INSANE DRIVERS

A Menace to Motorists

SCIENTIFIC AMERICAN

Including:
A DIGEST OF
SCIENCE & INDUSTRY

. . also . .

Amateur Photography

By Jacob Deschin

Vol. 161

•

No. 4

OCTOBER
1939

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a Copy

For MEN

who want to become independent in the NEXT TEN YEARS

IN the Spring of 1949 two business men will be sitting in a mid-town restaurant. "I wonder what's going to happen next year," one of them will say. "My business is fine now—but the next few years are going to be hard ones, and we may as well face the facts."

The man across the table will laugh.

"That's just what they said back in 1939," he will answer. "Remember? People were looking ahead apprehensively—and see what happened! Since then there has been the greatest growth in our history—more business done, more fortunes made, than ever before. They've certainly been good years for *me*."

He will lean back in his chair with the easy confidence and poise that are the hallmark of real prosperity.

The older man will sit quiet a moment and then in a tone of infinite pathos:

"I wish I had those ten years back," he will say.

● Today the interview quoted above is purely imaginary. But be assured of this—it will come true. Right now, at this very hour, the business men of America are dividing themselves into two groups, represented by the two individuals whose words are quoted. A few years from now there will be ten thousand such luncheons and one of the men will say:

"I've got what I wanted."

And the other will answer:

"I wish I had those years back."

In which class are you putting yourself? The real difference between the two classes is this—one class of men hope vaguely to be independent *sometime;* the other class have convinced themselves that they can do it within the next few years. Do you believe this? Do you care enough about independence to give us a chance to prove it? Will you invest one single evening in reading a booklet that has put 400,000 men on the road to more rapid progress?

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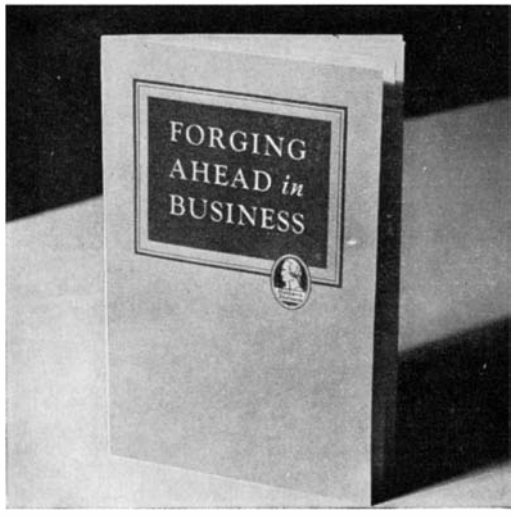

"FORGING AHEAD IN BUSINESS" is an interesting, helpful booklet. It is yours for the asking. Send for it. Measure yourself by it. Look clearly, for a few moments, into *your* next few years. Whether or not you will follow the path it points is a matter that you alone must decide.

● ● ●

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The SCIENTIFIC AMERICAN DIGEST

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NINETY-FIFTH YEAR • ORSON D. MUNN, Editor

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DESIGNED to test the effect of water upon brakes, to test the tightness of new car bodies, to determine the controllability of cars as they hit large pools of water, and to assist engineers to protect ignition systems against flooding, the new water pit illustrated on our front cover has been installed at the Ford Motor Company test track at Dearborn, Michigan. Our cover illustration shows a new car being driven through the pit at 60 miles an hour.

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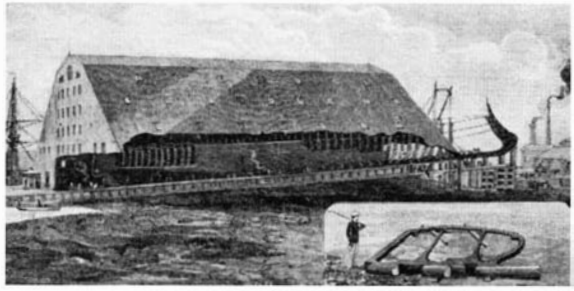
50 Years Ago in . . .

Scientific American

(Condensed From Issues of October, 1889)

MAINE—"The steel cruiser Maine, in course of construction at the Brooklyn Navy Yard, is now in skeleton condition, most of the frames being up. When completed she will be the largest vessel ever built for the United States Navy, being of 6648 tons displacement. The mammoth shed where the work is in progress was erected during the Civil War . . . Doubtless, to its constructors, the dimensions of this shed seemed sufficient for the longest craft that was likely to be built. Yet the prow of the Maine, with its steel ram and spur, extends many yards into the open. Inside this shed nearly three hundred men are now at work."



BENDING — "The largest bending rolls that the Niles Tool Works are now building for the Mare Island Navy Yard, San Francisco, possess very interesting features. . . This machine will bend mild steel plates 2 in. thick by 22 ft. wide. It is guaranteed to bend armor plate 1½ in. thick by 22 ft. wide. The work is done by four forged rollers, two in the center, arranged one vertically over the other, to grip the sheet between them, and one on either side of the center to bend the sheet."

FLOOD—"During the Conemaugh flood, thirty-two locomotives, some of them weighing 91,640 lbs., were tossed about like corks, 23 of them being conveyed an average distance of 1347 feet down stream, one going 4844 feet, the shortest trip being 480 feet."

PARCELS POST—"In June last the Postmaster-General submitted to the Chilian minister the draught of a convention between the republic of Chile and the United States for the establishment of a parcels post system and a postal money order system between the two nations."

TRANSANDINE RAILWAY—"The Andes are being crossed at the Uspallata or Cumbre Pass, where there will be a tunnel 3.1 miles in length, at an elevation of 10,450 ft. above sea level. The pass itself is nearly 3000 feet higher, or at 13,015 ft. and is situated 4¼ miles south of Aconcagua and 3.84 miles north of Tupungato, in 33 degrees S. latitude. It will thus be seen that the summit level of the Transandine Railway is far above any European lines, which at the Rigi reach to 5753 ft., and at the St. Gothard 3788 ft."

WAGES—"Some paper has started the silly question, 'Do Inventions Decrease Wages?' Certainly they do not. On the contrary, inventions increase wages, shorten the work day, and decrease prices. In fact, inventions constitute the only possible way by which labor can be emancipated from drudgery, long hours, and poor pay. Inventions are increasing every year, and wages are constantly advancing in all countries where they are utilized."

YELLOW FEVER—"Dr. George M. Sternberg, surgeon in the United States Army, has just returned from a six months' stay in Cuba, where he has been continuing his researches with reference to yellow fever. He has brought with him specimens of microbes, with which he will continue his investigations during the winter at the Johns Hopkins University."

PHONOGRAPH—"In reply to numerous inquiries we can only say the phonograph has not yet been reduced to that simplicity and perfection of operation necessary for its general sale and introduction. It is true, several examples have been produced which are in use, and many interesting experiments have been made . . . But in most cases, in order to get really satisfactory results, we believe it needs the employment of an expert to watch, adjust, and work the instruments. We are informed the machine has recently been improved so as to dispense with all adjustments, thereby rendering it entirely automatic, and making it practical in the hands of everyone. If the phonograph has reached this stage of simplicity and perfection, we predict for it a bright future."

WHEELS—"Carriage manufacturers are predicting that in the not distant future wooden wheels will be done away with, and steel wheels substituted, on account of the increasing scarcity of lumber for wheels."

CRUISER SPEED—"Advices from San Francisco state that the calculations regarding the horse power speed developed by the cruiser *Charleston*, just completed by the trial board, show a maximum horse power of 7093 and an average horse power of 6816 for four hours; average speed, 18.75 knots, though a maximum of 19½ knots was developed for a short time."

DANGER—"The most curious protest against railways . . . was that drawn up by the Royal College of Bavarian Doctors, recently discovered in the archives of the Nurnberg Railway at Furth, the first German line constructed. It contains the following passage, pointing out the danger of the new system of travel: Travel in carriages drawn by a locomotive ought to be forbidden in the interest of public health. The rapid movement cannot fail to produce among the passengers the mental affection known as *delirium furiosum*."

DRILL—"An interesting electrical machine can be seen in operation on the framework of the new warship *Maine*, in the Brooklyn Navy Yard. It is a drill. Instead of the slow and tedious pawl and ratchet hand drill commonly used, is one that is set a-whirling by an electrical current sent through carefully insulated wires. A three-quarter inch hole in a three-quarter inch plate can be drilled in less than a minute."

AND NOW FOR THE FUTURE

¶Defense of American Ports Against Possible Invasion, by F. D. McHugh.

¶In the Home Land of the Earliest Settlers of the Valley of the Nile, by Major R. A. Bagnold.

¶The Mesotron, and How Modern Physicists Tracked it Down, by Charles W. Sheppard.

¶Protecting the City of Los Angeles Against Floods, by Andrew R. Boone.

¶Man, as a Machine, is a Mechanical Misfit, by G. H. Estabrooks.

OUR POINT OF VIEW

Co-operation

HOPE for a future of safer motoring, and for longer lives for members of the motoring public, may be gleaned from three articles in the present number. First is "Insanity at the Wheel," on page 199, second is "Self-Contained Unit Headlight," and third is "Motoring Eye Health for 1940," the last two appearing in the Digest section. It does not take much reading between the lines to realize that here are examples of tangible co-operation between diversified forces, all acting toward the common good.

With psychiatry bending commendable efforts toward weeding out the unfit among drivers (we hope this will continue on an ever-expanding scale), the electrical industry directing research toward better and safer lighting for motor cars, and the glass companies developing better and safer safety glass for windshields and car windows, we find many reasons to believe that the death toll on the highways, reduced in 1938, will be still further reduced during 1939 and 1940.

Now, if more and more drivers will only awaken to a realization of what is being done to protect them against themselves and will contribute their share to the co-operative effort, we can really get somewhere in the matter of highway safety. Naive though it may seem at first blush, it is nevertheless a fundamental truth of motoring that individual applications of the Golden Rule to the rules of the road will go a long way toward making for safer and happier driving. —*A. P. P.*

Pan-American Trade

TRADE with Mexico and Central and South America looms large in the thoughts of some of this country's commercial interests. Partly, there is the profit motive but more important is the item of self defense. Freer intercourse between the peoples of the Americas, more enlightened good-will and mutual respect, and an equable exchange of goods and services, all will assist in stemming the tide of foreign ideologies which threaten the peace and independence of several of our southern neighbors. The less this hemisphere is dependent upon nations of other parts of the world, the less likely there is to be coercion—economic, political, and social—from those quarters.

Yet despite the need for closer co-operation so that our export-import problems might be solved, there are those who blandly refuse to open their minds to logic. Notorious is the hatred some South Americans have for the United States. This attitude, however, is understandable—and curable, too, if it is properly attacked, vigorously and with open minds and sympathetic hearts. But those who despise all Norte Americanos fall far short of being as stupid as some in this country who wish to increase their export business. These are the ones who, with important export products, never, or half-heartedly, attempt to get the prospective buyer's viewpoint.

Many American companies think that they can get foreign business by the same tactics with which they get it at home. They believe the star salesman in the States can get volumes of business abroad whether he knows the language, habits and customs, likes and dislikes, and manner of doing business of the foreign people to whom he would sell. These same companies answer their foreign correspondence incompletely and apathetically. Cases are known in which queries, involving the expenditure of large sums, when sent to European producers and to this country simultaneously, elicited detailed answers by air mail from the former, with technical data and catalogs, and a mere acknowledgment by ordinary mail from the American companies concerned.

The answer is obvious. If we are to expand our export trade—if we really want to!—and thus keep our farms and factories operating at a higher efficiency, we must develop a new understanding of the problem. It becomes necessary that we look with serious eyes at the faults in our system and then use a little gray matter to correct them. The stakes are worth it—for all the Americas.—*F. D. M.*

T. Hart Anderson

RICHNESS of achievement marked the life of T. Hart Anderson, nationally known patent lawyer and director of Scientific American, who passed away at his New York City home on August 15. His age was 74. A native of Louisville, Kentucky, he had been an Examiner in the United States Patent Office, a lawyer in Boston and New York for 44 years, and our director for several years.

"Judge" Anderson's genial smile will long live in the memories of his friends and associates. Many will, indeed, continue to try to emulate him, for he had attained that precious friendly calmness, so rare in these rushing times, that remains unruffled by the affairs of little men. Possessed of a judge-like dignity and a superior knowledge of law —especially of that pertaining to patents—he commanded the respect and admiration of men and courts alike.

His gentle manner, coupled with his many successes in significant litigation, suggest as an epitaph for him the old Latin phrase of lawyers: "Suaviter in modo, fortiter in re."

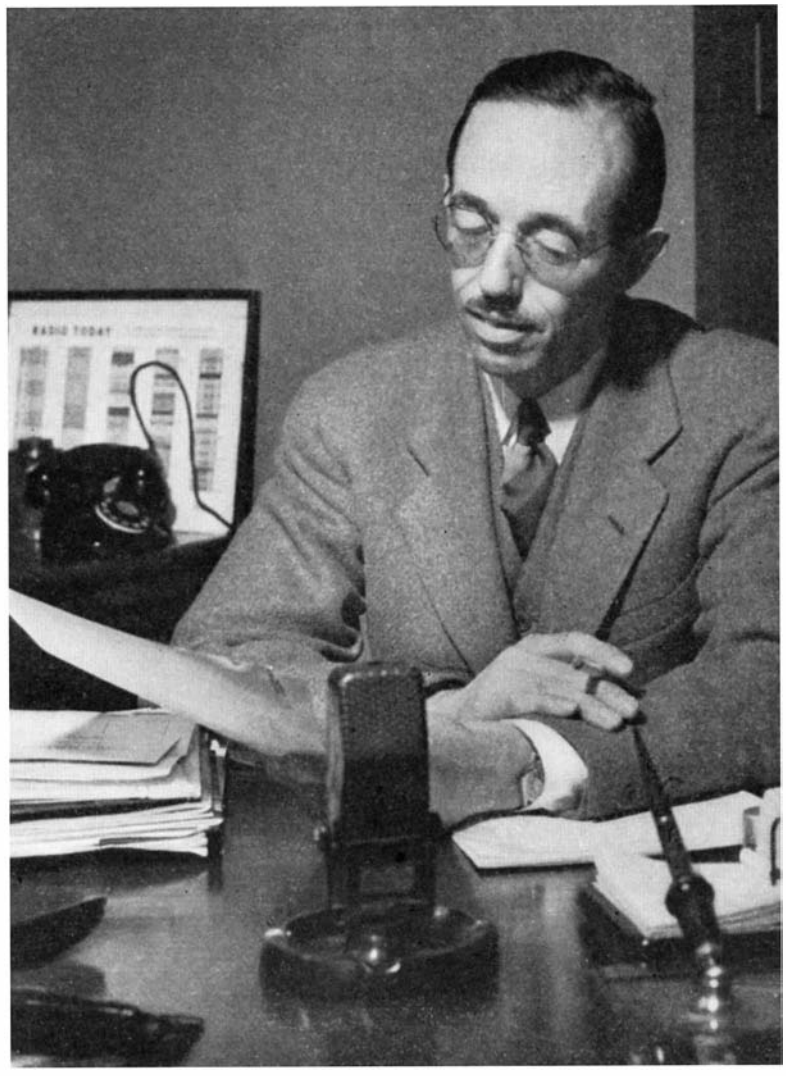
Degrees, Comfort

EVERYBODY knows that there are days when the thermometer is a liar. On a given day in midsummer, let us say, it stands at 88 degrees, which is really hot in some places, yet the day may be quite agreeable. Perhaps on the next day the mercury has fallen a full ten degrees, yet life may be almost unbearable. We say that the first day was dry, while the second was muggy. In more scientific terminology, the relative humidity—that is, the ratio of the amount of water vapor mixed with a given amount of air to the amount that the same air will hold at the same temperature—has changed from low to high. Moving up more closely to what actually goes on when the muggy day comes, the number of water vapor molecules in the air has increased, the effect is to cause a larger number of speeding molecules to leave the air adjacent to the victim and add themselves to the sticky film of liquid in which he is bathed, in proportion to those which, similarly speeding, simultaneously escape from him. Thus his net evaporation is reduced and he probably goes around all day "beefing" about it's being hot and getting himself glared at by others who already know it. Yet on such a day it isn't as hot as it was yesterday when it was so comfortable.

