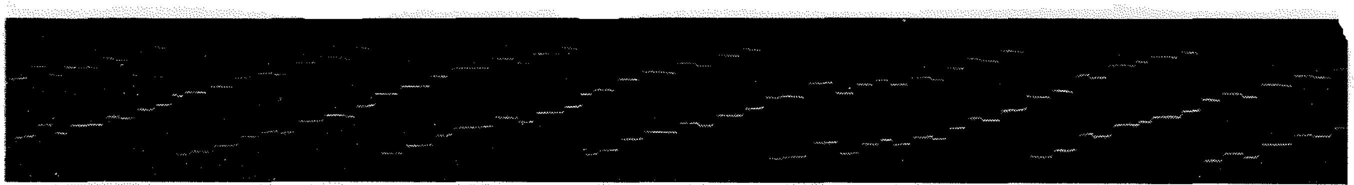
In 1861 a French surgeon and anthropologist named Broca was called in for consultation on the case of a soldier who had lost the power of speech. Broca examined the soldier for four days, and on the morning of the fifth, the patient died. Broca made an immediate autopsy, found a lesion or area of damage in the left frontal lobe of the brain, wrote a paper describing the localization of speech in that frontal lobe, and presented the paper and the preserved brain to the French Academy, all by five o'clock that evening. For that one big day, although the soldier remained anonymous, Broca's name goes down in history in the term "Broca's convolution."

That was only one of a number of important developments during the last four decades of the nineteenth century which gave rise in the twentieth century to a host of experiments on brain functions and their relation to mental phenomena. The basic investigations of Professor Lashley, of Chicago and Harvard, are among the most notable. Lashley, who works principally with rats, places the animal on a small pedestal facing a wall. In the wall there are two doors. On one door is painted a triangle, on the other a circle. Behind each door is a shelf with food. The door with the circle is unlatched so that if the animal jumps for that door, it goes down and he can get to the food. The door with the triangle on it is secured. If the rat jumps to it, he bumps his nose and falls into a net below. The order of placing of the two doors is completely random, because rats, having a very keen sense of spatial direction, quickly learn to jump always to one side if the correct door is always on the same side. After some dozens or hundreds of trials, depending upon the I.Q. of the rat, he learns how to jump always to the correct door. Lashley then operates on the rat's brain and removes a small, carefully delimited area, the location and size of which are varied systematically from rat to rat. After recovery from the surgery, the animal is once again tested to see whether or not he has forgotten his previously acquired skill. If he has lost the skill, presumably the destroyed area of the brain was necessary for that skill. By making



AT LEFT:

Reaction time determination. The experimenter, on the left, after a warning signal, presents a light or sound to the subject, who must respond as quickly as possible by pressing down one of the five keys. Through a pair of matched relays, the delicate chronometer, reading in one-thousandths of a second, runs only during the time elapsing between the presentation of the stimulus and the response of the subject. Simple reaction time experiments consist of the re-



An eye movement record. The behavior of both eyes is shown graphically. The duration and placement of each eye fixation and each regression can be measured by study of the film, which also shows eye-coordination and, by means of a standardized test, the degree of comprehension of the material. (a) Above, eye-movement, poor reader—slow, excessive regressions. (b) At right, eye-movement, good reader—poor lateral control.

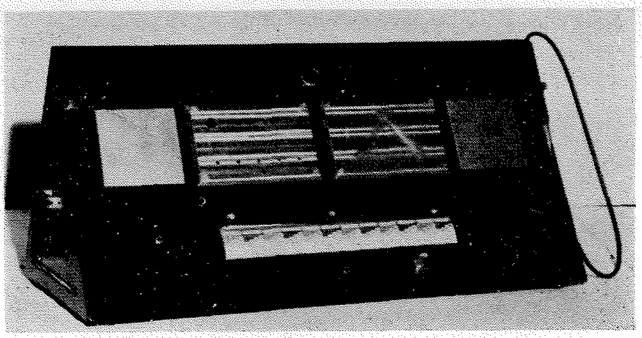
hundreds of such carefully controlled experiments, Lashley discovered just which areas of the brain are essential for various kinds of learning.

More important still is Lashley's observation that under certain conditions a rat which has lost a given skill, through surgical removal of an essential part of its brain, can later relearn that skill, presumably with some other part of the brain. This has significant implications for cases of human brain injury or tumor. An example is that of a little girl of seven who, up to that age, had been developing quite normally and who had a large vocabulary. At that time she suffered an attack of encephalitis, which, after subsiding, left an area of chronic infection in the left frontal lobe. The surgeon had to remove much of that lobe in order to clear up the infected area. After the operation she lost all her speech except the words "No, No" and "Mama." The older view, that there were rigid, permanently established areas for each psychological function, held that this girl, since she had lost the normal speech area, would now be permanently mute. The newer view, encouraged by the work of Lashley and many others, suggested that this girl might possibly relearn speech with some other part of the brain. Accordingly, after several weeks of complete rest, she was given a 15-minute training program each morning and afternoon by a competent speech specialist, who made sounds for her and encouraged her to repeat them. At the end of some 10 weeks, she had acquired about 20 words and was progressing so rapidly and relishing her education so much that the training was intensified. But one evening she had a violent convulsion. She had two more during the night and by morning she had lost not merely the 20 new words, but also "No, No" and "Mama." The convulsions were the brain's way of protecting itself against an over-strenuous program. She was once again given several weeks of rest and then the training was reinstated, this time for only five minutes a day. Her progress was naturally slower, but the convulsions did not reappear, and gradually she was restored to a complete school course. She is now almost 11, has an intelligence quotient of 140 and hardly ever stops talking. Unfortunately, we do not know what her intelligence quotient was before the illness. It is possible that it was somewhat lower than 140, because there are some

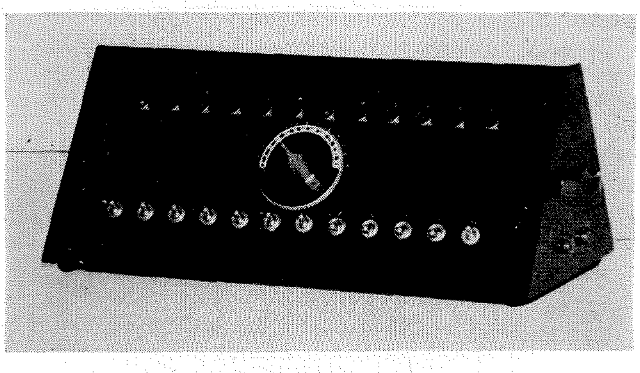
sponse by a predetermined key to a predetermined stimulus. In the more complicated discrimination experiments, the subject has to reply with a certain key for a certain light, and he does not know beforehand which light will come on.

AT RIGHT:

The examiner, on the right, is here presenting one of the tests in the Wechsler-Bellevue Scale, which is one of the best intelligence tests for adults.



With this motor skills apparatus accurate measures of steadiness, dexterity, precision, and reaction time can be made.



The Occidental modification of the Yerkes apparatus allows the psychologist to study the ways in which concepts or hypotheses are formed. Problems of varying degrees of difficulty are set up for the subject on the apparatus. His method of attack shows vividly forms that his mental processes take.

cases where surgery seems to improve intellectual efficiency by removing some of the inhibitions which bedevil so many people. Unfortunately these reeducational procedures as yet are applicable to only a limited number of brain disturbances. The location and size of the injury, the intelligence, personality, and age of the patient all influence the amount of reeducation possible.

INTELLIGENCE MEASUREMENT

Let us go back to the 1880's. Charles Darwin's cousin, Sir Francis Galton, whose career was bound up not merely with psychology, but also with meteorology, statistics, and eugenics, began a series of investigations into the causes of genius. Galton, as part of his program, invented a little test of thinking and imagination. This was apparently the beginning of the intelligence testing movement. About 1900 a better series of tests was begun by a great French scientist, Alfred Binet, who was invited by the French government to discover how feebleminded school children could be distinguished from lazy but bright children.

Out of these beginnings, one at the upper end of the intelligence scale and one at the lower, there has grown up a vast literature on intelligence measurement and a number of reliable techniques for investigation. This movement had its real impetus in 1917, when a committee of psychologists was invited by the Surgeon General of the United States to prepare a group of intelligence tests for the proper placement of Army recruits. The committee's work resulted in the development of two famous measures, Army Alpha and Army Beta. Alpha was given to men who could read, write, and understand English; Beta was for illiterates and foreign born. These tests were given to a total of over two million men, and while by modern standards they were crude, with a considerable probable error, they still did a helpful job in recruit placement. They showed that the most intelligent occupational group in the Army was composed of the engineers. In World War II, the improved descendants of Alpha and Beta are being relied upon very heavily in the classification program of the armed services. Modern intelligence, aptitude, and personality tests are particularly valuable in selecting men for the air corps and the mechanized divisions of the armed forces, and are also used extensively in industry and education.