A thermometer gives but one factor in measuring bodily comfort; relative humidity adds a second, while a third is air movement.

An instrument combining these three factors is now available but before its use can become widespread the public must be taught what relative humidity is. By publishing relative humidity percentages some newspapers arouse curiosity and in time the scientific point of view may be inculcated. Good work—keep it up.—*A. G. I.*

Personalities in Science



O. B. HANSON

ONE generally thinks of an engineer as a technical man talking in mathematical terms and thinking with a slide rule. But O. B. Hanson, vice-president and chief engineer of the National Broadcasting Company, is one of the rare exceptions.

"O B," as Hanson is known to his associates, is essentially an artist with the inquisitive mind of a scientist. Thinking in terms of an artist and working as a scientist is the secret of Hanson's achievements in the field of radio and television.

Born at Huddersfield, England, Hanson was brought to this country at the age of one, when his father moved the family woolen business to Connecticut. Young Hanson showing an early aptitude for music and drawing, his family later sent him back to England for eight years of study at the Royal Masonic Institute in Hertfordshire where, in addition to his regular classes, he had special instruction on the violin.

Hanson says that he never really cared for the violin and wanted to play the piano, but his family insisted. However, he had no intention of making music his life work. He would probably have become an architect, if it hadn't been for the sudden death of his father. That event put an end to his ideas for a higher education and, as a boy of 16, he returned to America and went to work in the Underwood Typewriter Company's factory at Hartford, Connecticut.

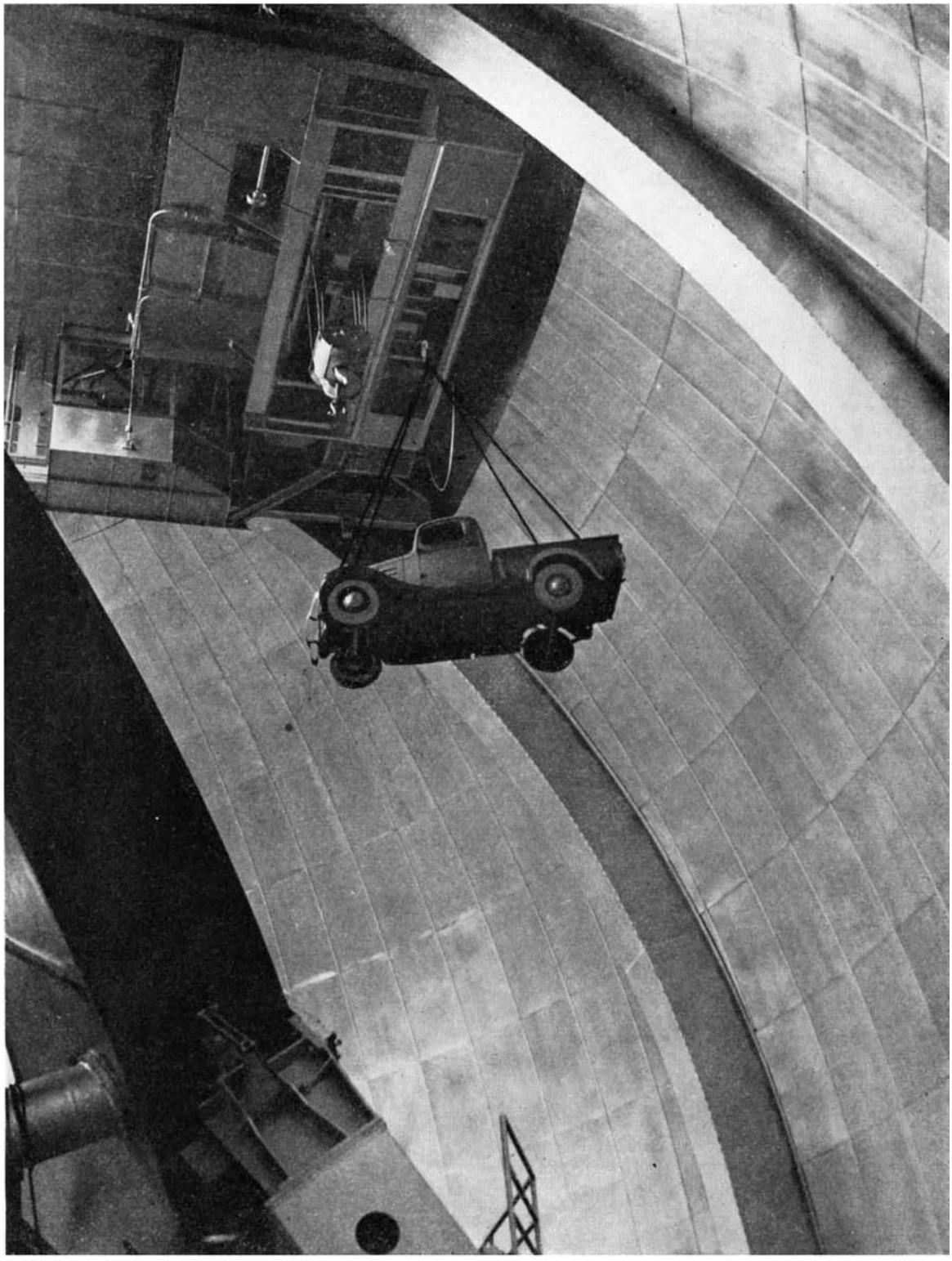
Hanson's interests became centered on wireless telegraphy in 1912 when the *Titanic* rammed an iceberg in the North Atlantic and sank with an appalling loss of life; for it was only through the ship's wireless that a horrified world learned of the tragedy. It was not wireless telegraphy as such, however, that intrigued the eager youngster; it was the unexplored possibilities of its development. He soon began to think in terms of radio telephony and, later, of television. Here was work to tax the artist's imagination and bring into play all the skill of the scientist. Here was his life's job, an unexplored field in which he could revel.

In 1917, Hanson became a member of the Marconi Company's engineering staff, rising to the position of chief testing engineer in six months. The war over, he had a short fling as head of his own electrical business in Hartford. Then in 1920, station KDKA, Pittsburgh, owned by the Westinghouse Company, had begun regular broadcasting and Hanson built himself a receiver and listened to the first test transmissions. Immediately his course was decided. That course led eventually to his present position.

However, as in all good stories, young Hanson started at the bottom of the radio ladder. His first job was with station WAAM, Newark, New Jersey, where he held the various positions of chief engineer, operating engineer, program director, and announcer. For all practical purposes, Hanson was station WAAM. In the years that have followed, the world has seen the rapid rise of radio as an art and as an industry. Hanson's own rise has been always a step ahead.

It is not an exaggeration to say that Hanson lives, eats, and sleeps his work. His home at Westport, Connecticut, is a veritable testing ground for technical improvements in both radio and television. He designed it himself and it contains many special features that only an artistic man of science could possibly have continued. Even his hobbies—photography, yachting, and music—become factors in his regular work; photography he finds has given him many useful ideas in the development of television; on his yacht he has been able to carry out much experimental work in marine radio telephone; music is almost a fundamental of radio programs.

Hanson is a bachelor. His present family consists of a registered black and white Springer spaniel with a litter of eight pups. He is a fellow in the Acoustical Society of America, and a life member of the Veteran Wireless Operators Association Incorporated.



WHERE, OH WHERE HAS MY LITTLE TRUCK GONE?

THE huge dome for the new 200-inch telescope on Mt. Palomar, California, is 137 feet in diameter, 137 feet high. Near the top, to lift the giant parts of the telescope, is a 60-ton crane, permanent. During the assembly of the telescope, states Russell W. Porter in transmitting this photograph taken by Ted Watterson, the engineer in charge of construction found a one-ton truck on the ground floor where he had ordered the space kept clear. A sling was attached to the truck and it was hoisted and left 100 feet aloft, to be discovered the next morning by the astonished driver. Photograph also gives striking idea of the vast size of the observatory dome and telescope.

Disregard of signals causes injury or death to thousands each year. By a wide-spread application of the examination methods discussed in the article below, it would be possible to eliminate from the highways those drivers who, because of physical or mental instability, cannot be depended upon to observe those rules of the road which must be heeded if safety for everyone is to be achieved

INSANITY AT THE WHEEL

To What Extent do Psychopathic Cases Contribute to Motor-Vehicle Accidents? . . . Weeding Out the Unfit by Specialized Analysis of Attitudes

By ANDREW R. BOONE

YOU smash into the car ahead, dash past the red signal, send pedestrians scurrying for safety as you swing the wheel hard. You may not have contributed to the nation's 32,400 deaths and 1,150,000 non-fatal injuries resulting from automotive mishaps last year, but that's no sign that you are sane. Crazy drivers crowd the highways, and their insanity is easily demonstrable. Hell hath no friend like these speeding, swerving, horn-blowing lunatics, and psychology is determined to find them, thus aiding the engineer and the automobile builder in curbing the grim reaper.—*A. R. B.*

SWAGGERING into the Detroit license bureau, T-102 was blissfully unaware of the blow that fate was about to deal him. He had lost his taxi-driving permit and driver's license some weeks earlier, and now demanded permission to resume earning his livelihood by piloting a cab through the streets of the nation's fourth city.

"See Judge Maher," said the man at the counter, and T-102 swaggered out, confident that the judge would restore him to his seat behind the wheel.

Into the austere courtroom of Traffic Judge Thomas F. Maher walked T-102 next morning, and hardly had his lawyer presented a petition for recovery of lost privileges than the judge passed him along: "Have a talk with the traffic psychotechnologist."

T-102 blinked at this command, comprehending not at all, and shortly thereafter stepped briskly from the elevator into the 17th floor hallway of nearby Barlum Tower, opened a door marked "Psychopathic Clinic," and handed across the counter the brief court order requesting his examination.

It was here the 36-year-old taxi driver became T-102, a psychological guinea pig in whom Alan Canty, the psychotechnologist whose official designation had so startled his visitor, took an interest no greater nor less than in any of the many traffic violators who expose their mentalities to his searching inquiry every week.

Canty put T-102 through the ropes, over the jumps, across the hurdles. Physical examination revealed him to be normal. He stood five feet ten inches tall, weighed 190 pounds. His voice was slightly hoarse. Neurologically, he was negative; his vision was found adequate when both eyes were used, though a trifle subnormal when the eyes were tested individually. Depth perception and color vision were good. He was thoroughly familiar with the traffic laws.

An inspector from the Police Department's license bureau accompanied T-102 on a driving test. He performed according to the requirements of the law, although . . . mark this! . . . making turns violently, blowing his horn excessively, trying to make pedestrians and drivers move out of his way, "thus showing no consideration for the rights of others."

THIS check was by no means conclusive. It demonstrated the man's ability to drive, but beyond that ability lay an attitude which Canty explored further. He took T-102's psychiatric history. He asked many questions designed to bring out that attitude and reveal his level of intelligence. He studied the record. Here is what Canty found:

During the 15 years which T-102 had lived in Detroit, he received 287 tickets for various traffic violations. "Minor violations," explained the subject nonchalantly, as though these infractions had no significance since he had injured no one. That was only the beginning.

Courtesy Auto Club of Southern California

Many motor-car accidents are caused by thoughtlessness and a disregard of the rights of others. Carried to extremes, such irresponsibility will become "driving lunacy"

We'll skip the details, and come to the important point. Canty gave T-102 an intelligence test, found him to possess the intelligence of a nine-year-old child. Further, his intellectual weakness was complicated by his conviction that laws were made to beat, not to obey.

Canty finished the job, passed his conclusions along to Lowell S. Selling, M.D., clinic director, and here's what Dr. Selling wrote Judge Maher:

"While this man is certainly not insane in the conventional sense, his conduct is as unpredictable and dangerous as the usual insane person's would be, for he has no more consideration of the rights of others than one who suffers from an actual serious mental disorder. We might call him a 'driving lunatic' because of this irresponsibility. The fact he has had no previous accident record is a matter of luck, and he is bound to get into serious trouble in the future if he drives. In fact, he has continued to drive although he has had no license. Finally, we consider T-102 the most dangerous man to have been examined in the last 200 cases, and, of course, could not indorse the granting of a license to him."

And, of course, Judge Maher refused T-102 a license. Which concludes our interest in T-102 as a case, but not as a symptom.

How many nine-year-old mentalities step on throttles and guide their motor cars through traffic, menacing life and property? To what extent do intoxication, emotional instability, maniac depressive psychosis, epilepsy, faulty mental attitudes in general which may be classed as insanity contribute to the appalling total of deaths and broken bodies?

No one knows the precise cause of all accidents, because few accidents are investigated thoroughly enough to reach the causes. Then, too, several factors usually are involved. Defects of highway and vehicle, actions of pedestrians and drivers—these contribute. But the driver, "defective in mind or body," according to the National Safety Council, is the most important element.

How may these wholesale killings and injuries by hundreds of thousands be halted—or can they? Traffic safety drives often are accompanied by increased killings. Where, then, lies the remedy? In psychiatric surveys? Do these surveys adequately reveal the "smart alecs," the "show-offs," the lunatics—borderline and real?

"Traffic accidents largely represent a disease," according to Canty, "and we seek the cause."

Detroit is finding the answer—by measuring human aptitudes regarding motor-car operation. Here street conditions are reproduced in the laboratory, and standardized tests evolved by Dr. A. R. Lauer, of Ohio State University, Dr. Morris S. Viteles, at the University of Pennsylvania, Dr. Harry R. De Silva, of Harvard's Bureau of Street Traffic Research, Charles S. Myers, at the National Institute of Industrial Psychology in London, and Canty bring to light some surprising facts.

One night in late June, for example, a 51-year-old man made a left turn, and, failing to straighten out on the right struck a car approaching along his left. Not much of an accident, but the police, trained to look for unusual behavior, decided to investigate carefully.

"Pretty tight, aren't you, buddy?" one policeman asked.

On the way to the station, the prisoner admitted he could "feel" the effects of a few drinks. At Judge George T. Murphy's request, Canty, put this man, now T-217, through the paces and learned he was suffering from hypertension, had an artificial left hand and a hernia on the left side of his body.

Alan Canty, whose work in psychotechnology largely forms the basis of the present article, is shown, at the lower left of the photograph at right, operating the reactrograph. With this device it is possible to test the reactions of drivers and hence arrive at conclusions regarding mental attitude

"Extremely explosive, aggravated by many years of chronic alcoholism," Canty reported. "Suffers inferiority complex. Very dangerous."

Oddly, T-217 agreed.

"Better put me on probation for six months and take away my license before I kill somebody," he urged.

Canty accepted the recommendation, and Judge Murphy forbade the gentleman ever again to touch the wheel of a motor car, adding: "We have no sympathy for drunk drivers."

Why revoke a man's license just because his car hits another? The accident, as it happened in this case was not the underlying reason. True, the driver had been negligent; furthermore, the happening was symptomatic of perhaps a more tragic collision. Detroiters value their lives. Their judges and psychologists propose to protect them.

T-217 admittedly had had a few drinks, but T-39 was cold sober when he smashed the trunk of a car whose driver had halted for a red light. Now, T-217, remember, was 51 years old, and

T-39, it developed, had barely turned 20.

"I pulled up, but my foot must have slipped off the pedal," T-39 told the police, who didn't like his excuse, and booked him for reckless driving.

"The guy must have been talking to his girl friend," the officers reported to the desk sergeant.

T-39 faced Judge Murphy and repeated his story. "Besides," he added, "damage was only seventy bucks."

This time, perhaps. But what about his next accident, and the next? The boy may have been entertaining his Number One Flame, but, while of average intelligence, Canty's probe revealed these additional significant facts about him:

History of venereal disease, coarse tremors of facial muscles and fingers, considerable motor incoördination, alcoholism, slightly defective vision.

Canty did not stop here. Perhaps some of these factors were in themselves effects, and not causes. As he proceeded with his examination he uncovered other facts of even greater bearing on that simple crash.

"HIS father," he found, "is a chronic alcoholic, unstable and irritable. His mother obtained a divorce when he was three, and went to live with a sister who was operating a 'blind pig.' The boy lived in several boarding homes and was a problem child in several schools. He admits having been arrested three times for being drunk, and recently was held in the Psychopathic Ward of the Receiving Hospital after taking an overdose of barbital."

T-39 had disintegrated, and it was not entirely his own fault. What to do with him?

"Your youth and attitude," Judge Murphy told him later, "make you worthy of help."

T-39 went on probation; his license will not be returned until he demonstrates to the court's entire satisfaction that his mental and physical health make him once more fit for the highway.

Traffic authorities, judges, and psychologists have no desire to diminish the number of drivers. They want honestly to protect the public—you and me—by adjusting drivers with correctable defects and eliminating from the streets and highways those too severely maladjusted.

This is the reason for Detroit's Psychopathic Clinic, which is a department of the Recorder's Court. It was established for the sole purpose of examining individuals referred by various courts of the city. To it come those who are convicted of traffic felonies, and those who by their behavior subsequent to arrest lead authorities to think psychiatric examination is indicated. All have been found guilty before Canty gets them. Upon his recommendations rest their punishment and rehabilitation, if any.

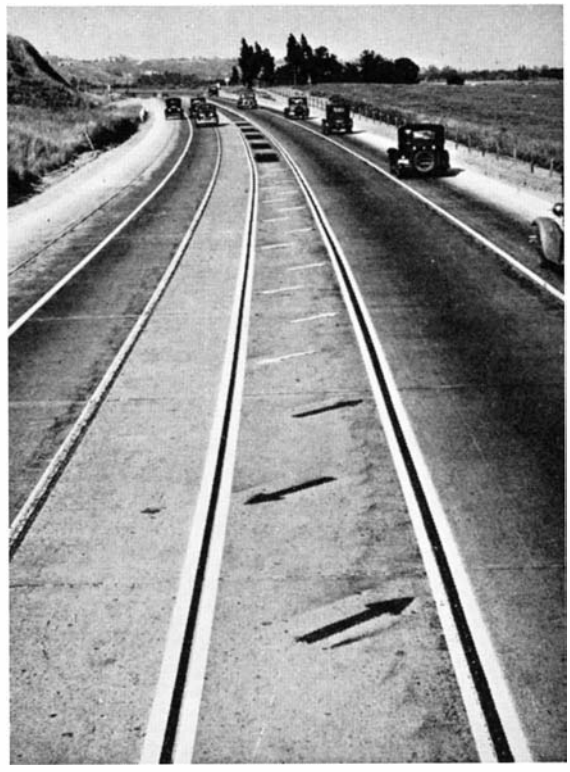
If this article seems to harp on *attitude*, the emphasis is wholly desirable, for *attitude* of the driver toward the law and his fellow man holds the key to success for this newest cross between judge and detective—the psychotechnologist. He never knows at the outset whether he's dealing with a temporarily unstable intellect or a dangerously insane driver. Nor is he interested—officially—in what he finds.

T-398 (you will note that Canty identifies none of his subjects, for unofficially he hopes each will somehow escape the damning implications of lunacy) seemed mild enough when picked up for speeding. His tone changed in the courtroom.

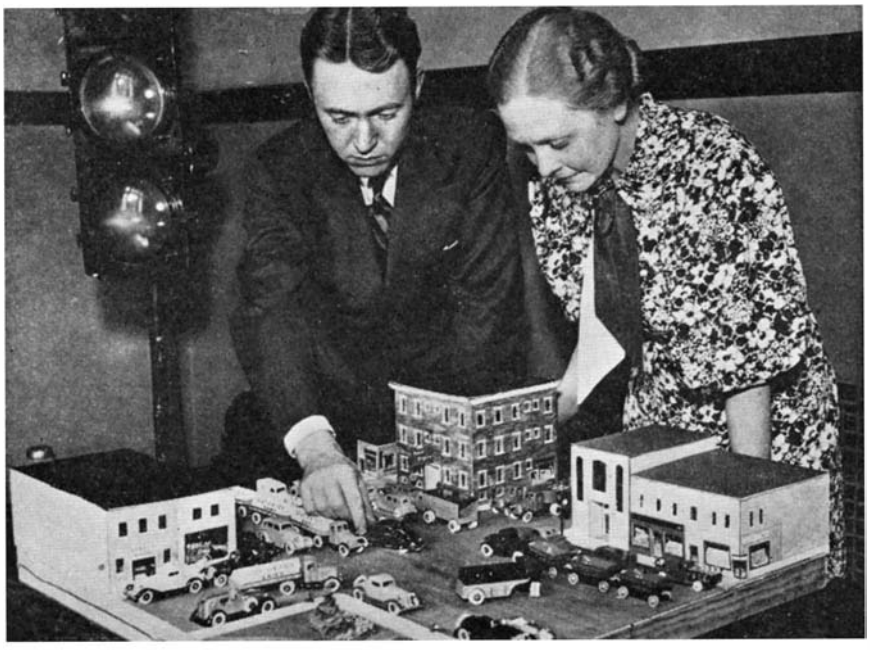
"These birds," indicating the officers, "want to get me. They've jimmied up my speedometer. Honest, your honor, I'm not guilty."

But in the quiet of the laboratory, the 39-year-old speeder unwittingly gave up an entirely different story. Not only had he been in the hands of a psychiatrist for treatment, but he was at that very moment suffering from a severe form of insanity. Crazy—and at the wheel!

No jail sentence for T-398. Eloise Hospital got him, where he will be denied all contact with the motoring public until death or medical science separates his physical body from his unfortunate mental deficiencies.



Arrows raised 1/4 of an inch above the surface of the road, some painted white and some black, have been installed on this California highway in an endeavor to reduce the state's accident rate



Street conditions, in model form, are reproduced in Detroit's Psychopathic Clinic, and standard tests are used to bring out facts about drivers' fitness

SUCH cases could be multiplied many fold were there such men as Selling and Canty on the job from Sandy Hook to San Diego, from Jacksonville to Jackson's Hole. Every community has these cases, yet so far there is only this fragmentary record of their criminally irresponsible driving.

More than 30,000 likely will perish in motor-vehicle accidents in 1939—many of them victims of men like T-102 and T-398. Make available to Canty the necessary constellation of factors upon which he builds a decision, and he'll soon tell whether John Jones, or you, or me, is a safe bet behind the steering wheel. Given a thousand Cantys, with scores of thousands of "attitudes" explored each year, and we'd have safer driving, need a hundred new hospitals for the insane—or both.

Research On High Pressures

A Curiosity of Science is Proving to Have Direct Practical Bearing on a Large Number of Industrial Problems . . . Examples of Promising Applications.

By THOMAS C. POULTER, Sc.D., Ph.D.
Scientific Director of the Research Foundation of Armour Institute of Technology, Chicago

IN the past few years "extreme pressure" has gone out of the realm of a scientific curiosity and has become a tool in the solution of practical problems.

In spite of the fact that, until recently. man was not able to develop pressures in the laboratory as high as 1,000,000 pounds per square inch, such pressures frequently occur about us in our everyday experiences. Pressures of a few hundred thousand pounds per square inch are occasionally produced in the hypoid gear in the normal operation of an automobile, in roller or ball bearings, under the wheel of a glass cutter, when the bullet of a high-powered rifle strikes a solid object, and in many other cases where two hard objects strike each other. They are, of course, confined to an extremely small space, and have a very short duration. Such extreme pressures in liquids or gases are much less common, but even gas pressures of nearly 1.000,000 pounds per square inch probably occur every day as particles of meteoric matter, traveling with a velocity of 30 miles per second, collide with the very light upper layer of the earth's atmosphere.

Recently an experiment was carried out in the high pressure laboratory of the Research Foundation of Armour Institute of Technology in which a pressure of 1,500,000 pounds per square inch was developed. This was the highest pressure ever produced experimentally in high pressure investigations. The pressure at the center of the earth is estimated to be about 3,200,000 atmospheres, or only 32 times as great as the maximum pressure that has been produced in the laboratory.

This increase in range of artificial pressures may clear up many puzzling questions which have formerly been considered impossible of solution. Very little attempt has been made in the past to utilize extreme pressure experiments in the solution of everyday problems of science and industry, but they are rapidly assuming a place of increasing importance, and in such experiments lie the answers to many questions of the greatest commercial importance.

A brief survey of the work that has been studied by means of the high pressure equipment now in the high pressure laboratory of the Research Foundation of Armour Institute of Technology will serve to show the great diversified application of such investigations.

The work was started in an attempt to study a reported effect of pressure upon the chemical reaction of sulfuric acid on zinc to form zinc sulfate and liberate hydrogen. This investigation was carried to a pressure of 30,000 atmospheres, during which it was found that the effect which we set out to study did not exist. In the course of the investigation we found many interesting things, including a little known chemical reaction of hydrogen on sulfuric acid to give hydrogen sulfide and water.

Other chemical reactions were investigated under extreme pressures, such as the reaction between sugar and water. The rate of this reaction was found to decrease with increase in pressure.

From the information gained as a result of our previous work, new pressure equipment was developed in which it was possible to carry on experiments in cylinders with glass, quartz, or diamond windows, which will withstand pressures of one half million pounds per square inch. In connection with this development many interesting phenomena were observed, such as the ability of glass or quartz windows one quarter inch thick to be bent to a radius of curvature of four inches as many as ten times before being broken.

The development of these windows made it possible to study the effect of pressure upon the manner in which a beam of light, which is vibrating in one plane, is rotated as it passes through compounds which tend to rotate this plane of vibration or polarization. This effect was to increase the rotation of all compounds studied, some of them being increased to three fold their normal value. Both materials which rotate to the right (dextro-rotatory) and to the left (levo-rotatory) were investigated. This provides a method of studying the progress of such reactions while the materials are under pressure.

The windows also made it possible to study the phosphorescence of zinc sulfide, and it was found that the effect is to decrease the intensity of the phosphorescence by a factor of one half for a pressure of 30,000 atmospheres. It was also found that a rapid change in pressure would produce a bright glow of the zinc sulfide. Aside from the intensity, the fluorescent and phosphorescent properties of zinc sulfide were very little affected by extremely high pressures. It, therefore, provided a convenient method of studying the effect of extreme pressures upon the radioactive decomposition of various materials by actually observing scintillation. These measurements confirmed the negative results of similar investigations by other observers using quite different methods.

Further investigations made possible by the pressure windows were the determination of the effect of pressure upon the index of refraction of certain liquids. This investigation showed that the theoretical relation developed by Lorenz-Lorentz for the relation between density and index of refraction holds for those substances investigated.

THE quartz windows were further utilized in making absorption spectra measurements of the effect of pressure upon the compressibility of the neodymium atoms at the various electron energy levels.

The effect of pressure upon living organisms has been studied, with the observation that 12,000 atmospheres are necessary to kill bacteria, but as the complexity of the living organism increases, the pressure necessary to destroy life decreases. Because of this selective effect of pressure in killing living organisms and the relation that exists between the pressure required and the size of the organism, it is possible that this may lead to developments of far-reaching importance in combating certain diseases. Some small forms of marine life about one fourth inch in length, such as hydra and planaria, were found to withstand pressures of from 10,000 to 20,000 pounds per square inch without any serious damage. The effect of high pressures was to precipitate

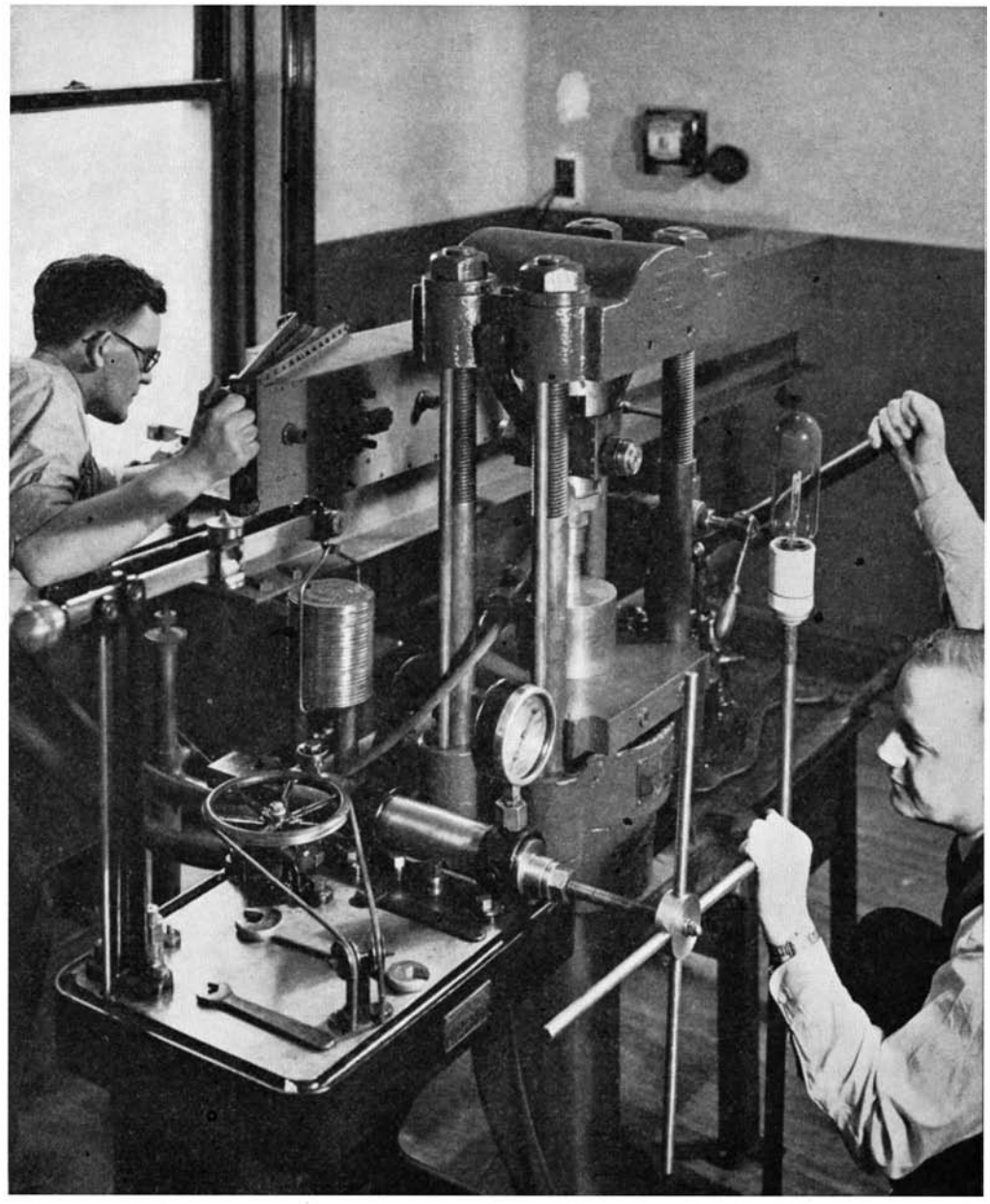
some of the colloidal constituents of the organism, and a study was made of the precipitation of other colloids, such as sulfur, silver, gold, ferric hydroxide, molybdenum blue, and prussian blue. Some colloidal materials are precipitated by the comparatively low pressure of 100 atmospheres, whereas others are only slightly affected by pressures as high as 17,000 atmospheres.