SOCIAL PSYCHOLOGY

The past 20 years have seen the birth of an experimental social psychology. People say, "There will always be wars because it is human nature to be aggressive and competitive." Can we experiment to determine the truth or the falsity of that assertion? We can and have and know the assertion to be incorrect. Human beings learn to be competitive or cooperative according to the kind of culture in which they are reared. Professor Lewin, at the University of Iowa, has experimented with Boy Scout troops and others boys' and girls' groups. One group was led by an aggressive, self-assertive, domineering personality, who directed activities about as follows: "Boys, we'll take a hike Saturday to Pine Creek. We shall leave at 2:30 and you will bring wieners and buns." Another group was led by a laissez-faire adult who let the boys alone to do as they pleased. A third group was under a leader who guided without directing. If a hike was planned, his group decided where to go, when to leave, and what to take. Of these three, the laissez-faire group became bored and tended to disintegrate. In the autocratic group, friction among boys became increasingly common, cliques formed, and aggressive outbursts against a scapegoat indicated barely suppressed resentment. The democratically led group showed increasing cooperation and, because there was no pressure from above, the boys could afford to feel friendly and generous toward each other. Contrary to the popular belief that competition is essential to success, children in the democratic group worked and played harder and with much more enjoyment than children in the highly competitive autocratic group.

Experimental investigations of this sort are complemented by the observations of our sister disciplines, anthropology and ethnology, whose research shows that the cultural patterns determine the competitive-cooperative patterns. New Mexico's Zuni and New Guinea's Arapesh have high degrees of internal cooperation, because from infancy each individual can best satisfy his motives through cooperation. The Nundugomor of New Guinea and the Kwakiutl of Vancouver Island learn to be highly competitive because only in that way can they survive in their respective cultures.

These studies show us that aggressiveness and altruistic cooperation are the result of training rather than of heredity. Therefore war is not an inevitable product of a depraved human nature; it is instead a cultural product which can be eradicated by educational processes.

CONTRIBUTIONS OF FREUD

In the 1880's a young physician sat day after day in his office in Vienna waiting for the patients who never came to him. A classmate of his, already well established as a fashionable doctor, one day said in pity, "Sigmund, I am going to send you one of my patients. She has

(Continued on Page 15)

THE MARKER PRINCIPLE
in Telephone Switching Systems

By FRANK H. WIEGAND

THE two basic requirements of any telephone system are, first that the equipment and circuits permit satisfactory conversations between users, and second that the equipment quickly connect any subscriber's line with that of any other subscriber. Among telephone engineers, the first requirement is referred to as transmission, while the second requirement is referred to as the switching system.

In a broad sense the switching system might be defined as including the circuit from the central office to the telephone instrument on the subscriber's premises; however, this is generally termed the "outside plant." The switching system concerns itself primarily with that portion of the subscriber's telephone instrument which is used to transmit electrical signals to the central office, and the equipment in the central office which responds to these signals and selects the desired customer's line.

SUBSCRIBER'S SIGNALING DEVICES

The oldest of all telephone switching systems is, of course, the manual system, where an operator connects the calling party with the called party by means of a cord circuit or by means of switching keys. The customer's signaling device in this system is the movable hook upon which the receiver hangs, and in the case of magneto instruments, the crank of the magneto type ringing generator. The signal in this case is used only to notify the operator that a connection is desired, the actual number being transmitted verbally.

Practically all of the automatic switching systems used in the United States have been of the "step-by-step" or "panel" types. Both of these systems include a dial on the subscriber's telephone by means of which he transmits electrical signals to the central office apparatus and thereby controls its operation in selecting the desired telephone line. In fact the dial has become almost universal as the subscriber's signaling device because of its compactness, ruggedness and low cost; and it is generally used on central office switchboards where operators have occasion to complete calls through automatic equipment.

In certain of the central offices, however, a device called a "Key Pulsing Set" is used in place of a dial. With this device the operator sets up the desired number by depressing keys in the same manner that a number is set up in an adding machine, and because of the faster operation she is able to complete more calls per hour. The cost and size of the present key-pulsing set probably will confine its use to operators in the central office; however, the laboratories are exploring the possibility of simplified key-type dialing equipment for use by subscribers.

NEW SYSTEM ANNOUNCED

One of the major development projects which were announced by the Bell Laboratories just prior to the war was a new system of dial telephone switching. This new system is called the "Crossbar System," since the new crossbar type of switch is used to make many of the required connections; however, a more descriptive name of the system would have been "The Marker System," since some other type of switch could have been used in place of the crossbar switch while still retaining the "marker" principle. Inasmuch as a detailed description of the crossbar switch is not essential to an overall picture of the marker principle, the crossbar switch as such will be brought into the discussion only as it performs its functions under control of the marker, which is the "brain" of the new system.

ANALOGY OF MARKER PRINCIPLE

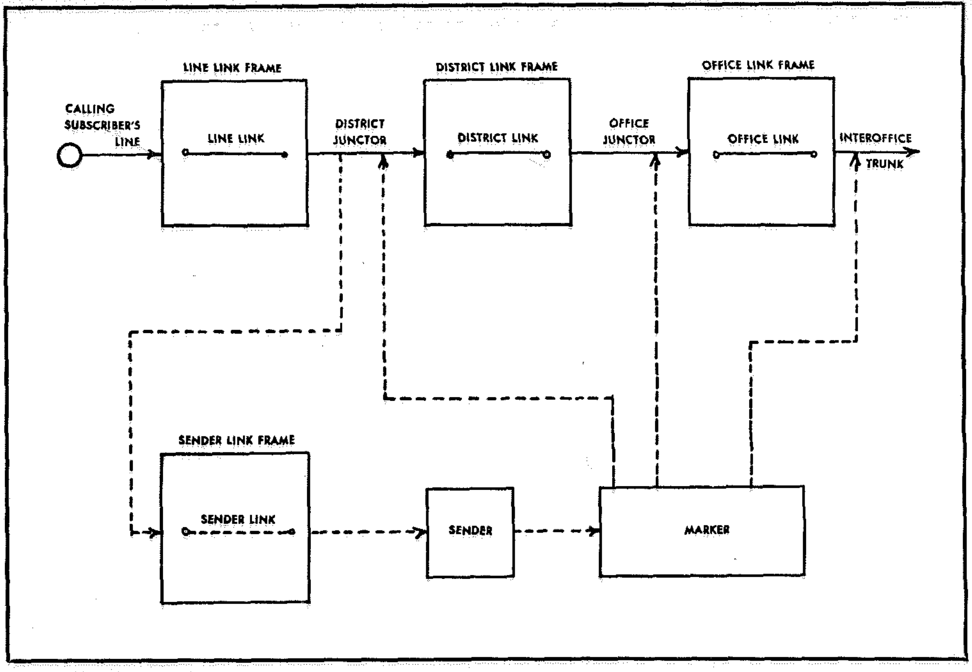
Perhaps the best way to point out the difference between the marker principle and the step-by-step principle which is now in use in southern California is by means of an analogy. If you were going to make a railroad trip from Los Angeles to Chicago, using the step-by-step principle, you would go to the station in Los Angeles and take the first train out of Los Angeles which was going in the general direction of Chicago. Let us assume that this train terminated its run at El Paso. At this point you would then take the first train headed east, which, let us assume, went as far as St. Louis, still with no assurance that you could get passage from there to Chicago. But if, at St. Louis, you were unable to obtain a reservation to Chicago, your trip would have to be abandoned and the train space consumed in taking you as far as St. Louis would have been wasted, and could have been utilized by some one else who wanted to go somewhere other than to Chicago.

Now, if you were to make this trip, using the marker principle, your ticket agent would communicate ahead to each junction point to be sure that a clear channel was available through each link of the journey, and if St. Louis reported no passage available to Chicago, he would try an alternate route through La Junta and Kansas City to Chicago. In case he was unable to make connections for you over the alternate route, he would give you a "busy signal" and you would "hang up," thereby leaving your seating space on the trains available for some other person whose trip could be completed. The ticket agent in the above analogy corresponds to the marker in the crossbar system, since each has the duty of locating a clear channel through all links of the trip (or call), trying an alternate route if the first attempt is unsuccessful, and preventing you from tying up train space (or telephone circuits) in case no clear channel is available.

EQUIPMENT INVOLVED IN OUTGOING CALL

Now that we have become acquainted with the marker principle through the medium of an analogy, let us see how it is applied in telephony by following the progress of a call through the crossbar system. In *Fig. 1* is shown a block diagram of that portion of the equipment between the calling subscriber's line originating end and the interoffice trunk circuit.

Each subscriber's line terminates on a frame, known as a "line-link-frame." It will be noted that the name of each of these frames includes the word "link." The links are the talking circuits between those crossbar type



AT LEFT:

FIG. 1. Equipment involved in a call outgoing from a crossbar type central office. Talking paths are shown by solid lines and control circuits are shown by dotted lines.