THE electrode potential of the hydrogen electrode was investigated under pressures up to 30.000 atmospheres and the voltage of the Weston Standard Cell up to 12,000 atmospheres. The effect of pressure on both of these is of a rather low order of magnitude.

The effect of pressure upon the penetration of water and numerous other liquids into glass and metal surfaces has been investigated with some very interesting results. Water was found to penetrate in considerable quantities to a depth of several millimeters into glass in only a few minutes' time. The penetration of alcohol and ether is somewhat less, and such liquids as paraffin oils, glycerin, and so on, penetrate scarcely at all. A similar effect, but to a considerably lesser degree, was observed for the penetration of liquids into metals. The penetration of gases into metals, of course, is more rapid than that of liquid and represents a problem of considerable industrial importance, particularly in the case of penetration of hydrogen into steel whereby the tensile strength of the steel is reduced to less than half its original value.

The normal dissociation of steam into hydrogen and oxygen, and the subsequent removal of the oxygen by its reaction with the metal of high-pressure steam lines, particularly under conditions where a high superheat is used, presents a problem of the utmost importance in the high-pressure, high superheat, steam installations that are being used at the present time. It has been shown that considerable quantities of hydrogen are continually escaping through the walls of the high-pressure, high superheat, steam lines, and this subject should be thoroughly investigated to determine to what extent this is affecting the tensile strength of the metal of the steam lines. If this effect is cumulative, as is the case under the conditions of many of our experiments, it might very well become a problem of great importance in high superheat steam insulation, if not indeed a limiting factor in the industry. We have found that this effect is not only a function of the temperature and pressure, but is also affected by the composition and heat treatment of the steel. It is, therefore, a combination high pressure and metallurgical investigation.

Other fields which have been investigated are: compressibility of liquids and solids, the effect of pressure upon the viscosity of liquids, and in some cases the change of state, or even transitions from one crystalline form to another.



A pressure of 580,000 pounds per square inch has been developed in this cylinder (between the four large tension bolts) which contains a glass window in either end for internal observation

A brief summary of the effect of pressure upon the properties of matter will reveal some very interesting facts. The following characteristics for liquids and solids are all affected by pressure: density, volume, index of refraction, electrical conductivity, thermal conductivity, magnetic permeability, dielectric constant, optical rotation, chemical reactivity, solubility, phosphorescence, fluorescence, physical strength, specific heat, latent heat, permeability to gases and liquids, and viscosity.

If we consider all but the last two items on this list, we will see that the effect is anywhere from a small percent up to certainly less than a factor of ten.

But now let us consider the last two items. The permeability to gases and liquids may be of the order of magnitude of many thousandfold, and the coefficient of viscosity of many lubricating oils is increased by as much as 200,000,000 times their value at atmospheric pressure. Some liquids are affected comparatively little by pressures of 400,000 pounds per square inch, whereas some oils acquire a hardness between that of metallic lead and metallic copper. It is, therefore, probable that the lubricant of the future, where extreme pressures are involved, will be a liquid little affected by pressure. This will serve as a carrier for a different material which becomes sufficiently hard under pressure to serve as the lubricant. It is therefore our belief that the permeability to gases and liquids and the effect of pressure on viscosity are the two characteristics that will represent the most fruitful problems for investigation, and certainly are the two that are most likely to produce noticeable effects in industrial processes involving high pressures. Investigation of the permeability of gases and liquids has already been discussed and the viscosity investigation of lubricating oils under pressure probably represents one of the most promising investigations to be carried out in this field.

Noise Control

Necessity, Not a Fad . . . Controlled at Source . . . Stopped or Damped by Scientific Design . . . Improved Efficiency, Calm Nerves, Less Deafness

By PHILIP H. SMITH

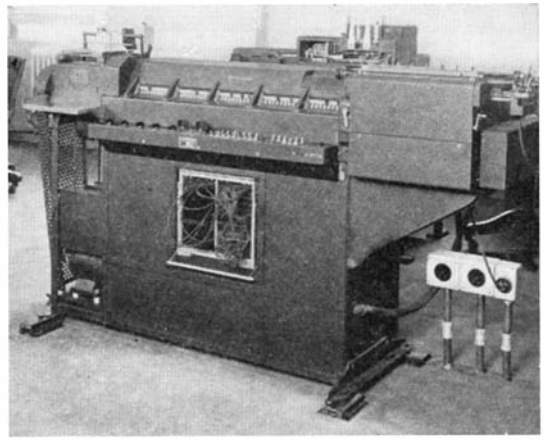
IF you attend the New York World's Fair and enjoy your visit to the Perisphere, that huge spherical structure which houses "The City of Tomorrow" exhibit, you can credit your pleasure to the new science of noise control.

This Perisphere shows what a scientific attack on noise can accomplish. Without acoustical treatment, this 180-foot diameter room would be a reverberating chamber of horrors. As it is, voices, a symphony orchestra, and moving machinery are housed peaceably and you hear pleasant sounds rather than a silly symphony of noise.

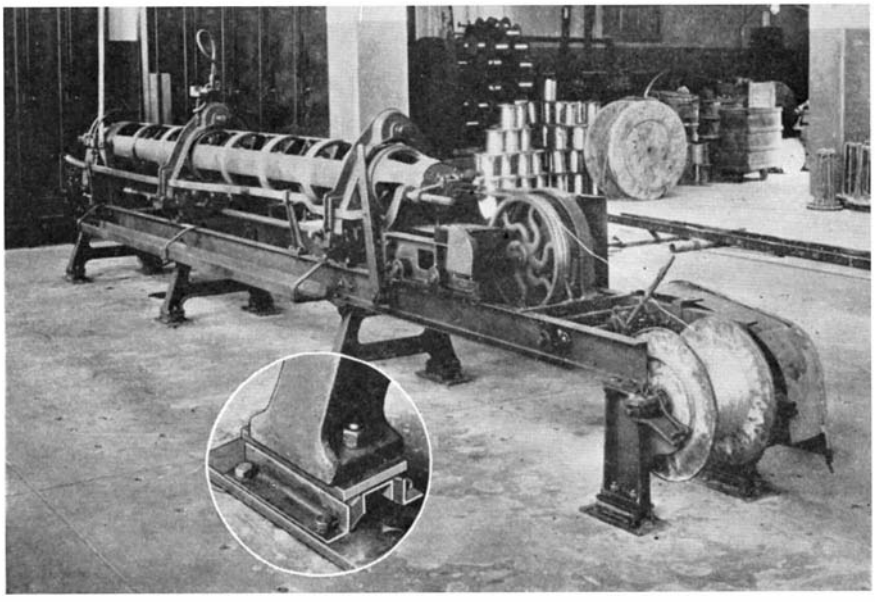
Noise control is a necessity, not a fad. The clatter of machines, the din of office equipment, produces deafness and nervous disorders, while the high noise level of modern civilization in all its phases lowers human efficiency and happiness. We know this to be true because controlled tests reveal that employees make fewer mistakes and produce more when their work environment is made quieter, and because the public responds quickly to noiseless products. Thanks to noise control, we enjoy automobiles which really live up to that old slogan, "No Noise But the Wind"; we go to the talkies because we can hear the actors free from the sound of film production and background disturbance; we can fly across the continent without cotton in our ears.

Industry benefits directly from the increase in sales which follows quickly upon the silencing of a product, but that is by no means the only advantage derived from attacking noise. Machinery which has been re-designed to reduce noise is often more efficient and frequently cheaper to produce than its raucous predecessor. Furthermore, the study of sound has led to the development of machines which employ sound for production control and product inspection, thereby lowering cost.

The new science has evolved from many years of study into the nature of sound and its transmission. Work with the telephone, and later with radio, has been contributory because investigators treated sound as a phenomenon to be controlled in the interest of creating wanted sound and subduing or eliminating the unwanted. Out of all this has grown a fairly definite procedure for tackling all noise problems.



Designed to be as silent as possible, the fast-running, "almost human" office machine at the right is further silenced by being mounted on rubber footings. Likewise, the clatter of the wire machine below is dampened by footings which absorb vibration and therefore some of the noise. Insert shows the mounting of rubber and steel



Every control problem has two phases. The first phase involves the measurement of sound. Two types of microphones are used for this: one is sensitive to velocity or particle motion, while the more commonly used is sensitive to pressure. The electrical circuit establishes the electrical equivalent of sound which can be analyzed in terms of frequency and intensity.

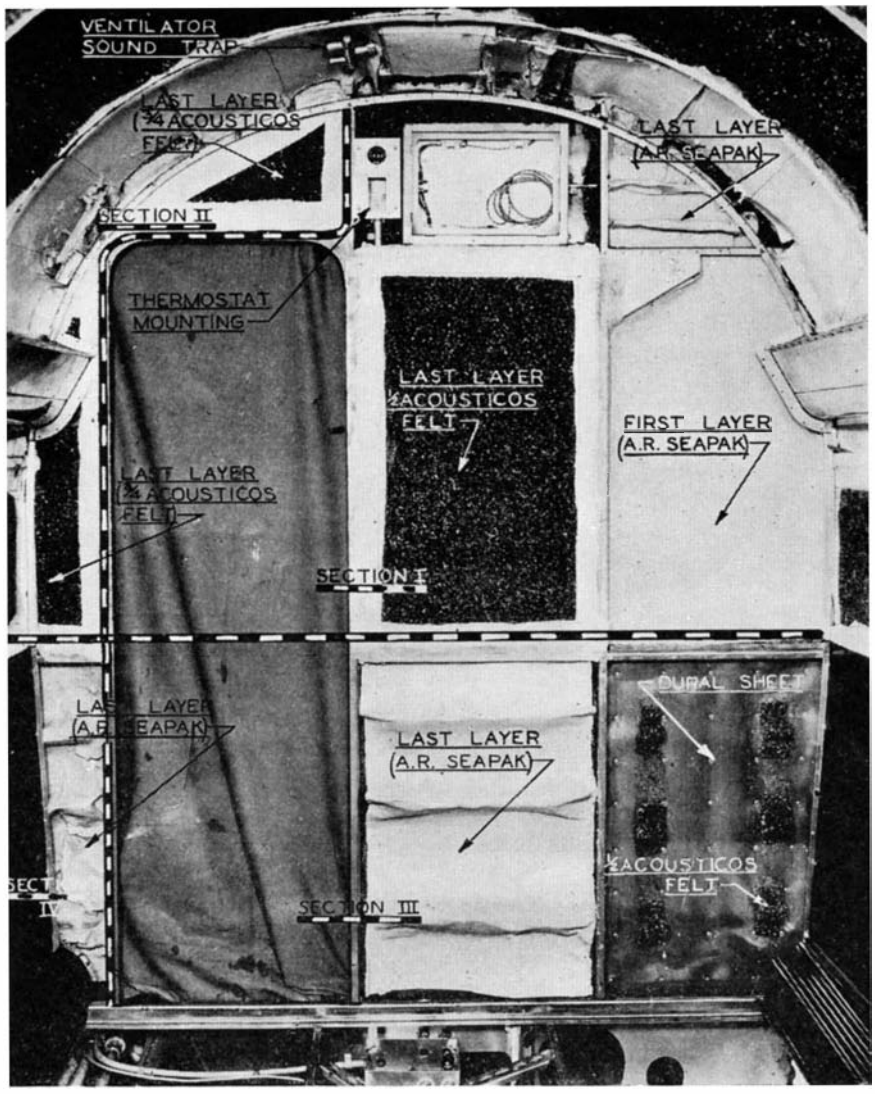
This first phase is known as the diagnosis. It is essential to the second phase which is the treatment. Most noise is made up of several sounds and the diagnosis seeks to sort out and identify the various components. Customarily, the specialist attempts to pull down the highest component and then proceeds down the scale until a level is reached which is considered satisfactory. His achievement is recorded as a lowering of decibels; that is to say, in a reduction of watts per square centimeter of acoustic power.

The engineer's skill centers largely in his ability to bridge the gap between analysis and application; in relating noises to their origin. Once he knows what offends and to what degree, he finds it relatively easy to choose between modes of treatment. Instrumentation alone will not do the job. Ears and past experience must be employed to interpret because noise control has not yet been reduced to a book science.

The engineer regards noise as a fact rather than as an abstraction. The elim-

ination is warranted only when there is an irritation to the human system. He seeks, therefore, to uncover the components and reduce them to a non-irritating level. His interest is in making life more bearable, rather than in banishing noise *per se*.

The fact that noise is always relative and that this relation is an integral part of the control problem is well illustrated by reference to the automobile. The seasoned car owner may recall the experience of coasting with a dead engine, to become conscious suddenly of many annoying chassis and body rattles hitherto unnoticed. With the engine sputtering again, the rattles became lost in the general clatter. Engineers met a similar experience when they undertook to silence automobile engines to make them what we now enjoy. When the engine was made less objectionable, other noises became prominent and so treatment was carried from one unit to another to achieve an overall benefit. Similarly, air-conditioning equipment suitable for city buildings has been known to be unbearable when installed in suburban dwellings where the background noises were lower.



Sound-proofing installation in the forward cabin wall of an airliner. Several kinds of fibrous sheets are built in. They include a coarse paper and felt

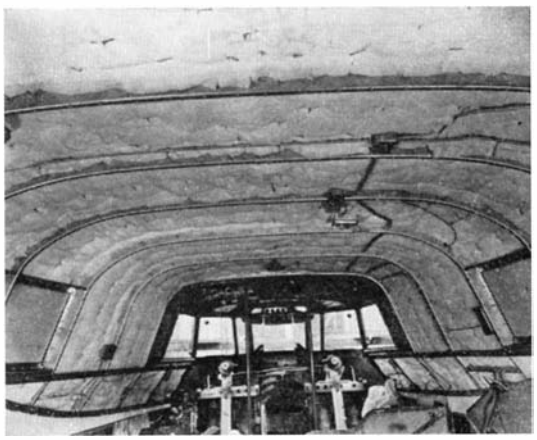
WHILE the passenger automobile illustrates the general problem of noise control it is by no means representative of details. Every noise problem tends to be unique, and to demand its own particular method of solution once it has been analyzed. The silencing of auditoriums, for example, involves the exclusion of street noises as well as the treatment of sounds generated within the structure. If the entertainment sounds are to be pleasurable, the specialist proceeds to determine the timing, direction, and strength of noises and to select the proper material to subdue the unwanted sounds without impairing the quality of the voice or instrumental performance. In early days of noise control when the science was less exact, sound-proofing was often overdone, with the result that the entertainment sounds were rendered lifeless, especially in radio studios.

The afore-mentioned Perisphere is really a unique auditorium calling for special treatment. It has the curved ceilings and walls surfaced with a sound-absorbent board made of shredded wood fibers and backed by two other absorbent materials placed in alternate squares. Some eight feet behind this surface treatment, a mineral wood product placed between the structural steel girders and lining the inner surface of the sphere's outer shell, traps whatever noises get past the inner wall and prevents reverberations from annoying the audience.

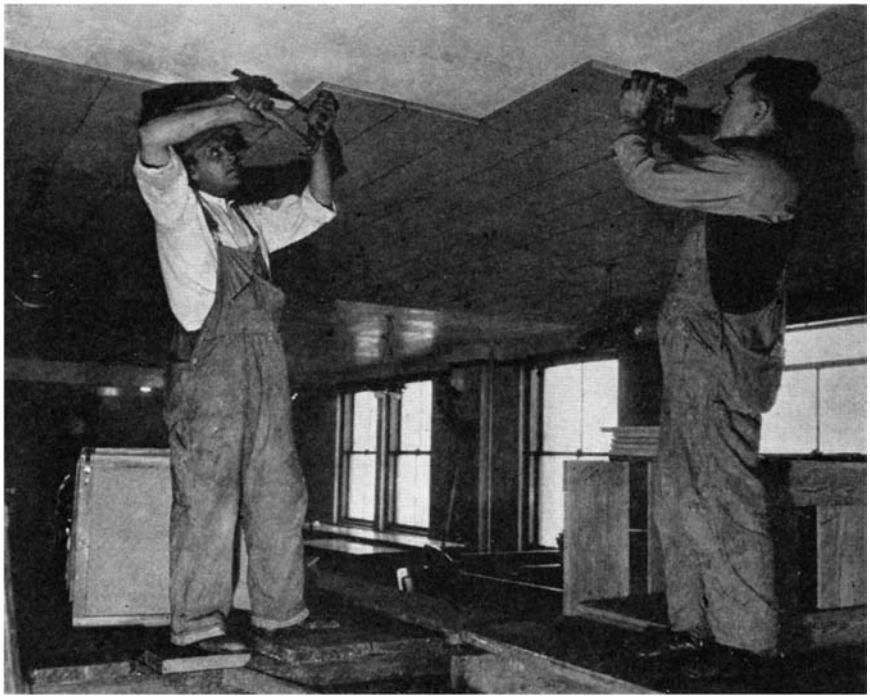
Often an important factor in the silencing of public buildings is attack upon air conditioning and operating machinery. Sometimes it is necessary to dampen blower noises, and to line air ducts and re-design outlet grilles to reduce the sound of rushing air. More and more the practice is resorted to of suspending heavy operating machinery on rubber-in-shear to prevent the transmission of sound vibrations.

It is possible to contrast the problem of noise control in the treatment of structures by citing instances of silencing a telephone booth and an aircraft engine test building. By studying the course of sound travel a very interesting booth has been developed which has no door and, therefore, does not get stuffy or become a steam bath on hot days. Sound which enters the open side is trapped by absorbent wall surface materials, while the exterior is treated to reflect and disburse the bombardment of unwanted noise. In the case of the aircraft test room, silencing the engine itself was out of the question as the purpose of the test was to take measurements running under normal operating conditions. Here, the building housing the engine was made as sound-proof as possible while the exhaust was carried by vertical stacks to a great height to be expelled with little annoyance to the investigators as well as the surrounding neighborhood.

Where there is motion there is apt to



Thick pads of glass wool next to the skin in the curved fuselage ceiling of a Clipper plane



Installation in a school of a Celotex product which effectively absorbs unwanted sounds, prevents reverberations and echos. *At right:* Johns-Manville sound deadening material being packed into the cushioned floor chairs which are part of a special "floating" construction that efficiently controls all noises

be noise and thus transportation equipment of various types has been receiving a great deal of attention. Recently, a silenced train was placed in operation on one of New York City's subways to demonstrate very convincingly what can be done in the way of insulating, absorbing, and otherwise dampening out noise to make travel more comfortable. Even track has been tackled from the noise elimination standpoint. In this same city, rubber tie plates have been tried out under normal operating conditions to determine the cushioning effect of placing the rails on rubber. While a measure of comfort is provided for passengers by this new device, the principal advantage accrues to adjacent building structures and to rails and rolling stock. About 90 percent of vibrations is prevented from reaching the buildings, while the life of rails and rolling stock is substantially lengthened. It is a little early to forecast an overnight adoption of rubber tie plates, but there is a strong likelihood that they will come into use where the greatest damage is inflicted by impact, such as on curves and on bridges.

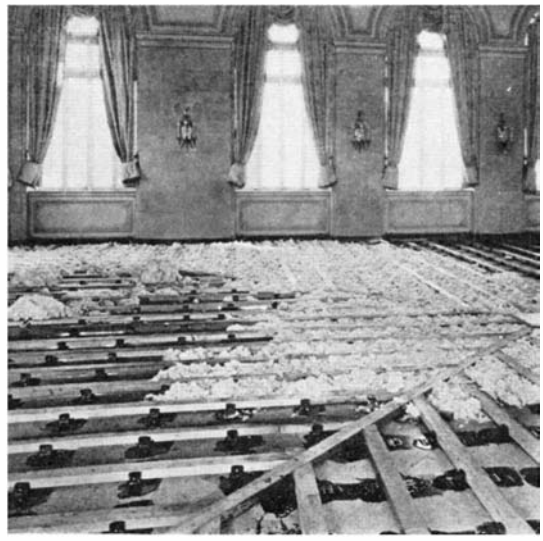
RUBBER suspension plays a very important rôle in the silencing of modern trolleys, buses, and streamlined trains, but much progress remains to be made. Noise control got its foothold in the luxury end of transportation and has still to make its real contribution to mass transportation vehicles via the road of silent design.

Apropos of rubber suspensions, a case can be cited which illustrates how easily the amateur noise controller can be led astray in his quest for silence. It is common practice to suspend heavy machinery at four points, although three-point suspension is often more satisfactory because it insures an even distribution of weight at all times. Knowing the efficacy of rubber suspension, one practitioner concluded that the more rubber the greater the absorption and placed a channel or frame of rubber under a machine in place of four blocks. It failed to silence because of the sealed-in area under the machine which permitted no escape of air as the machine rose and fell minutely in operation. In short, the vibrations were transmitted to the floor acting as a diaphragm under the action of compressing and decompressing.

Noise control engineers have practiced long enough to avoid such mistakes; they know what can and cannot be done. In early experiments with the automobile it was discovered that optimum silencing to be had by insulating chassis from body by means of rubber mountings was impractical. The advantage derived from the extreme quiet was offset by the uncomfortable sensation of body and chassis parting company momentarily on turning corners; thus a compromise was reached and resort made to other silencing practices.

If it is permissible to call a tank and a submarine transportation vehicles, they can be mentioned here as examples of highly important noise control work, even though the details are lacking. The interior of a tank is a poor place for survival at best and its operation has been hampered by the terrific din which military authorities now seek to subdue. At least one European Power is hard at work eliminating the noise from submarine operation to render the vessel more immune to discovery by sound detectors in the hands of the enemy.

It is now a well substantiated fact that silence can be had at less expense if built into a product, rather than by removing noise after manufacture. Often it costs less to produce a quiet machine than to manufacture a noisy one and there are innumerable examples of noise control work which has led straight to lower production cost, more efficient operation, and larger sales of the product. One noisy element in an otherwise well silenced product may be a large obstacle toward its wide use.

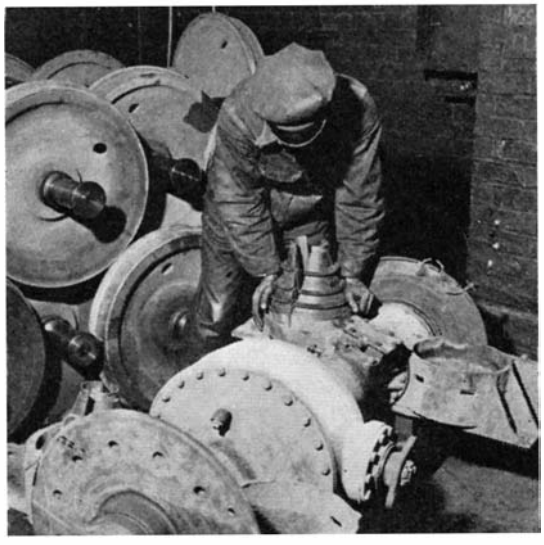


Consider for the moment the case of a street car which emitted a noise like a siren. When analyzed, it was discovered that the frequency of the sound was identical with the number of revolutions of the ventilating fan multiplied by the number of blades. With this clue the noise was tracked down and eliminated by allowing sufficient room for the rushing air to pass between blades and the metal outside ribs of the fan.

Outstanding among the examples of built-in silence is the modern commercial transport plane. One will recall the pioneer days of commercial flying when only the application of cotton to one's ears made transportation bearable. Today, cotton is a surplus commodity in aviation because the plane producers called in noise engineers to check design features in their relation to noise creation and transmission. The silenced plane did not arrive overnight. The first effort, that of trying to find a

sound-proof material to wrap around the plane, proved fruitless. Materials satisfy different acoustical needs and these had to be differentiated and evaluated as to their insulating value. More important, the sources of din had to be located and classified in the order of their importance, then tackled separately and jointly, because it was another discovery that silencing one component accomplished little; all contributory sources had to be treated.

By far the worst noise offender in an airplane is the propeller, and not the engine as might be expected. Engine exhaust ranks second and engine clatter third. Improvement came by increasing the distance from the tip of the airscrew to the fuselage and designing so that baggage or utility rooms would lie in line with the propeller; likewise exhaust was led to discharge as far from the cabin as possible. Engines are, of course, sources of vibration and, to overcome some of the disagreeable effects, flexible mountings were developed. Then, to improve conditions within the plane, the floors were suspended so that they virtually floated and windows were given flexible mountings in rubber.



An outstanding development for subway car noise control—a rubber spring to be mounted on the axles. It is constructed in the shape of a hollow cone with flanges inside and out, and is split through for mounting between the truck and car

Air ducts in air conditioning systems would carry the noise of motors and blowers through an air-conditioned building were it not for the sound-absorbent lining of the ducts, in this case Airacoustic sheets

The foregoing gives but a brief list of noise control elements in modern transport design. It does serve, however, to emphasize the principle of "before" rather than "after" treatment in design, because the accomplishment has been such a large factor in abetting the progress of commercial aviation. The advantages are evident for all to appreciate who fly. There are on the market other products less striking that have been favorably influenced by the patient and thorough work of noise control engineers, notably vacuum cleaners, mechanical refrigerators, and garbage dump trucks, while a good beginning has been made with business machines of many types. It will be found that quiet has been built-in rather than achieved through noise reduction in almost every instance where the result is outstanding.

Thus far we have made no comment upon sound deadening materials. This is wholly intentional; science and technique precedes materials and their application. Acoustical materials number in the thousands. They embrace a host of fibrous substances in countless forms, felts and felt compositions, cork, plasters, different forms of rubber, various combinations of hard and porous materials, almost without end. Each has its own peculiar combination of properties and the choice for any application requires experience and judgment.

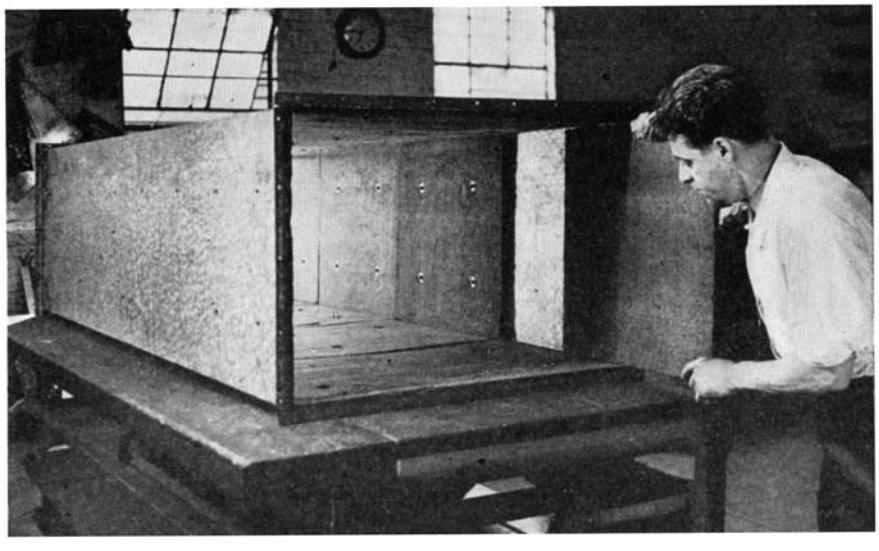
Noise control is in its infancy despite the rapid advance made within recent years. One has only to jot down a partial list of all the products which have not been silenced to reach his own estimate of the future. At the same time it would be a gross oversight not to include the utilization of sound for production control and inspection of products. This is a phase and a mighty important one of the noise-control science. It promises rapid development because the few things already accomplished demonstrate a dollars-and-cents saving more immediate and obvious than that derived from silencing noisy products.

Just as the electric eye has been focused upon productive purposes, so the electric ear has been turned toward industry. The ear is now being employed to regulate the flow of raw material to a ball mill. This device increases ball mill efficiency by 10 percent, while a similar percentage reduction has been made in power consumption. If gains are borne out consistently, the electric ear will undoubtedly come into use for the grinding of such materials as clay, limestone, silica and cement.

AMONG the instruments developed for product inspection which base on sound for their operating principle, there is one which checks over cans of condensed milk to locate those in which a bit of solder has broken loose to create spoilage. There is another which tests for the quality of abrasive wheels. A good wheel gives off a definite note which rings for a certain length of time when it is struck, and it is quite simple to check the pitch and duration of this sound. A third device tests for gear tooth contour by the sound of gears in mesh. This last device is extremely important as providing still another means for checking gears so that the modern automobile can be operated without an annoying hum at various speeds.

This harnessing of sound opens up an entirely new field and we may expect development here to run parallel with those which endeavor to eliminate or lower sound to non-irritating levels. Before noise control could be undertaken in a serious way as a specialized enterprise it had to produce tangible results at a reasonable cost. Those results have been accomplished and the time has come when the specialist comes close to saying: "I can kill so many decibels for so many dollars." This gives the go-ahead sign to industry.

Photographs courtesy Boeing Aircraft Co.; Celotex Corp.; Douglas Aircraft Co., Inc.; B. F. Goodrich Co.; Johns Manville Corp.



Our Galaxy Re-Measured

Galactic Rotation Effects, Interstellar Absorption and Certain Dynamical Constants of the Galaxy Have Been Determined from Cepheid Variable Stars

By HENRY NORRIS RUSSELL, Ph.D.

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

THE most powerful method we have for sounding the depths of space depends upon variable stars of the Cepheid type. The remarkable relation between the periods and the real brightness of these stars, first detected by Miss Leavitt at Harvard, some 30 years ago, has been fully confirmed by later studies.