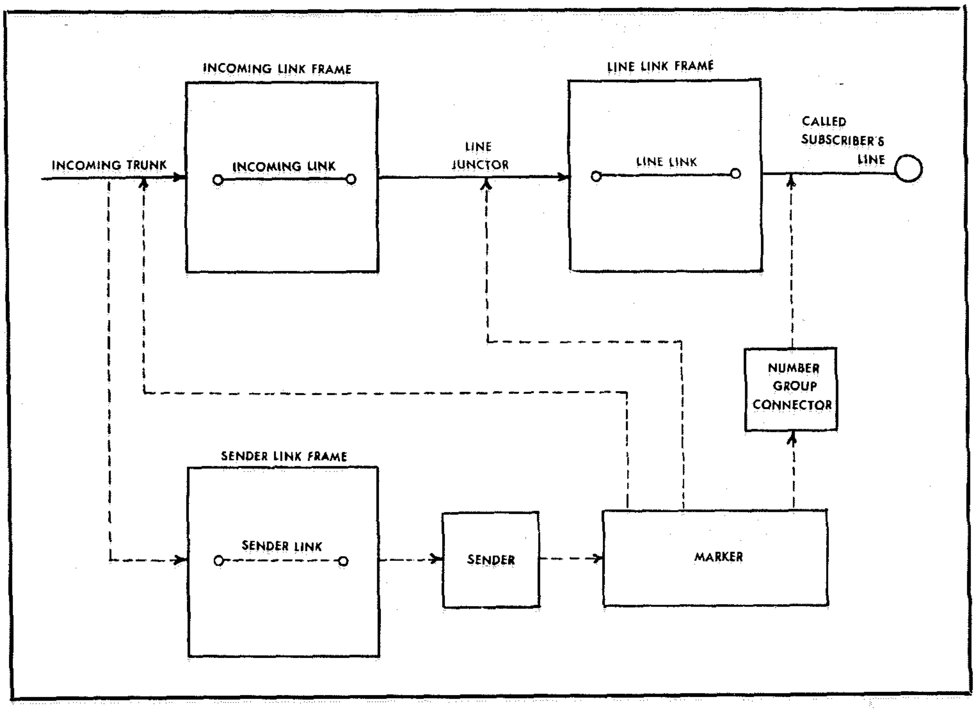
switches which are mounted on any frame, this name being used to distinguish them from the talking circuits between the frames, which are called "junctors."

When the calling party lifted his receiver the control equipment associated with the particular line-link frame on which his line appears noted his desire to make a call, scanned the district junctor circuits to be sure that an idle one was available, scanned the links between the primary crossbar switch on which his line appears and the secondary crossbar switch on which the idle junctor appears, and then simultaneously operated the mechanism of the proper crossbar switches, thereby connecting him through to a district junctor. At the same time a clear channel was located between the district junctor and an idle sender. This entire process of selection and connection requires only two-thirds of a second, after which dial tone is sent to the calling subscriber, and the control circuits are free to serve another call.

MARKER DIRECTS OUTGOING CALL

The calling subscriber now dials the letters and numbers of the telephone number he desires and the sender receives these and registers them within itself by the operation of appropriate relays. A marker is now called into the circuit to analyze the call and schedule a clear channel through the equipment to an outgoing trunk leading to the office whose prefix was dialed. Typical of the questions which must be answered by the equipment in order to handle properly each call are the following:

1. Is the calling party entitled to dial a call to the prefix he has dialed, or should this call have been handled as a toll call?
2. Is this call from a coin-box telephone, thus requiring that another piece of equipment called a "coin supervisory circuit" be brought into the connection to collect or return coins at the proper time?
3. If zone registration is included in the tariff structure, how many zones will this call pass through, and how many regis-



AT RIGHT:

FIG. 2. Equipment involved in a call incoming to a crossbar type central office. Talking paths are shown by solid lines and control circuits are shown by dotted lines.

trations on the calling party's message register should be made?

4. Is this a party line, and which party on the line should be charged for the call?
5. What is the location on the district link frame of the particular district junctor being used on this call?
6. Which idle trunk on which office link frame will carry the call to the distant office?
7. Which links and which office junctor can be used to build the circuit between the district junctor and the outgoing trunk?
8. Can the distant office be reached through a tandem office in case all direct trunks to the office are in use?

One of the interesting by-products of the system is that the marker provides cross-connecting facilities which permit the location of the trunks on the office frames to be independent of the office code dialed. Each marker can handle as many as 800 office prefixes, which is more than enough to handle even the largest system.

OVERLAP FEATURE

The call handling capacity of each marker is increased by incorporating what is known as the "overlap feature." This feature permits a marker to be working on two calls at the same time; that is, it can start decoding the office code which is being dialed on the next call, while still marking a clear channel for the previous call.

Before a marker leaves the connection it is working on, it makes a check to see that all of the contact points of the crossbar switches are properly closed, thus insuring that the circuit is complete to the distant office. Having completed all of its functions in approximately one-half second, the marker disconnects and signals to the group of senders that it is ready to handle another call. The markers which handle the originating end of the call are called originating markers, and a group of five or six originating markers is generally sufficient to handle a central office of 10,000 subscriber terminals.

CALL INCOMING TO CROSSBAR OFFICE

In the distant office, a terminating marker performs a similar function in locating a clear channel between the incoming trunk and the called subscriber's line shown in *Fig. 2.* Here the problem is somewhat different, in that the originating marker can locate any idle trunk to the desired office, whereas the terminating marker must locate one particular line out of all the subscriber lines in the distant office. It will be noted, however, from a comparison of *Figs. 1 and 2* that the general layout of the terminating equipment is similar to that in the originating office.

When the call whose progress we are following is extended to the distant office, it becomes an incoming call with respect to that office, and a terminating sender is connected to the incoming trunk by means of crossbar switches which are mounted on the terminating sender-link frame. The originating sender now transmits to the terminating sender the called telephone number, each digit of which it had previously recorded. Here again, the overlap feature is incorporated, since the originating sender may start transmitting the first digit of the called telephone number before the calling party has finished dialing the last digit.

TERMINATING MARKER FUNCTIONS

Having received the called telephone number, the terminating sender calls in a terminating marker, which

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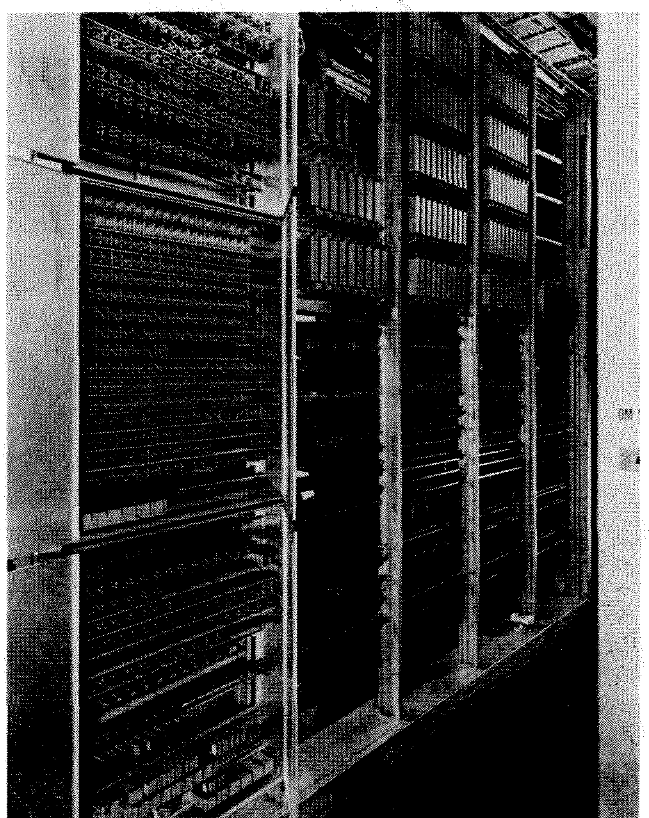
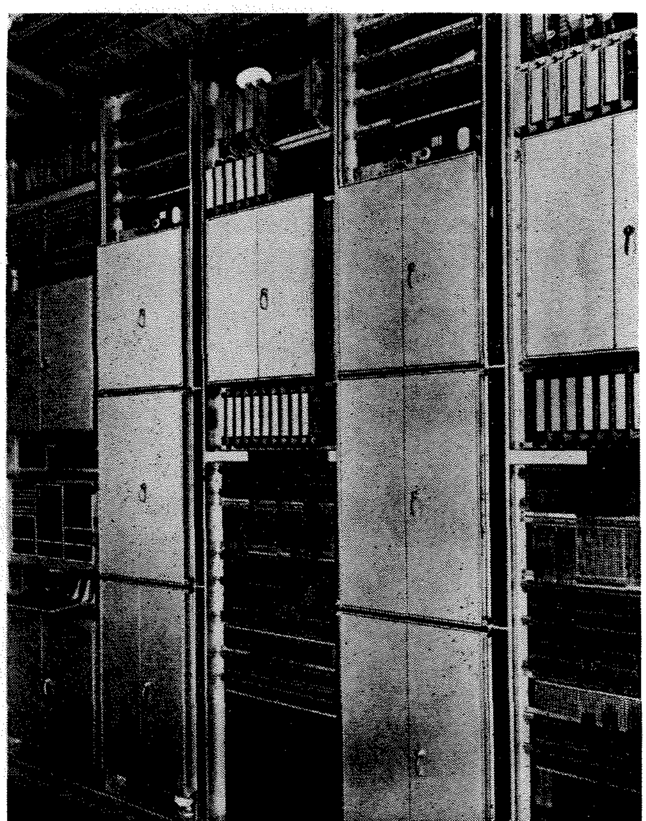


An originating marker, with relay cabinet at the left, route relays at the upper right, and cross-connecting terminals at the lower right.