Measured by photographic effect—that is, in violet light—a star of this sort, with period 2½ days, is 350 times as bright as the Sun. For a period of five days the brightness is 550, for ten days it is 830, 20 days, 1500, and, for a 50-day period, 2500 times the Sun's. If then we can find the period of variation—which is not so hard if we have enough photographs to work on—we know how bright the star really is; and, knowing how bright it looks, we can calculate the distance.

Useful as this relation is, we are still in ignorance of its physical cause. We have very good reason to believe that variable stars of this type are pulsating—alternately expanding and contracting—and the theory of these changes has been worked out in considerable detail. But this theory depends on the laws of gravitation and of gas-pressure. It tells us that a star pulsating with a given period must be of a certain density (lower for longer periods), but places no restriction on its size. The observed fact that stars of a given period (and density) have all the same brightness, and hence the same size and the same mass, must depend in some way upon the manner in which heat is generated from atomic sources inside the stars.

WE are pretty sure now that the heat is liberated evenly at the time when the star is smallest, and hottest inside; but we do not know the details. Unless the internal structure of these stars is very queer, they cannot be hot enough inside to utilize the process by which Bethe has explained the shining of the main sequence stars. We may know soon what else happens—in fact, promising suggestions have been made by Gamow—but we cannot be sure.

Fortunately, we do not have to wait to understand the process in order to use the facts. Were it not for one obstacle, we could map out all the nearer portion of space, up to 1,000,000 light-years or more. But there is something really in our way—great clouds of thin haze in space which weaken the light of the stars behind them, and make them look fainter than they would otherwise appear. Many of these clouds are sharply defined, and show conspicuously against the background of the Milky Way—but there is an increasing weight of evidence that these are only dense portions of a vast thin fog which extends along the plane of the Milky Way to enormous distances but only a little way on each side of it.

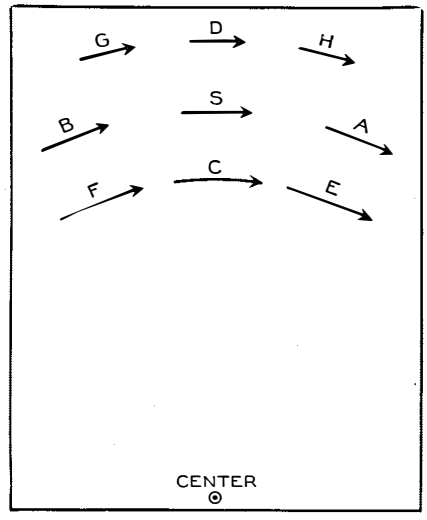


Figure 1: Effect of stellar motions

When we look at an object, such as a spiral nebula, which lies far out of the galactic plane, our line of sight soon escapes from this dust-haze and enters intergalactic space, which appears to be almost perfectly clear. But distant objects in the galactic plane are much diminished in brightness, even though there are no obvious obscuring clouds in front of them.

Simple and convincing proof of the existence of this absorption has recently come out of the admirable work which Dr. Joy of Mount Wilson has done in measuring the radial velocities of Cepheid variables. Since these objects can be seen at great distances, they should be particularly suited for our use in a study of the rotation of the Galaxy.

Our more persistent readers may recall a discussion of this some months ago [December, 1937.—*Ed.*] of which the main point may be repeated here. Suppose that the Milky Way is in rotation about a great mass of stars at its "Center" (Figure 1), and that the Sun *S* is moving in a circular orbit, at a speed represented by the arrow. Stars at *A* and *B*, ahead of it or behind it in its orbit, will be going at the same speed, and neither receding from us or approaching. A star at *C*, nearer the center, will be moving faster—like a planet nearer the Sun. Its motion will be crosswise, and its distance will not change; but one at *E* will be running away from the Sun, and receding, and one at *F* overtaking it, and approaching. Stars on the opposite side will be moving slower than the Sun. There will be no change of distance at *D*, but the Sun will run away from *G*, and catch up with *H*. The net result is that stars in two opposite parts of the galactic circle will be receding and those in the intervening quadrants approaching. The greater the distance of a star from the Sun, in a given direction, the greater will be the speed of approach or recession: indeed, this will be proportional to the distance, until the latter becomes a considerable fraction of the distance to the center (when things get more complicated).

THE Sun is not moving in a precisely circular orbit; but this is easily allowed for. For the stars in the general vicinity of the Sun—say 100 light-years—the differences from circular motion will average out. Hence the motion of the Sun, relative to the general average of these stars, will represent its difference from motion in a circular orbit about the galactic center. It is fairly easy to find this motion, and to allow for it.

Let us now return to the Cepheid variables. Their observed velocities must be corrected for the "solar mo-

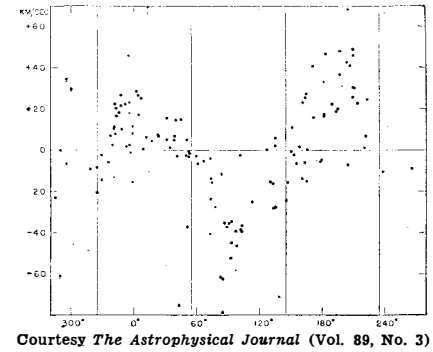
tion" just described, and also for the motion of the surface of each star, arising from its alternate expansion and contraction. To eliminate this it is necessary to make many observations of each star, distributed at different phases of the variation, so that a curve may be drawn to represent the changes in velocity—from which a true average value may be derived.

This has made Dr. Joy's work very laborious, as, on the average, a dozen or so plates were needed for each of the 156 stars on his list.

When it is added that more than half these stars were fainter than the tenth magnitude, and some of them below the 14th, we may begin to realize what an enormous amount of diligent observing has gone into his results.

When the normal velocities for each star are cleared of the effects of motion of the Sun relative to its neighbors, and plotted against the galactic longitude, a very marked double oscillation is seen (Figure 2). The plot looks rather ragged, which was to be expected, as stars at very different distances, with different rotation-effects, have been combined.

If the stars are sorted out according to their distances—calculated on the assumption that there is no absorption of light—it is found (Figure 3) that the nearest stars show only a small effect, not greatly exceeding the deviations for individual stars (which represent the differences of their motions from circular orbits). For the next group, the amplitude is great, and for the two remoter groups, the rotation-effect greatly exceeds the individual motions of the stars.



Courtesy *The Astrophysical Journal* (Vol. 89, No. 3)

Figure 2: **Velocities of 156 Cepheids according to galactic longitude**

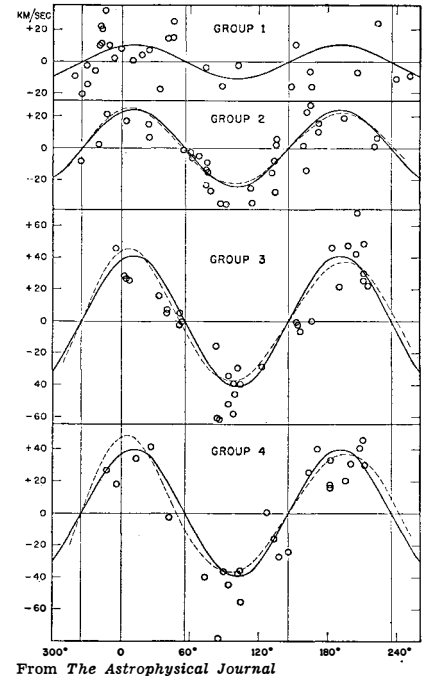
No more convincing proof of the galactic rotation could be desired; but there are still complications. The average distances for the four groups, calculated without absorption, come out 1700, 5000, 10,400 and 20,000 light-years; the half-ranges of the effect are 10, 23, 29 and 38 kilometers per second—and by no means proportional to the distances, as the theory demands. The simplest explanation for this is that there is a general hazy absorption of light such as has been described above. This makes the more distant stars look fainter and leads to an overestimate of their distances. By "cut-and-try" methods—assuming various values for this absorption, calculating corrected distances, and seeing whether the results run in proportion to the observed rotation effects—Dr. Joy finds that a good agreement can be reached with an absorption of 0.85 magnitude per thousand parsecs, or $0^m.26$ in 1000 light-years. The average distances for the four groups then come out 1400, 3500, 5400 and 7500 light-years. For the nearer stars the effect is not great, but for the last group it is very serious. There can be little doubt that this result is substantially sound, for investigations based on quite different data indicate about the same amount of absorption.

Accepting this value, it appears that the depth to which we can study the structure of the Galaxy with the aid of Cepheid variables is limited. Even a very bright Cepheid, of period 50 days, would appear of the 16th magnitude at a distance of 20,000 light-years, and of the 19th at 30,000.

OUR only hope of finding more distant objects lies in the fact that the obscuration appears to be not uniform, but patchy. There are dense clouds in places, thinner ones elsewhere, and nearly clear regions. The value given above is a sort of general average. In heavily obscured regions we should not be able to see as far; and Joy notes that there are no Cepheids in his list at calculated distances greater than 4000 light-years within 20 degrees on each side of the galactic center in Sagittarius, where the obscuration is known to be heavy. Even here, though, there is a chance that there may be gaps between the great clouds, which provide "windows" through which we may see some much more distant objects. A careful detailed study, region by region, is required to detect these, and promising results have been obtained at Harvard.

It is only when we look right along the galactic plane, flatwise through the absorbing haze-layer, that we get into so much trouble. Joy concludes that this layer is 1300 light-years thick. Light coming in at any considerable angle to its plane will not have a long enough path in it to be greatly weakened. This assumption of a uniform layer with sharp boundaries is again greatly oversimplified. It is almost certainly irregular in thickness and thins out gradually.

One thing which the Cepheid velocities give accurately is the direction of the center of the Galaxy—of the line *S-Center* in Figure 1. This is found to lie in galactic longitude $325°.3 \pm 1.3$ —in very good agreement with other determinations. The distance of the center is much harder to determine accurately, but the figure shows how it can be done. The point *B* at which a star would neither approach S or recede from it lies on the circle *BSA*, so that the single *BS-Center* will be less than 90°. If we can determine it, and the distance *SB*, we can find *S-Center*. Using the second and third of his groups of stars (which should give the best values) Joy finds the distance of the center to be 38,000 and 24,000 light-years. The first value should be more accurate, so that he adopts 33,000 light-years (10,000 parsecs) which again agrees with the results of other observers. This is so much farther away than even the remoter Cepheids that no great difference is made in the calculations when it is taken into account. (Dashed curves, Figure 3, show results.)



From *The Astrophysical Journal*

Figure 3: **Rotational curves for the four star groups named in the text**

When allowance is made for galactic rotation, the outstanding residual motions of the Cepheids are found to be small—averaging only 11 kilometers per second. As the circular velocity about the galactic center is nearly 300 kilometers per second, their orbits must be very nearly circular. They are very nearly in one plane, also, for the average distance from the mean plane is only 200 light-years as against a probable diameter of at least 50,000.

Only one thing prevents these results from being definitive and final. The southern Milky Way, from Carina through the Southern Cross and Centaurus, is below the horizon of Mount Wilson, so that the only spectroscopic observations available in this region are those which have been made with smaller telescopes in the southern hemisphere.—*At Sea, M. V. Britannic, June 30, 1939.*

CUBA-KEY TO MANGANESE PROBLEM

Manganese Vital in Steel Manufacture...We Have None...War Would Cut Down Imports...Cuba Now Supplies Some...Momentous American Achievement

By RICHARD B. CLARKSON

CUBA today holds what may be the most important single key to America's national security in time of war.

Nine years ago this wasn't true. Since then, American capital has developed, in Cuba, America's only nearby source of a raw material vital to our national defense—a dirty looking, sooty ore of manganese. This ore is an absolute essential for the manufacture of steel, the metal that wins wars.

Attention in United States metallurgical circles has been focused recently on our national procurement problem as regards manganese and other materials essential to industrial operation, by passage of the $100,000,000 "stockpile" bill, signed by President Roosevelt early last June. This bill, aimed at reducing the "dangerous and costly dependence" of the United States upon foreign sources of "strategic materials," is designed to encourage development of our domestic sources.

American private enterprise has already contributed largely to solution of one aspect of the procurement problem. The Cuban-American Manganese Corporation, a subsidiary of the Freeport Sulphur Company, has developed in Cuba the world's only plant for concentrating manganese ore on a commercial scale by the flotation process—which means that they did something that metallurgists had for years considered next to impossible. Direct result of this development was that Cuba, which in 1931 provided less than 1 percent of American manganese needs, last year sent us over 25 percent of our total imports for consumption.

THE importance of this development may be fully realized only when considered against a background of facts regarding the properties of manganese, and the tenuousness of our foreign sources of supply. Manganese is not just one of a list of more or less essential materials. Of all the strategic raw materials, it has been rated *Number One* in importance by the War Department. Furthermore, there are many grades of manganese ore, and not just any grade will do.

Manganese is the only material which can be used economically as a de-oxidizer and de-sulfurizer in blast-furnace operations at steel mills. About 14 pounds are used in making a ton of high-grade steel, and, without manganese, no steel could be manufactured economically in this country. To be of use to the steel industry, the manganese ore must be of "ferro grade"; that is, it must have a metallic manganese content of about 50 percent.

Although deposits have been charted in 20 states, these are for the most part of such low grade in their natural state as to be virtually useless for steel manufacture. Costs of concentration have for years been considered prohibitive. Concentrating methods other than the flotation process were applied to American ores during the World War, under the spur of war-time necessity, but this work was not conducted on an important scale after 1918.

Since the war, we have depended for about 95 percent of our supply upon foreign sources, in countries that possess deposits from which high-grade manganese is obtained at exceedingly low labor cost—Russia, India, Africa, and Brazil. Russia has for years been our number one supplier and, in spite of the Cuban development, still is.

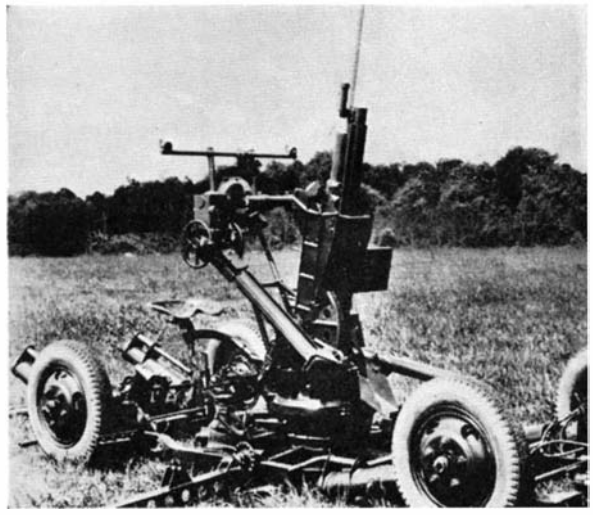
As long as we remain largely dependent upon such remote sources for our supplies of manganese, we face the probability of a drastic curtailment of supply with a flare-up of war in Europe. Such an emergency would almost surely result in the establishment of blockades at the focal points of trade routes serving warring nations—particularly in and around the Mediterranean—through which pass shipments of manganese to the United States from both Russia and India.

In the light of these facts, the significance of the Cuban development may be seen as two-fold. In the first place, Cuba is only 90 miles off Key West and there is little possibility that shipments of manganese from this source could be interrupted in the event of war. In the second place, the rise of Cuba as an important source of so vital a raw material is taken by many as pointing the way to possible similar development of our domestic sources.