Each terminating marker consists of two bays, one consisting chiefly of three cabinets of relays, and the other of one relay cabinet and the cross-connecting terminals.

Significant Engineering Developments
IN AIRCRAFT DESIGN

By WARREN FURRY

JAMES RUSSELL LOWELL once said in effect that true scholarship consists in knowing not merely that things exist, but *what they mean.* This statement suggests that a summary of the salient points in the history of aircraft design might serve as an inventory of aircraft engineering accomplishments. We hope that it will also promote some thinking about the needs of the aircraft industry which must be supplied by engineering endeavor. To those of us who aspire to fruitful research and the rewards of inventive labor in this field, or related fields, such an inventory should be useful; and since modern history is the history of science and engineering, our discussion will be concerned with matters of historical importance.

The history of an industry usually may be written as the story of men; men who discovered the principles of the science involved; men who invented the industry's tools and devices; and those who otherwise engineered its technical and commercial development. In the case of the aircraft industry, however, no one man dominated any of these fields. Many men, working independently but concurrently, effected a development with a rapidity that is unique in industrial history.

It would be impossible, in one short article, even to enumerate all the individual engineering developments that have contributed to advancement in aeronautics. For this reason, our history of design will be condensed into an abstract of those groups of developments that we believe have had the greatest influence on design.

In selecting the divisions of engineering to be covered, we may ask, "What are the basic engineering considerations involved in the design and production of airplanes?" We might answer by stating an engineering definition of an airplane, as follows:

An airplane is a machine or craft that must be so shaped and devised as to fly spectacularly, if military, and economically, if commercial; it is a structure, the whole and each part of which must be designed to carry certain estimated loads imposed by gravity, air pressures and inertia; it is a vehicle that must be made self-propelling by a power plant; and it is a product that must be manufactured rapidly if military, and profitably if commercial. Summarizing: An airplane is a craft, a structure, a vehicle and a product.

From this definition then, our fields of engineering are aerodynamics, structures, power plant and production. It is interesting for us to note that the aerodynamics developments are the only ones that are purely aeronautical. The remainder are largely matters of mechanisms, power, structures and metallurgy. But, being directed toward the attainment of areonautical objectives, these matters have been subject to the necessity for constant compromise which characterizes aeronautical design.

AERODYNAMICS

Outstanding developments in aerodynamics include: 1. Airfoil and cowling shapes, 2. Wind tunnel techniques, and 3. Flight testing techniques. In speaking first of the airfoil, it may be well to consider that generally the term "airfoil" defines any surface that is designed to produce a reaction by deflecting an airstream. However, designers commonly use the term to mean the cross-sectional shape of an airfoil, or most often merely the cross section of a wing.

It was logical that improvement in airfoil shapes was among the first to be undertaken. Our earliest airplanes were nothing more than powered gliders and consisted of little more than sets of wings. These wings often were simply frameworks covered only on the lower side. But it was found by experiment that a covered convex upper surface produced a pressure differential contributing more to the lifting effect than the reaction produced by the lower surface. Experimental work involving closed airfoils took place in Germany, France and England before the first World War, and the United States air service conducted some investigations at about the same time.

In the 1920's the National Advisory Committee for

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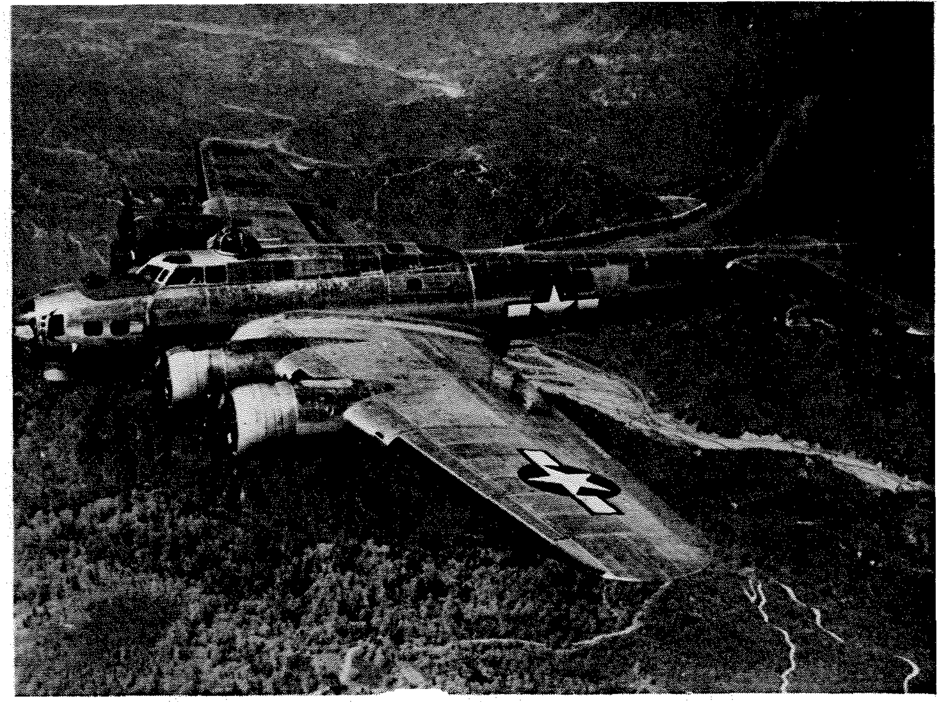
The Constellation. Lockheed high-altitude, long-range heavy transport; now used exclusively by the United States armed forces.



AT RIGHT:
The B-17 G Bomber, United States Army's standard "Heavy," now being produced in quantity by Lockheed.

Aeronautics, a Federal agency (NACA), began extensive research on airfoil shapes. A series of wind-tunnel tests was conducted on families of airfoils, *i.e.,* groups deriving their cross-sectional shape by regular variations of a basic outline. The results of these and similar tests enable designers to select an airfoil according to the wing-performance characteristics desired. Further tests led to the development of laminar-flow airfoils, so called because of near-absence of airstream turbulence at critical points on the surface. Undergoing experiment are even more advanced shapes that may render obsolete those that we now regard with highest favor. Without modern airfoils, aircraft speeds above the range of automobile speeds would be impossible. Without them, wings would need to be vastly greater in size to produce the required lifting force.

It would seem appropriate at this point to explain that the helicopter is omitted from this list for two reasons: first, because experiments with such devices were begun independently of other aeronautical endeavors at a very early date, and in one sense we may consider the helicopter as a separate and distinct invention; second, because the development of present-day rotating-wing aircraft has been largely founded on the results of aerodynamic research in connection with fixed-wing aircraft. In this latter sense, helicopters and autogiros may be considered as adaptations of the conventional airplane.

A somewhat similar development to that of airfoils is to be found in engine cowling shapes. Evolved by collaboration of aerodynamicists and power specialists, the NACA cowl for air-cooled engines has resulted. This familiar device smooths out the airstream that otherwise would be made violently turbulent by an "exposed" engine. In so doing, it assists also in controlling engine cooling.

These cowling shape developments share "high-speed honors" with the airfoils; they constitute one of the outstanding contributions made by this country in improvement of speed.

The primary proving ground of aerodynamics is of course the wind tunnel, and its steadily advancing technique is of first importance. It enables designers to secure, from models, data that would otherwise be obtainable only after flight testing of completed planes. The full value of the wind tunnel is best appreciated by aerodynamicists who have used it in solving complicated problems of flight stability.

Improvement in the aerodynamics phase of flight testing is closely correlated with advancement in wind-tunnel work. In fact, the results of its development have proved the value of both techniques.

The importance of advanced methods of flight testing is, however, independently significant, since such testing is concerned also with power plant operation, with structural efficiency and with vibration.

Early flight testing was performed by "wringing out" a new plane, *i.e.,* flying it in all feasible attitudes, and executing all known maneuvers. In such testing, the instruments consisted chiefly of the pilot's senses of sight, hearing and touch (in case of a hot engine, his sense of smell, also). But data thus obtained were not always quantitatively reliable. (At least no more so than the degree of sensitivity of the seat of the pilot's pants.)

Modern flight testing is accomplished with extensive instrumentation. Numerous engine, flight, strain-gauge and vibration instruments are installed and the readings frequently are recorded photographically to reduce the possibility of human error.