The Cuban-American Manganese Corporation was formed in 1932, but work preparatory to its formation began as early as 1930, when the Freeport Sulphur Company instigated petrographic studies of ore and rock formations in Cuba. This work was undertaken on samples taken from north of the town of Cristo in Oriente province, on the lower slope of the Sierra Madre Mountains.

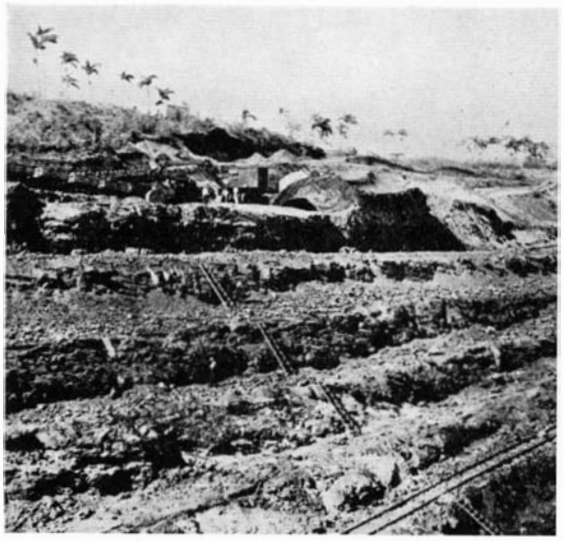
BEFORE 1930, many attempts had been made by other concerns to concentrate the Cuban ore, but all experimenters had come to the conclusion that the ore bodies were too irregular in occurrence and too low in grade to concentrate. Freeport's preliminary investigations of the ore bodies revealed that—in their field to the north of Cristo—there existed some high-grade manganese ore, varying in manganese content between 38 percent and 50 percent. Most of it, however, averaged around 18 to 20 percent—a grade far too low to be used by steel manufacturers.

Previous investigators, however, had confined their experiments to the conventional gravity separation method, which operates on the principle that manganese differs in specific gravity from the material with which it is combined in nature. It was discovered by



Freeport that insufficient difference existed between the mineral and the "gangue" material—dirt—from which it was to be separated, to allow efficient concentration. Other previously-attempted methods of dissolving and precipitating the ore were found to be either inefficient or prohibitively costly.

Having cleared away the deadwood of old methods, the company concentrated



Manganese from Cuban ore pits, like the one at right, promises to solve a large part of the problem long surrounding this material which is essential in the manufacture of steel. By a flotation process developed by Americans—one step of which is shown below—these ores are supplying an increasing percentage of our needs for manganese vital in steel production. And without steel, nations would perish, especially in wartime, from lack of guns, trucks, machinery, and other necessary equipment

all subsequent effort on the development of an altogether new system—the flotation method, which "washes" the ore free of impurities.

The method which was finally worked out and is used today at the Cuban-American plant, is a complex one. It involves grinding the ore to "unlock" the manganese oxide from the gangue material; dilution (enormous quantities of water are used in the flotation process); use of reagents for frothing and floating the manganese and for slime-dispersing; flocculating; and sintering, which eliminates water from the hydrous oxide mineral.

Numerous mechanical difficulties were encountered from the beginning, but by February, 1935, the plant was on the verge of profitable operation. It was at this point in 1935, however, that the United States-Brazil trade pact caused such a drop in the domestic price of manganese that operations at the Cuban-American plant were immediately suspended. A program of further research was then projected, aimed at reduction of operating costs. The result of this research was installation of the only "wet process sintering kiln" used in the Western hemisphere. Made with the help of F. L. Smidth & Co., Danish builders of metallurgical kilns, this mechanical device "agglomerates" the wet concentrate, accumulating it in easily-handled lumps or nodules.

Development of the process was, for all practical purposes, an American undertaking, since nearly all equipment for mine and concentrating plant was purchased from the United States, by American capital. America has reaped and will continue to reap the benefits in peacetime, and may find the development to be the salvation of its steel industry in time of war.

It is probably true that special local terrain difficulties and special difficulties of transportation may preclude the possibility of applying to the ores of the United States the exact process used in Cuba. Nevertheless, it is possible that the Cuban development may serve as an important stimulant in implementing the provisions of the recently-passed "stockpile" bill—a major purpose of which is to encourage development of our domestic sources.

This bill authorizes the expenditure—during the next four years—of $100,000,000 to acquire stocks of strategic raw materials which are today obtained by the United States largely from abroad. It provides, furthermore, that all purchases shall be made in accordance with the "Buy-American" act of 1933, which states that the purchasing agent may allow a reasonable price preferential to domestic producers, as opposed to foreign producers. The practice has been to allow a preferential of at least 25 per-cent. With this as a stimulant, and with the Cuban-American development as an encourager, it is possible that the next decade may witness the development of a domestic manganese industry able to provide for at least the greater part of our domestic steel industry's needs for this material.

IN evaluating the Cuban development, and its established and potential effect on the domestic economy of the United States, it should be remembered that manganese for steel is of course an essential ingredient of peace-time industrial operation. This is an age of steel in which we live. In the past half-century, the capacity of American steel furnaces has expanded over 1000 percent. Today, steel manufacturing is a $4,200,000,000 industry, third largest in the nation, annually paying nearly a billion dollars in salaries and wages to over 600,000 employes. And, just as steel has grown in importance, so manganese imports have increased, soaring from about 250,000 tons of ore in 1930 to over 900,000 tons in 1937.

There is a growing universal awareness of the importance of all raw materials in preparedness planning. The effective power of a nation is no longer determined by the extent of its territory, nor by its wealth in gold, nor even by its strength in armies or equipment in munitions, but rather by its capacity for continuous production of hob-nailed boots and canned beans, tanks and rifles, ammunition and airplanes. It takes 17 men, manufacturing and distributing war materials, to keep one man on the fighting front. And for large scale industrialization, raw material is the first essential.

The implications of America's raw materials shortage were cogently summed up recently by T. M. Girdler, chairman of Republic Steel Corporation, who said: "God grant that this country does not become involved in war, yet even if we are at peace while other nations are at war, our supplies of imported metals might be cut off for long periods. Down in Kentucky, buried in deep underground vaults, we have stored away a great pile of gold. The time might come when we would gladly give all of that gold for a pile of desperately-needed manganese . . ."

If another M-Day should dawn in America, Cuba will be ready with at least a partial solution to the crisis; the plant production can be stepped up beyond its present output. Or it may be that, when the emergency arrives, the United States will already have profited from the Cuban lesson in solving metallurgical difficulties now holding back development of manganese deposits in the United States proper.

Eyes That See Through Atoms*

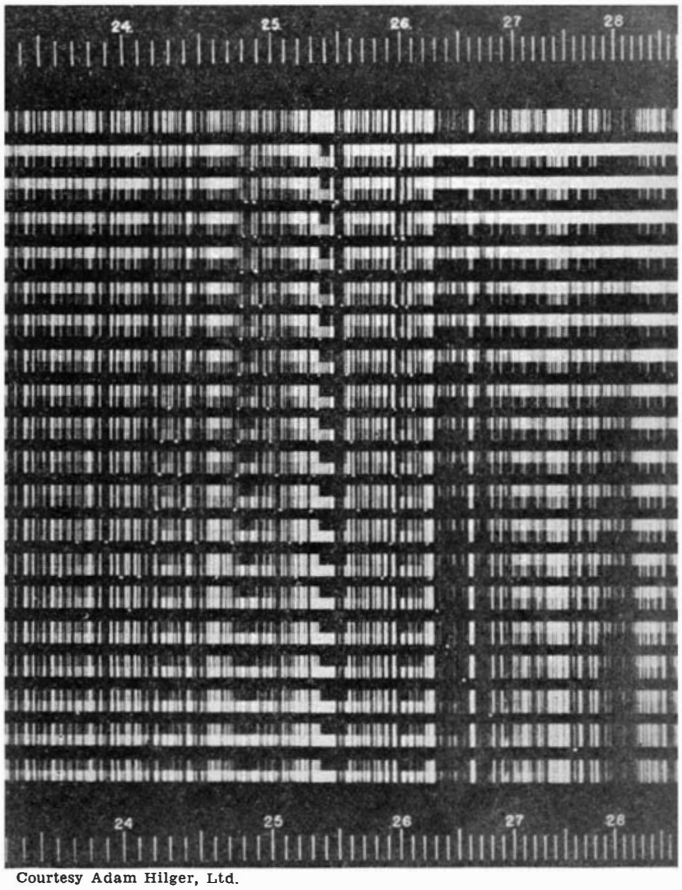
(In Two Parts—Part Two)

Spectroscopic Analysis the Supersensitive . . . In Vitamin Research the Spectroscope Short-Circuits the Overworked Rat . . . The X-Ray Spectrograph

By GEORGE RUSSELL HARRISON, Ph.D.
Professor of Experimental Physics and Director of the Research Laboratory of Physics at the Massachusetts Institute of Technology

WHEN the spectroscopist burns a substance in an electric arc to force it to emit light, the molecules of which it is composed are torn asunder. These molecules consist, of course, merely of groups of atoms clinging together in definite patterns. When vitamins or hormones or other such complex materials are studied, it is the molecules themselves which are of interest, rather than their constituent atoms. Though such materials would be destroyed if burned, fortunately they can be studied with the spectroscope by an entirely different method from the one used for detecting atoms—a method which leaves them entirely undamaged. If a material is at all transparent, light can be sent through it, and waves of certain lengths will be absorbed by its molecules. The spectrograph can then be used to obtain information about the molecules by analyzing, not the light which it receives, but that which is missing because absorbed before it enters the spectrograph.

Vitamin A, for example, has been found to absorb strongly any light waves which are slightly shorter than violet waves. Therefore, instead of feeding cod-liver oil to rats for weeks to discover how much vitamin A a given sample contains, the standard procedure now is merely to send a beam of ultra-violet light through the oil, and measure with a spectograph the amount of light of wavelength 3280 angstroms which is absorbed by a layer of oil of measured thickness. Care must be taken to dissolve from the cod-liver oil any non-vitamin material which might absorb light waves of the same length, but such offending impurities can easily be eliminated by mixing chemicals with the oil, which change them to soap.



Courtesy Adam Hilger, Ltd.

A portion of a typical spectrogram as used to determine the Vitamin-A content of cod-liver oil. Reference figures at top and bottom indicate wavelengths in angstroms, while the tier of absorption spectra shows differences in light absorption for varying thicknesses of oil, as may be seen by choosing some prominent line or feature and running it downward

Analyzing a transparent or translucent substance by studying the light it absorbs is particularly convenient because the material is not destroyed, and the method is quick, clean, simple, and accurate. The two questions which any such analysis must answer are "What substances are present?" and "How much is there of each?" Light absorption measurements answer the second question very definitely. It is estimated that a layer of material only five atoms thick can, in many cases, be detected by the light it absorbs. By combining a microscope with a spectroscope a speck of vanadium only 100 atoms long by 100 atoms broad by five atoms thick has been observed. Ability to detect such a clump of matter, containing only 50,000 atoms, weighing a billionth of a billionth as much as a dime, stamps this method as one of the most sensitive available.

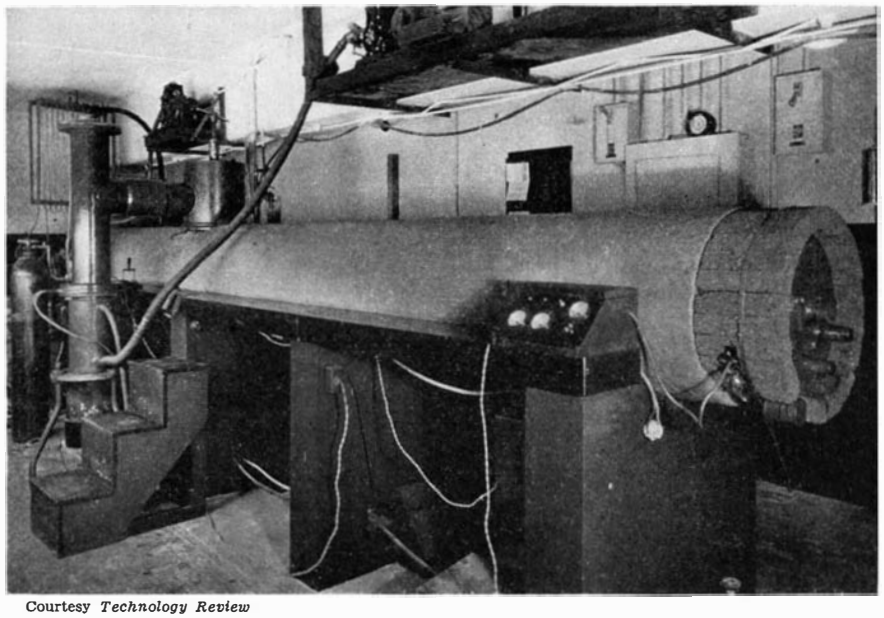
ALL life ultimately depends on absorption of light, for it is the absorption of sunlight by the green leaves of plants which keeps the plant and animal worlds alive. Biologists have long used the spectroscope in their efforts to learn how the chlorophyll of green leaves manages to capture sunlight, and, with its aid, store in the leaf carbon from the air as cellulose, starch, and sugar. Many a leaf, green or brown or yellow, has been held before the slit of a spectrograph and had its inner structure plumbed with light in an effort to unravel the secrets of chlorophyll and carotin and other complex molecules on which life depends.

In the ultra-short-wave region of the spectrum lies a broad band of waves entirely untouched except by the pioneering surveys of spectroscopists studying the spectrum for its own sake. Such useful applications of these waves as there may be, and there are probably many, must wait until further experiments have been performed designed to perfect ways of handling these delicate rays. No one has yet succeeded in finding a solid material which is transparent to light waves shorter than one fourth as long as those we call violet and longer than X rays, and which could be used for windows to allow light to enter and leave experimental apparatus. Thus far hydrogen and helium are the only materials which the ultra-short light waves

have been found able to penetrate, and though windows have been made of such tenuous gases, it is something of a trick to do this.

In the realm of the still shorter X rays—waves similar to light, but less than one thousandth as long—almost all matter becomes relatively transparent. Windows of many types are thus available, but the technic of handling X rays is still very crude; we have no lenses to bend them, no mirrors to reflect them, no microscopes to see with them. In spite of these lacks, two powerful methods of using X rays have been discovered. The first is to take ordinary shadow pictures with them, such as have revolutionized medicine and surgery during the past 40 years. The second is to send the X rays through a special type of spectrograph.

Revealing as is the glimpse through flesh or metal which an X-ray shadow picture gives, it is crude compared with that obtained by means of a spectrograph. Then the glimpse is into the very atoms of matter themselves—even farther into the hearts of these atoms than is possible with an ordinary spectrograph.



Courtesy *Technology Review*

The world's largest vacuum spectrograph, at the Massachusetts Institute of Technology. Since air is opaque to light waves shorter than about 2000 angstroms, all air must be pumped from the light source, the spectrograph, and the camera if such rays are to be photographed. Note vacuum pump and valve at rear

IN 1912 Dr. Max von Laue had the brilliant idea that a crystal, such as rocksalt or diamond, might separate X rays into beams of similar wavelength much as an ordinary diffraction grating separates light into its colors. The diffraction grating consists of thousands of parallel lines traced on a mirror; the crystal, argued von Laue, consists of millions of parallel lines of atoms, very close together, and perhaps these closely spaced lines are just what is needed to sort out the short-waved X rays. Experiments carried out at von Laue's suggestion showed that his idea was a good one. When a narrow beam of X rays was sent through a crystal, bright and dark spots appeared on a photographic film held behind the crystal, and the positions of these were found to depend on the different wavelengths in the X-ray beam, and on the arrangement of the atoms in the crystal. Sir William Bragg and Professor W. L. Bragg soon were able to arrange the crystal in a spectrograph so that clear, sharp, spectrum lines were obtained with X rays, entirely similar to those produced when visible or ultra-violet light is sent through an ordinary spectrograph.