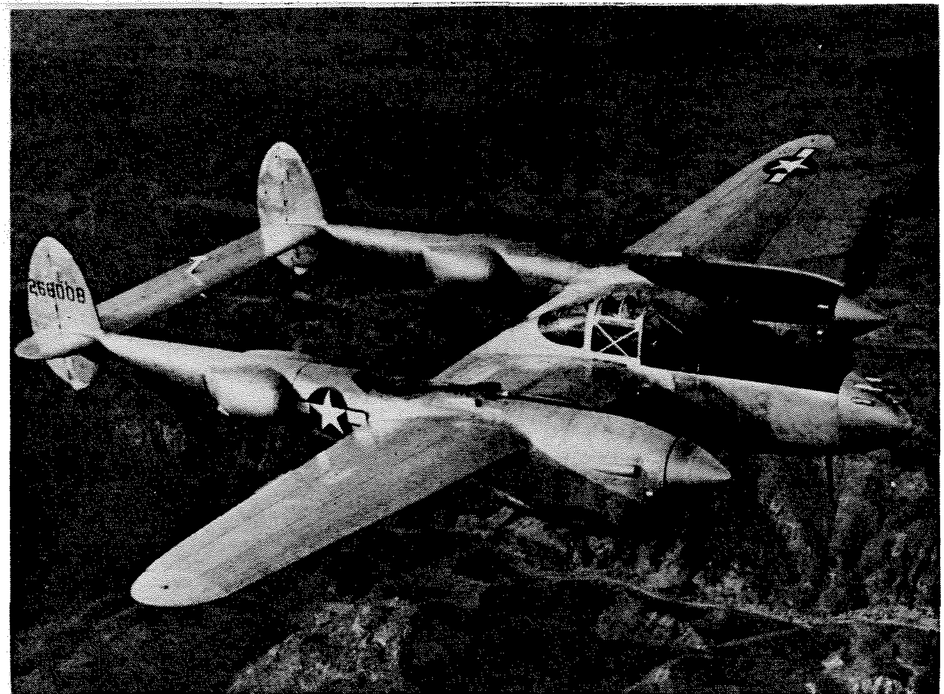
Without the information that can be gained only by the expert analysis of flight test data, the mistakes that are always made in the design of high-performance aircraft would be far more costly. They would certainly prolong the business of redesigning to remove "bugs" and they might often result in loss of life and airplanes.

STRUCTURES

In the field of structures (under which term we include both structural design and analysis), there are three classes of development which demand attention: materials, thin-sheet design and structural testing.

From the purely aircraft structural standpoint, a desirable material is one with a high strength-weight ratio. Our present popular high-strength alloys of aluminum, of magnesium, and of steel have this characteristic. Most of these alloys represent long years of metallurgical research and experiment. In some applications, these metals have already attained a practical limit in strength per unit weight; that is, higher unit strengths could not be practically utilized to make parts smaller, and therefore lighter, because of limitations imposed by handling and manufacturing requirements.

It is to be expected, however, that new materials will be developed that will be almost revolutionary in their effect on design. It is possible that improved bonding agents and fabrication methods may permit more exten-



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Lockheed P-38 Interceptor, the famed "Lightning" pursuit plane that has proved to be World War II's most versatile combat aircraft.

sive use of plywood. At present, however, the metals, which may be consistently manufactured with uniform strength, are in no danger of being supplanted as material for primary structure.

In the matter of structural design, the use of thin-sheet material may be said to have made the all-metal airplane possible. Thin-web beams, for instance, are comparatively easy to build. They can retain their rigidity in spite of local damage from gunfire. They are eminently adaptable to the type of construction usually associated with the cantilever monoplane.

Semi-monocoque design, which in one sense is an adaptation of thin-web beam design, utilizes the airplane's sheet-metal skin or covering to carry a considerable portion of the imposed shear and bending loads. This arrangement is in direct contrast to early designs in which the craft's covering was structurally parasitic.

Many of our early plane builders checked the strength of their structures by guess. Testing of wings and other major assemblies often was done only by determining their "feeling" of rigidity. This estimated rigidity was then compared with the required stiffness as evaluated by the pilots' observations of deflections in flight.

Designers now have data that enable them to predict the maximum loads that will be imposed upon each part of a plane. They have methods of analysis by which to compute, during the design stage, the strength of parts and assemblies; and they have developed methods of physical testing by which the predictions and computations may be substantiated.

Thus by means of new materials, refined designs and perfected testing, our modern, structurally-efficient aircraft have been evolved. These developments are factors that help to make operation of our airlines commercially feasible. They have produced the designs that make the performance of our military aircraft unparalleled.

POWER PLANT

The development of aircraft engines during the 40 years since Kitty Hawk is an achievement deserving of a volume. The Wright Brothers themselves built the nine-horse engine that was used in their first successful flight in 1903. Later engine designers worked quite independently of plane designers, frequently too independently. Sometimes airplane designs were otherwise completed before the selection of an engine was made. Even now, planes are designed "around" the chosen (or the available) power plant. The trend, however, is as it should be: toward co-design of plane and power plant.

Generally speaking, increases in airplane size and performance have followed in the wake of the development of engines. Weight-power ratio has been steadily reduced, and fuels have been as steadily improved. The fuel-injection principle and automatic oil coolers have marked important steps forward. The supercharger and the constant speed (controllable-pitch) propeller have made high altitude flying possible.

Like structural improvements, many engine developments have hinged on metallurgical discovery. But the needs for power plant advancement are confined to no one field. Diesels, gas turbines, jet propulsion and even atomic energy experiments are in our laboratories and on our test stands.

Although most so-called aircraft companies are technically airframe manufacturers, they are usually responsible for the complete airplane as delivered to the customer. They buy the bare engine from the engine manufacturer, plus accessories such as carburetor, starter, generator, etc., but then their own power-plant specialists are required to design, with the help of consultation with representatives of the engine builders, the complete fuel, exhaust and cooling systems necessary to produce the finished aircraft. These systems include air intake ducts for carburetor and oil cooler, exhaust collector rings and tail pipes, fuel and oil tanks and transmission lines, turbo-supercharger installations, cowling and nacelle enclosures and a vast hydraulic, electric and cable control system.

In the power-plant field designers need, among other things, a perfected automatic engine-control system. And in overall design, progress from 10 pounds per horsepower to one pound per horsepower is a tremendous advancement, but it isn't enough. We must go further, both toward reduction of weight-power ratio, and toward increase of engine efficiency.

PRODUCTION

Our first commercial airplanes were built somewhat laboriously with the extensive use of many hand tools. Usually they were constructed all in one piece. Repairs and replacements often involved actual destructive operations. Our production engineers have now broken down the fabrication process into component assemblies and sub-assemblies. Repair or replacement, and even final assembly on the factory line, may be accomplished without drills, files or other cutting tools, needing only "a wrench and a screwdriver."

Successful airplane production, like all modern machine manufacturing, depends upon the interchangeability of those parts and assemblies which are intended to be identical. This feature of interchangeability is achieved through the use of ingeniously coordinated jigs and fixtures. Designs then, are executed so that the fabrication process may be adapted to the use of such tooling.

Individual parts are manufactured rapidly and with precision by being designed for production on such machines as the punch press and turret lathe. These machines make possible the aircraft industry's closest approach to true mass production. Such methods of joining as spotwelding and metal stitching are also worthy of mention in this connection.

A large portion of aircraft design work is purely mechanical in aspect; it is the same kind of work that is done in designing a vacuum cleaner, a farm tractor and a Diesel-electric locomotive. Naturally, close attention is given to weight saving; in other respects, airplane design is simply product design.

It is therefore not difficult to perceive the importance of such "design for production" in our industry today. It makes possible the high rate of delivery that will provide the planes necessary to win the war. After victory, the same consideration will be an outstanding factor in controlling costs of commercial aircraft, and of the private planes which many of us will own or operate.

In conclusion, it is not intended to disregard the importance of the great number of inventions and developments that have advanced aviation—using the term aviation as distinguished from airplane design. Most of these applications, although not falling into the categories discussed, are of an engineering nature. Some of them have revolutionized certain phases of flying, and thereby have influenced design. De-icing mechanisms, for instance, have made operation possible in weather that otherwise would be prohibitory. Cabin pressurizing and improved oxygen apparatus have made flying practical at the high altitudes attainable with our supercharged engines. Auxiliary airfoils and high-lift devices such as wing slots and flaps permit operation from small landing areas. Blind-flying instruments and the automatic pilot so extend the range of permissible flying conditions that designs must be modified accordingly.

There are scores of other developments, all of them important; none of them perfected; any of them worthy of considerable effort toward improvement. And as new devices come into use, entire new fields frequently are opened for research.

For young engineers, these fields are tough and competitive, and will be increasingly so, but this condition should not be considered a limitation. The industry will continue to need men who appreciate as being unusual the opportunity for interesting engineering work in connection with aircraft and aviation development.

New Frontiers of the Mind

(Continued from Page 8)

nothing organically wrong with her, just a lot of hysterical symptoms, and I haven't time to bother with her." Sigmund Freud had time, and let the patient tell him her troubles day after day until, to their mutual surprise, she was cured of "neurosis." Freud then wrote an article describing the method of "mental catharsis." Beyond one or two caustic remarks by older and wiser physicians, however, few noticed the article and the world slumbered on, unaware that it was harboring in that drab Viennese office an *enfant terrible* who, in the words of Thomas Mann, was to exert an impact on the twentieth century comparable to that of Darwin on the nineteenth and of Galileo on the seventeenth. Much of modern literature, drama, and painting can be understood only in Freudian terms. James Joyce, Eugene O'Neill, Salvador Dali, to name only three, are saturated in psychoanalysis.

Freud is one of those people who are now pointed out with pride; now viewed with alarm. It is difficult to be neutral and objective about him. His admirers point out the wealth of helpful concepts which he developed—rationalization, sublimation, projection, repression—and a long glossary of others. His critics assert that many of his interpretations were wrong and much of his thinking fuzzy, that his generalizations were so sweeping that they can neither be proved nor disproved, that his methods were far from scientific, and that his emphases were logically untenable. As one wit has put it: "The sex drive is so very important that it is impossible to over-emphasize it—but Freud has succeeded in doing so."

Freud's preoccupation with the sex and death wishes blinded him to the other motives of men, but his critics have to admit that for all his errors Freud's influence was great enough to produce a radical change in the contours of the psychological frontier. He was the hair shirt which goaded us to activity; he was the red flannel underwear which made us scratch in new places. Freud forced us to consider genetic development, especially of the first three years of life; to recognize the existence of unconscious motives and their rationalization; and to attack the problems of frustration. He was frequently wrong, but his wrongness produced much rightness.

NERVOUS BREAKDOWN

Recent studies of "experimental neurosis" probably would never have been performed had it not been for the work of the great Russian, Pavlov, on conditioning. In the early years of this century, one of Pavlov's assistants reported that a laboratory dog had suffered a "nervous breakdown" when presented with a problem which he could not solve. Like many other important observations, this finding lay dormant for years. But in the 1930's in several laboratories, particularly that under the direction of Professor Maier of Michigan, a series of experiments was started to find out why that dog broke down. Maier uses Lashley's basic method—a rat on a pedestal learning to jump to one of two doors. When the rat has learned to go always to the door with the circle on it, Maier bends out the sides of the triangle so that it becomes more and more circular. Finally the rat can no longer discriminate between the two figures; when that happens he is frustrated between his hunger and his desire to avoid a fall into the net. Under stress, individual rat personalities emerge. Some—the Horatio Algers—keep on trying, getting approximately half of their trials correct by chance. Some appear to try—they jump, twist in the air, kick a glancing blow against the door, and land in the net; they get no food but they avoid the punishment. The shy rats refuse to jump. Some develop a "nervous breakdown." A few jump to the floor and rush blindly around the room; some jump hysterically up and down in one spot; some shiver and shake; others lie completely supine, so that they may be pushed or pulled into any position as though they were wax. We get exactly the same symptoms in a mental illness found in humans, catatonic schizophrenia, which is an attempt to solve a problem by completely passive resistance, by utter resignation.

These experiments of Maier and others extend our frontiers for two reasons: They substantiate the theory that some nervous breakdowns, at least, result from psychological frustration rather than from purely physical illness. Moreover, they throw some light on the practical problems of heredity and environment by determining whether the children of neurotic rat parents are more easily disturbed than are the children of "Horatio Alger" parents. To control the environment, it is, of course, necessary to have both neurotic and normal young rats raised by neutral foster parents.

THE FUTURE OF PSYCHOLOGY

All of these studies present certain foci of emphasis which give us clues to the future development of the science of psychology. They show us the psychosomatic principle—that mind and body are a unity, that there are no mental phenomena divorced from physiological or chemical influences, and conversely that there are no body changes which are uninfluenced by mental phenomena. They give us more understanding of what the psychologist calls readjustive behavior. They show us that, whereas we bring into the world an innate pattern of reflexes and of hungers, it is possible to modify these inherited mechanisms to an enormous degree. That means that it is possible to produce either the civilized man or the criminal, the sane or the insane, the selfish or the altruistic, by varying the kinds of conditions under which the child is reared. We know now enough to prevent a considerable percentage of all the insanity and of the crime which bedevils the world, if the public is willing to apply to these problems the techniques which modern science has developed. It is not over-optomistic to state that we also know enough to prevent future wars as we learn to feed properly the fundamental hungers of individual men. Psychologists are emerging from the ivory tower of the early years of experimentation and are taking an increasing interest in problems of social control and progress. The research which they are carrying on will yield better ways of living.

The Marker Principle

(Continued from Page 11)

performs the following tasks in a time interval of about one-half second.

1. The marker locates the test terminals of the called line, using a "number-group-connector" circuit to accomplish this mission.
2. The called line is then tested to see if it is idle or busy, and if found to be busy, the marker orders the trunk circuit equipment to return a busy signal to the calling subscriber. This test also indicates what type of ringing current should be applied in order to signal the proper party on the line.
3. From the test terminals the marker then determines the location of the called line on the line-link frame.
4. The marker then selects a clear channel for a talking circuit from incoming trunk to the called subscriber's line, in the same manner that the originating marker set up a channel from the calling subscriber to the outgoing trunk
5. Under control of the marker, the relay equipment in the incoming trunk circuit applies the proper type of ringing current to the called line and sends an audible ringing signal back to the calling party.
6. If the called number is that of a P.B.X. (private branch exchange) or a subscriber having more than one line, the marker will recognize this arrangement and test all of the lines associated with this subscriber's listed telephone number, testing as many as 20 simultaneously, and will select an idle one. A point of special interest here is that whereas all previous telephone switching systems required that all the lines to one subscriber be numbered consecutively to permit this "trunk hunting" feature, the crossbar system with its marker operation permits scattering the trunks of a P.B.X. group, or they may even be assigned in certain instances to a special group of numbers outside the regular 10,000 series. This scattering of trunks which have high incoming calling rates is of particular interest to the traffic engineer since it permits better balancing of the load carried through the various channels of the equipment.
7. If the number which has been called is an unassigned line, or one which has been disconnected, the marker recognizes this condition, and routes the call to a special intercepting operator.

TROUBLE INDICATOR CIRCUIT

With a system as intricate and complicated as the crossbar system, the location of the source of trouble would be a very involved process, and would cause equipment which should be working at a high call fill to be held out of service a considerable length of time unless some automatic trouble-indicating feature were included. When a marker encounters circuit trouble, it routes the call over an alternate channel and calls in a trouble indicator circuit which locates the trouble and sounds an alarm, thus permitting the repairman to get the faulty equipment back in service in a minimum length of time.

NEW TYPE RELAY

One item of equipment which has not been mentioned thus far but which contributes in a large measure to marker operation, is a new type of relay which is called the "multi-contact relay." This relay employs two magnets and two armatures, each of which operates half of the contacts. With both halves functioning together, the relay will close 60 contacts simultaneously; however, the halves may be operated separately with a maximum of 30 contacts each. Each contact is double, the end of each moving contact spring being forked with a contact on each tine of the fork. With a single contact the number of failures per thousand operations is very small, but with two contacts in parallel, the probability of failure is negligible. With this type of relay, the large number of circuits in the marker can be extended to the associated equipment almost instantaneously, permitting a high call handling capacity for each marker.

CONCLUSION

Present indications are that the marker principle is here to stay, and new applications of this type of circuit continually are being discovered. That this is not just a laboratory model, but is a commercially-proved system is evidenced by the initial installation which has been functioning in New York for several years, and other installations scattered across the United States, including two or three in the East Bay district of San Francisco. To date none has been introduced in southern California, the step-by-step system being used exclusively in this area thus far. As far as the telephone user is concerned, he places a call through a crossbar system in exactly the same way that he does through a step-by-step system, but to the telephone engineer the introduction of the marker principle represents an entirely new approach to the problem of telephone switching.

Flash of Genius Doctrine

(Continued from Page 4)

Patent Office then the Patent Office must institute a new type of prosecution in which each inventor-applicant is required to show his personal prior art. The ramifications of such a requirement in cases of research organizations of any size constitute a tremendous burden. A premium would be placed upon fraud, deceit, and misrepresentation.

It is clear that the time has arrived when legislative enactments must be forthcoming which will restore the patent law to a sound position. The current judicial trend, visible from many signposts, is toward the elimination of patents as a factor in American economic life. The question of what is to be considered a patentable invention is but one of a number of questions to be considered as is indicated by the "Report of the National Patent Planning Commission" *(XXV J.P.O.S. 455)* and by the Committee Report to the Patent Law Associations of the United States, entitled "Program for the Development of American Patent Law and its Administration" *(XXVI J.P.O.S. 104)*. Whether or not a "uniform test or standard" for determining patentability, as recommended by the Commission, is possible or practical is doubtful. There is no doubt, however, but that the "flash of genius" should not be that test or standard. A statute which does no more than eradicate this cancerous misconception and which leaves to courts of original jurisdiction the determination of each case upon its merits will be a real step forward.

C. I. T. NEWS

MECHANICAL ENGINEERING LABORATORY IN PROCESS OF CONSTRUCTION

Excavation for a Mechanical Engineering Laboratory was started in September. The building covers an area of approximately 50 by 70 feet opposite the Aeronautics Building, and adjacent to the alley which comes into the campus from San Pasqual Street. The building will consist of two basements and three stories above ground, and will house a portion of the Mechanical Engineering Department equipment and offices.

The immediate necessity for this building was the result of the large amount of space required for War Project work on the campus. In addition to providing quarters for the Mechanical Engineering Department some space will be temporarily utilized by the Construction and Maintenance group of the Institute.

It is of particular interest to note that the contract for the construction of this building was awarded to Ray Gerhart, class of '13, who is a Pasadena contractor. It is hoped that this laboratory will be the first of several units to be built after the war to provide for other facilities of the engineering departments. Present plans call for the completion of the unit now under construction some time in February, 1945.

1943-44 MEMBERSHIP

Affairs of the Caltech Alumni Association are conducted on a fiscal year basis from July first to June thirtieth, each year. An item which may be of interest to the Alumni is that concerning the number of participating members for the fiscal year ending June 30, 1944.

A recent tabulation shows that there were a total of paid members amounting to 1,200 and of these 171 were fully paid Life Members. It is somewhat difficult to arrive at a figure indicating the total number eligible for membership but based on an approximation of the number, we find that about 40 per cent of those eligible, actually paid dues for the support of the Association. Insofar as information is available concerning similar associations, it appears that this is a very good record.

ATHLETICS

UNDEFEATED, untied, and unscored on, Caltech's powerful football team closed an enthusiastic, but brief, season early in October. Final exams, Commencement and vacation placed a natural limitation on the schedule.

When the coach, Chief Specialist Mason Anderson, assembled the squad at the opening practice in August, it appeared that a strong and experienced team was in the making. Soon installed in starting positions were: Don Tillman (220), Associated Student Body President at center, John Sogorka (215) and Leo Coda (160) guards, Paul Kohlhaas (211), and John Nichols (195) tackles, and Don Snyder (195) and Howard Westlake (165) ends, Ross Dana (185) and Leo Voyles (180) halves, Bill Young (197) quarter and Bill Gulley (175) full. This lineup started all games. The line averaged 194, the backs 184 and the team 194. Dana, Young, Kohlhaas and Sogorka played at Stanford, and Gulley, Snyder and Coda had junior college experience. Tillman and Nichols were Caltech students as civilians and had played in high school.

In the opening game at the Rose Bowl, Tech trampled rough-shod over the Redlands Bulldogs 67-0. Striking swiftly behind a well oiled offense, the Beavers scored their first touchdown in five plays, and rolled up a 27-0 halftime score. Tech scored at will and even the playing of reserves for more than half of the game did not retard the scoring. The Engineers rolled up 17 first downs and 405 yards, while holding the Bulldogs to three downs and 28 yards.

Leo Voyles scored three times on reverse plays, while Ross Dana, at half, and Bill Gulley at full, were consistent ground gainers.

The return game at Redlands resulted in a 39-0 Tech victory and started out as a repetition of the preceding game. The Beavers scored in the first eight minutes on a 20-yard forward pass from Gulley to Dana and a 27-0 lead was again established at half time. In the second period, Redlands opened up with their spread formation and flanker passes, and while always threatening, never were able to penetrate the Caltech 20.

Playing in the Coliseum, Tech maintained its perfect record in trouncing the U.S.C. Jayvees 20-0. The Engineers took the opening kickoff and marched 88 yards to score in the first four minutes. Ross Dana put the ball in scoring position with a 38-yard run, and Leo Voyles scored on a reverse from the three-yard line. Three plays later, Voyles raced 65 yards on another reverse to score the second time. Final tally came in the third quarter when Bill Gulley plunged from the three-yard line, after a 56-yard march.

In the final game, Tech handed U.C.L.A. Bruin Jayvees a 33-0 defeat in the Rose Bowl. Sparked by Ross Dana, who crossed opponent territory twice, and was on the tossing end of another score, and Bill Gulley, whose deft aerials and runs set up three tallies, the Engineers tallied in every quarter but the third. When the final gun popped, the winners had marked up a total of 20 first downs against a mere four for the JV's.

Forty-five men were retained on the squad all season, and practically all men were used in all games. The starting lineup, however, was seldom used more than half of any one game.

Thus ended the season for the greatest football team in Caltech history. Coach Anderson produced a smooth and well drilled team, which was tops in all departments. The diversified attack and the precision in execution made it one of the most interesting of all Caltech football teams.

PERSONALS

1898

The president of the American Telephone and Telegraph Company, Walter S. Gifford, announced that the company has established a trust fund to finance post-doctorate fellowships in physical science in honor of DR. FRANK B. JEWETT, president of the National Academy of Sciences and vice-president of the American Telephone and Telegraph Company. Dr. Jewett retired from active service in September.

1920

PROFESSOR WARREN L. BEUSCHLEIN of the chemical engineering department and a member of the University of Washington faculty, passed away September fifteenth in Seattle. Through his untiring efforts, Professor Beuschlein is credited with having built the chemical engineering department of this university into one of the best in the country.

1922

GLEN M. WEBSTER has been promoted to lieutenant colonel. He is stationed at Oregon State College at Corvallis.

LIEUTENANT STANLEY VAN DYKE has been missing in action since the plane on which he was navigator, failed to return from a raid on Kiel a year ago.

MAJOR JOHN E. SHIELD is now serving as a civil affairs officer with the British Army in Normandy.

1923

BASIL HOPPER who has been identified with the Union Oil Company since graduation, is vice-president in charge of manufacturing and will direct all refinery operations.

1924

W. L. HOLLADAY has recently taken a position with General Air Conditioning and Heating Company of San Francisco and Oakland as refrigerating engineer.

1926

HARRY E. CUNNINGHAM, senior engineer with the U. S. Bureau of Public Roads, Washington, D. C., has completed the law course at George Washington University and was awarded the degree of Juris Doctor "with distinction." Harry did it the hard way (six years of night school) and realized a long-standing ambition.

JAMES M. CARTER has recently resigned from Aero-Jet Engineering Corporation and is now engaged in consulting work.

GEORGE RUSSELL is employed by Union Iron and Steel Company of Los Angeles.

FRANK STREIT was at C.I.T. in September, travelling in connection with O.S. R.D. work he is doing under sponsorship of Columbia University. He is coordinator on a project.

LIEUTENANT COLONEL STUART SEYMOUR has been transferred with his anti-aircraft group from Muroc Lake to Fort Dix, N. J.

LIEUTENANT G. W. CLAPP is Assistant Naval Officer of Squadron DTC-18 C, Rodd Field, Naval Auxiliary Air Station at Corpus Christi, Texas. Before the war, he was engaged in advertising work for the Philadelphia Rapid Transit Company.

1927

RAYMOND E. COX now holds the position of chemical engineer for Bireley's Division of General Foods Corporation in Hollywood, Calif.

CAPTAIN THOMAS SOUTHWICK was at home for a few days on his way to Camp Beale. He has been at Fort Belvoir for a couple of years.

M. MAXWELL BOWER since the first of the year has been in charge of the Systems Branch of the Camp Evans Signal Laboratory at Belmar, N. J. His home is at Fort Monmouth.

1928

FRANK NOEL is resident engineer for California Division of Highways on a Federal access road to the Army's Hammond Hospital at Modesto, with headquarters at Stockton, Calif.

1929

RICHARD G. ROFELTY for the past two years has been employed in Alaska as project engineer for the Guy F. Atkinson Company.

LIEUTENANT (J.G.) HAROLD A. CORBIN is now stationed at the anti-submarine warfare headquarters in Norfolk, Va. He writes "my present job is interesting but the hours are terrific, involving many all-night sessions for as much as 22 hours at a stretch."

It is with deep regret that we report the death of MAURICE H. SINRAM on October 16, after a two-day illness. He was employed in the Traffic Department of the Southern California Telephone Company, Los Angeles. He is survived by his wife.

LIEUTENANT COLONEL ALLEN W. DUNN writes that on July 29, he and two other alumni, Major Ed Joujon-Roche, '28, and Captain Robert G. Macdonald, '33, met at the Camp Sutton Officer's Club. Captain Macdonald is now Second Battalion Commander in Colonel Dunn's regiment after having returned from prolonged sea duty in the South Pacific. Colonel Dunn is commanding the 1318 G. S. Regiment.

LIEUTENANT COMMANDER F. A. WHEELER was chief engineer of the U.S.S. Princeton, a medium-sized fast carrier, which has been reported lost in waters of the Philippines. For the past three years Fred has been "riding the waves" with the Navy.

1930

RAYMOND W. HOEPPEL announces the arrival of Ronald Edward, born August 30, 1944.

R. STANLEY LORD has been assigned as principal assistant in the U. S. Geological Survey (Water Resources Branch) at Salt Lake City, Utah.

1931

JOHN R. McMILLAN announces the arrival of his little daughter Linda Jean.

LIEUTENANT COLONEL BEN HOLZMAN after spending an adequate time at bases in the North Atlantic, is now on duty with the U.S. Strategic Air Forces in Europe.

1935

GEORGE JARVIS TOOBY and the former Miss Genevieve Grace Ferrier came up the aisle as husband and wife at a recent formal wedding in Pasadena, Calif.

LAMAR McMILLIN announces a future Caltech registration in the class of '68; F. L. McMillin, Junior, who has just made a "personal appearance."

NELSON P. NIES, N.D.R.C. Chemist for Dugway Proving Ground at Tooele, Utah, stopped at the Institute for a chat while in Pasadena a few weeks ago on vacation.

CAPTAIN BOB BARD (BAKEMAN) who is with the Engineers in New Britain, writes that the American soldier will always be interested in sports, and that athletic contests are constantly in progress just a short distance behind the fighting lines.

HOWARD GLUCKMAN and Mrs. Gluckman are the proud parents of a son, whose arrival was an event in early summer.

1936

AL CREAL is in Washington using his scientific knowledge in the purchase of trick equipment for the marines. He saw some real action in Tarawa. He's a lieutenant colonel now.

ENSIGN HOWARD GERFEN, U.S.N.R., assigned to the U.S.S. Cornell, was visiting at the Institute before going out on the high seas.

1937

ROBERT B. LOCKWOOD is proud to announce the birth of a daughter named Lynda, who came in July.

LIEUTENANT COLONEL WM. J. ELLISON is serving overseas in the New Guinea area.

LIEUTENANT (j.g.) RIDGELEY LEGGETT is radar officer aboard a submarine operating in the South Pacific.

1938

R. C. STONE is employed by C.I.T. as research assistant on one of their projects at Inyokern, California.

HOWARD S. SEIFERT is working at the GALCIT No. 1 Project as project engineer.

LUIS TEJADA was receiving congratulations around the Institute on his announcement of the birth of a son, August 29.

CLAY T. SMITH and Mrs. Smith of Grand Junction, Colo., announce the arrival of a son, Dean Austin, on September 24, 1944.

1939

MAJOR PAUL ENGELDER spent several days on the Campus recently, having been on duty at the Marine Headquarters at Washington, D. C. for the past year. At the conclusion of his furlough, he expected to leave for further duty in the South Pacific.

GEORGE CROZIER has been promoted to hydraulics design engineer at Lockheed Aircraft, Burbank, Calif.

1940

GILBERT R. VAN DYKE who is serving with the meteorological section of the Army Air Forces, has been promoted to major.

ROBERT B. GLASSCO has recently received the rank of Ensign and is at the Naval Air Station in San Diego in the Assembly and Repair Division.

WILLIS G. WORCESTER writes that he is the proud parent of a baby daughter, Nancy Toy, born on June 17. Willis is working in the General Engineering Laboratory, General Electric Company, Schenectady, N. Y.

JOHN W. JACKSON has been promoted to Associate Professor of mechanical engineering at the University of Maryland.

1941

JOE LEWIS, JR. Joe was home on a 15-day leave from basic training at Farragut, Idaho. At present he is in Radio

Tech School at Chicago. His rating is seaman, second class. Joseph W. Lewis, III, is the "master of the house" now since his arrival on August 3.

JOSEPH F. ROMINGER recently commissioned as ensign in the U.S.N.R. is at the Princeton Indoctrination School.

ENSIGN PHILLIP BROOKS, U.S.N.R. recently finished his Navy indoctrination at Fort Schuyler, New York City, and is now stationed in the Navy Bureau of Aeronautics, Washington, D. C.

DONALD E. DAWSON has been playing the role of father since last May on arrival of Terrell Edwin Dawson.

DR. HORACE RUSSELL, JR. Friends of Dr. Russell will be grieved to learn of his sudden death in August as the result of injuries incurred in a fall while horseback riding. He was on the staff of C.I.T. for five years where he served as research fellow and instructor in inorganic chemistry. At the age of 27, he was one of the most promising young chemists in the country.

ENSIGN GRICE AXTMAN after completing an indoctrination course at the University of Arizona, has recently been assigned to duty at the David Taylor Model Basin at Carderock, Md. Prior to entering service, he had been an industrial engineer with the Southern California Gas Company, Los Angeles, Calif.

LT. (J.G.) GLENN BILLMAN, who had been ordered to the Naval Academy at Annapolis for a year's post graduate course, suddenly found his orders cancelled and has been assigned to another carrier.

1942

BOYD T. MARSHALL and Miss Billie Rose Christensen were united at a smart wedding event which took place in late summer.

ROGER BRANDT is supervisor of material efficiency in the Cathode Ray Tube Plant of Sylvania Electric Products Company, Emporium, Pa.

LLOYD W. MERRYFIELD is a private in the medical department of Fitzsimmons General Hospital in Denver, undergoing medical laboratory training.

LIEUTENANT FRANK A. FLECK having finished teaching at Central Instructors' School for Navigators in Louisiana, is now stationed at Long Beach, Calif., where he will ferry planes to the South Pacific.

FRANCIS C. LYLE and Miss Sabilla Elizabeth Nichols of Pasadena were married at the Pasadena Wedding Chapel early in October.

LIEUTENANT AL LANDAU, former soccer coach at the Institute, participated in the invasion of France in Normandy.

LIEUTENANT GEORGE MEYER has finished his special course at the sub school at New London, Conn., and is now on duty in the Pacific.

LIEUTENANT ROBERT ANDERSON, US.N.R., visited Caltech on his way to Bureau of Aeronautics, Washington, D. C., after 20 months of service in Australia and the South Pacific.

CARTER HUNT has been on the U.S.S. Fulton for five months and has recently been promoted to full lieutenant.

RICHARD LATTER has been promoted to full lieutenant. Upon entering service as an ensign, he was given a two-months' course at Cornell University, then assigned to duty in the Radar section.

GEORGE P. SUTTON and Miss Kathleen McMullan were united in a formal church wedding at St. Paul's Presbyterian Church in Los Angeles. The groom is employed at Caltech as an instructor in mechanical engineering.

LIEUTENANT (j.g.) HARRY MADLEY is in charge of testing and repairing equipment at the Naval Supply Depot at Clearfield, Utah. He has held this post for nearly a year.

HOWARD C. HALL. In late June, Mr. Hall was inducted into the Navy on a radio technician program and is stationed at Great Lakes, Ill.

ROBERT MERRICK spent his vacation in Pasadena. He is with the U. S. Rubber Company at Charlotte, N. C., in the capacity of assistant general foreman. His plant is manufacturing 40-mm ammunition for the Navy.

PAUL MADER is with the same firm as Bob Merrick but with the Naugatuck Chemical Division at Naugatuck, Conn., doing laboratory work.

1943

LIEUTENANT (j.g.) WILLIAM HALPENNY has been assigned to the Post Graduate School at the Naval Academy for a year and a half course in naval engineering.

LIEUTENANT (j.g.) CHARLES McDOUGALL as a blimp-patrol pilot, has been flying the submarine patrol off the coast of South America.

FIRST LIEUTENANT HOLLIS HANCHETT stopped in the Institute for a chat. He had been stationed at Lowry Field but was being transferred to McCook, Nebr.

ENSIGN DOUGLASS REID was visiting in Pasadena while on leave. He is stationed on a destroyer in the South Pacific.

ROBERT M. BENSON and Miss Vlasta A. Svatek of Franklin Square, New York, were married late in the spring. Bob is an assistant project engineer for Sperry Gyroscope Research Laboratories at Garden City, N. Y.

ENSIGN CHARLES P. STRICKLAND, JR., is in the engineering department aboard an aircraft carrier which has seen action in the South Pacific.

1944

LIEUTENANT RICHARD DAVIES is a navigator on an army bomber and is now stationed in England.

CADET LOUIS GOWANS Ex. '44 is taking his naval primary flight training at Peru, Ind.

JOHN NELSON returned to his home in Honolulu after graduation, to accept a position with the Honolulu Gas Co.

AL SAPLIS has been inducted into the Army and is stationed at Camp Roberts.

A. JOHN A. MORGAN, seaman 2nd class is based at the Naval Air Station in San Diego. He is a draftsman in the Assembly and Repair Division.

RICHARD GILMAN has just been commissioned second lieutenant, Marine Corps, having completed training with an officer candidate class at Quantico, Va.

FRED W. MORRIS, JR., is in Officer's Candidate School in Signal Corps at Fort Monmouth, N. J.

JIM PLOESER is at Cornell Medical School doing research. He was married recently at Providence, R. I.


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