If X rays are sent through a piece of metal, the small crystals of which it is composed can be studied with the X-ray spectrograph. This use of X rays has particular application in the heat treatment of steel. In one foundry it had always been found necessary to keep certain metal parts for six hours in a furnace at high temperature, to bring them to the proper strength and hardness. Then the arrangement of crystals in the metal was studied, and the realinement of the atoms and crystals during heat treatment was followed with an X-ray spectrograph. As a result it became possible to work out theoretically a special short course of treatment lasting only half an hour, and on trial this proved to give better results than the longer treatment, at one fifth the cost.

Pieces of metal which undergo great stress, like airplane propellers, usually show changes in their internal structure a considerable time before they are ready to break. Propellers are almost always X rayed by the shadow method, to discover internal flaws, but they should also be studied from time to time with the X-ray spectroscope to insure that their atoms show no signs of wanting to let go of each other.

How well a piece of cloth will wear depends on the quality of the fibers of which it is woven, and how strong and flexible these fibers will be depends greatly on the character of the molecules of which they are composed. The X-ray spectrograph can be used to look right down through the fiber structure directly into the arrangement of atoms in these molecules, and sometimes shows that improved arrangements of atoms would make better molecules, hence sturdier fibers, hence stronger cloth.

In cotton, wool, and asbestos fibers the molecules are found to consist of long strings of atoms lying side by side; here are substances respectively of vegetable, animal, and mineral origin which are similar in molecular and in outer form. Mica is composed of molecules which form broad flat crystalline plates arranged in layers which are held together so loosely that they can be split apart without difficulty. In diamond, on the other hand, carbon atoms hold strongly to each other in three dimensions to form crystals which cannot be torn or split, and hence produce the hardest substance known. But change the arrangement of these diamond atoms ever so little and groups of them begin to slip apart, the crystal structure changes, and instead of the hard, abrasive diamond, we have graphite, one of the softest and most slippery solids known.

IF a piece of rubber is held between an X-ray tube and an X-ray spectrograph, the spectrum shows that so long as the rubber remains unstretched the molecules in it are arranged helter-skelter with no semblance of order. But when the rubber is stretched, long chains of molecules appear, which contract and expand like coiled springs. The unusual ability of rubber to stretch and then return to its original shape can be traced directly to the molecules of which it is composed.

About lubrication the X-ray spectrograph gives important information, for it shows that greases and oils contain long molecules which slide over one another in layers.

The physicist has been able to contribute the telephone, the radio, the motion picture, television, and a dozen other adjuncts of civilization, only by using the powerful tools with which he has armed himself for the investigation of nature. Among these tools the spectrograph is outstanding, ever ready to yield new information on the structures of atoms, on the arrangements of the molecules which these atoms form, on the multitudes of substances which can be produced from these molecules, and hence on many of the activities of men, machines, and material universes.

Two Elements For One

The Most Important Scientific Discovery of the Present Year is also the Biggest Explosion in Atomic History . . . Splitting the Uranium Atom

By JEAN HARRINGTON

THE Fifth Washington Conference on Theoretical Physics was sitting in solemn conclave when the news broke. Professor Nils Bohr of Princeton and Professor Enrico Fermi of Columbia rose to open the meeting with an account of some research going on in a Berlin laboratory.

Professors Bohr and Fermi are Nobel Prize winners both, and their names are as well known to scientists as Toscaninni's is to music lovers. The Conference therefore expected something extra special. They weren't disappointed.

It was January 26, 1939. A few weeks before, at the Kaiser Wilhelm Institute in Berlin, Dr. Otto Hahn, a distinguished German physicist, had obtained an utterly unexpected result from some more or less routine experiments. Following the original example of Professor Fermi, Dr. Hahn and his co-worker, F. Strassmann, had for many months been bombarding uranium with neutrons and studying the debris left by this atomic warfare.

It would not have surprised them at all to find radium as one of the products. In fact, they had done so before, or thought they had. Radium and uranium are near neighbors in the table of elements, and it is nothing new for scientists to transform one element into another close to it in weight and electric charge.

But it was news, and big news, to discover barium among the debris—barium, which is only a little more than half as heavy as uranium. It meant that the neutron bullets had succeeded not merely in knocking a few chips off the old block, but in blowing the whole atom asunder with a terrific explosion.

The theoretical and practical import of Hahn's discovery may not be immediately obvious to the laymen. The article will attempt to interpret its significance in later paragraphs. But on the scientists, the news had the same effect as the tidings of gold in California had on the Forty-niners. They flew to their laboratories to find the treasure for themselves.

A few insiders had already jumped the gun ahead of the Conference and of the rest who learned of the discovery through the newspapers. In Copenhagen, Dr. O. R. Frisch and Professor Lise Meitner, who had previously worked with Hahn on the same problem, had verified his results ten days earlier. A group of Columbia University physicists, including Fermi, independently thought up and carried out a similar experiment by January 25, the day before the Conference. By the time the meeting wound up its affairs January 28, three more laboratories—at the Carnegie Institution of Washington, Johns Hopkins, and the University of California—joined the chorus of confirmation. In a word, Hahn was right. Uranium, and thorium, too (thorium is also among the heaviest elements), had been split in two by neutron bombardment.

THE phenomenon was quickly dubbed "nuclear fission," and in the months ensuing since its discovery, nuclear fission has grabbed the spotlight from the "heavy electron" sensation of 1937-8. Dozens of the world's top-flight physicists have been busy as bees, roaming the clover of a new field of research.

The first task of the investigators was to get a picture of what had happened. Dr. Frisch and Miss Meitner promptly supplied a pretty good one.

The nucleus of an element, they pointed out, is now thought of as an aggregation of protons and neutrons packed together into an inconceivably small space. The number of protons, or units of positive electric charge, accounts for the chemical behavior of the element. Neutrons are units of weight and have no charge. Together the neutrons and protons make up the mass of the nucleus.

The simplest nucleus is the single proton belonging to the lightest element, hydrogen. Going up the atomic scale, adding one proton and a varying number of neutrons for each successive element, we arrive at last at uranium. This heaviest of elements is invariably characterized by its 92 protons; in its commonest form it contains 146 neutrons as well, giving it a total weight of 238. Two other forms, weighing 235 and 234, also occur in small quantities. These are called the three natural *isotopes* of uranium, and are distinguished by the shorthand symbols U^{238}_{92}, U^{235}_{92}, and U^{234}_{92}.

Now all the known elements heavier than mercury—that is, thallium, lead, bismuth, polonium, radon, radium, actinium, thorium, protactinium, and uranium—have isotopes that are naturally radioactive. Their nuclei are so complicated that occasionally one will spontaneously simplify itself by shooting off a particle.

We can picture the process nicely if we imagine for a moment that the radioactive nucleus is like a drop of water, composed of many molecules. One of the molecules near the surface somehow acquires a little more energy than its fellows and evaporates.

The stage is now set to return to Dr. Frisch and Miss Meitner, whom we left some paragraphs ago. Their conception of the nuclear fission process continues the analogy of the drop of water. Suppose the H_2O molecules are violently agitated by a source of energy outside the drop. Instead of evaporating gradually, the drop splits in two. Similarly, a uranium nucleus, stimulated by the impact of a neutron bullet, may divide into two smaller nuclei of roughly equal size.

These fragments are in themselves unstable, and quickly disintegrate to form still other nuclei. In fact, a whole series of transmutations generally follows the fission of uranium or thorium. Since Hahn first found barium among the products, he and other investigators have identified antimony, tellurium, iodine, xenon, caesium, and lanthanum in one group; bromine, krypton, rubidium, strontium, and yttrium in another, with many possible additions.

The explanation is simple enough. The original fragments contain too many neutrons in relation to their proton content, and must get rid of them to achieve a stable form. One of two things happens. The nucleus may simply expel a whole neutron, reducing its weight by a unit. Or one of the neutrons may be converted into a proton plus a negative electron inside the nucleus, which promptly ejects the electron. In the latter case, the nucleus remains approximately the same weight but acquires an additional positive charge, thus becoming a chemically different element. Experiments have proved that both these types of disintegration actually do take place.

No one knows yet whether the same two original products are always formed when uranium divides, or what they are.

But if one of the fragments is barium, with 56 protons, the other must have 92 minus 56, or 36, protons, which would make it an isotope of the gas krypton.

If the barium tries to stabilize itself by emitting an electron, it becomes a lanthanum isotope, which may in turn convert itself into cerium by electron emission. The krypton also disintegrates in the same way, successively becoming rubidium, strontium, and perhaps yttrium and zirconium. We can show these chain reactions by a formula where the subscripts represent the number of protons of the products:

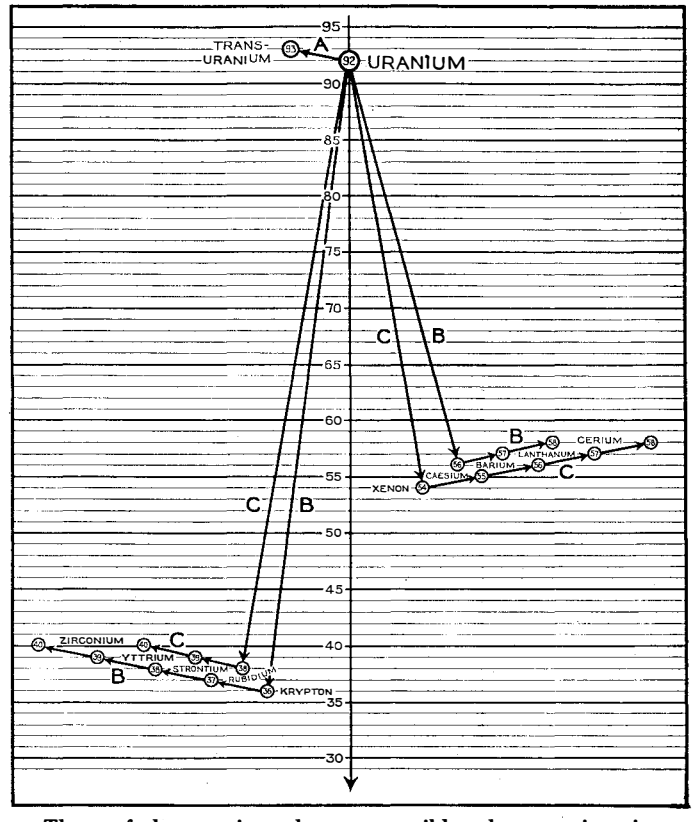
$Ba_{56} \rightarrow La_{57} \rightarrow Ce_{58}$
$Kr_{36} \rightarrow Rb_{37} \rightarrow Sr_{38} \rightarrow$
$Y_{39} \rightarrow Zr_{40}$

Again, if the two original fragments are strontium and xenon instead of barium and krypton, we may have the following chain reactions:

$Sr_{38} \rightarrow Y_{39} \rightarrow Zr_{40}$
$Xe_{54} \rightarrow Cs_{55} \rightarrow Ba_{56} \rightarrow La_{57}$
$\rightarrow Ce_{58}$

In a discovery like this in the realm of pure science, it is always easier to see the theoretical importance than to find a practical application. The fission of uranium has provided a field day for the physicists who like to take atoms apart and find out what makes them tick. It adds a new chapter to their knowledge of the nucleus—the forces that hold it together, the collective behavior of its constituent parts, its reaction "under fire," its destiny.

studied their chemical properties they found inexplicable variations. Last November, just a few weeks before Dr. Hahn stumbled on the real secret, he announced that he had found at least 16 different kinds of nuclei resulting from neutron bombardment of uranium. Some of them, indeed, behaved chemically like barium, lanthanum, and other light elements, but they were thought to be isotopes or isomers of heavier elements such as radium. (Isomers are nuclei having the same total weight but different chemical properties. Isotopes have the same proton content but varying total weights.)



Three of the reactions that are possible when uranium is bombarded by neutrons. Each horizontal line represents a chemical element containing the indicated number of protons, *A* represents the formation of transuranium. *B* shows the split of uranium into barium and krypton, with the chain reaction that follows it. *C* represents the division into xenon and strontium followed by its own subsequent chain reaction

In addition, it clears up a mystery of long standing, dealing with elements heavier than uranium. When, in 1934, Fermi began his experiments with uranium, he soon found that negative electrons were always emitted under neutron bombardment. We know now that they are usually the products of the chain reactions just described; but at that time nuclear fission was not even dreamed of. Fermi naturally concluded that the uranium nucleus captured the neutron, converted it into a proton, and expelled an electron.

Here, then, was a supposedly new element with 93 protons, unknown to nature. Moreover, this new element seemed to emit another electron to form another new neucleus of 94 protons. These were called "transuranic" elements, and up until lately they were a headache to the numerous investigators who worked on them. The latter kept finding more and more transuranics; and when they

When the announcement of nuclear fission came, it was immediately realized that the electrons were not in general emitted by the uranium nucleus itself but by its lighter fragments. The mystery of "transuranic elements" was practically solved. It does seem, however, that a neutron bullet occasionally fails to give its target quite enough energy to divide; the uranium isotope disintegrates by electron emission and really does form a new element with 93 protons. But one such problem child is far better than 16.

So much for the theoretical significance of nuclear fission, far-reaching though it is. It is pretty hard to amass as much weight on the practical side of the balance. But our imaginations are immediately seized by the terrific amount of energy liberated when a single uranium nucleus explodes. The two fragments fly apart activated by some 200,000,000 electron volts—a total far greater than that associated with any other atomic phenomenon except cosmic rays.

The tabloids love to write of blowing up the world with a gram of matter, and it's not such a sensational idea as one might think. Even a tiny mass has an enormous potential of energy if it could but be freed. It is just such a conversion of mass into energy that speeds the fission fragments on their way.

The weight of any nucleus is never quite equal to the sum of its individual protons and neutrons. A small proportion of their mass, called the "packing fraction" or "mass defect," is somehow transformed into the force that holds the nucleus together. Otherwise the positively charged protons would all repel each other and scatter in every direction.

The packing fraction for uranium is, because of its large number of particles, greater than that for the simpler elements into which it divides. This difference in energy is released with the two fission fragments.

OF course, 200,000,000 volts is an astounding energy compared with the size of the bodies which possess it. But for practical purposes it is absurdly small, amounting only to about three ten thousandths of an erg. In more everyday terms, it would take 25,000 *billion* fissions per second to produce one horsepower—figures which dwarf even the national budget. The very best a laboratory can do so far is produce a few hundreds per second.

If atom smashing could be made more efficient, power production by means of nuclear fission would not be beyond the realms of possibility. But under present conditions, the process is as inefficient as removing the sand from a beach a grain at a time. Or, more graphically, it is like shooting with buckshot at a netwood of beads strung yards apart. The size of the target is comparable with the size of the projectile, the empty space between targets is enormous compared with the diameter of either, the stream of bullets cannot be well controlled or aimed, and therefore it is much more probable that a neutron pro-

jectile will fly past a uranium nucleus than to score a direct hit and be captured. In fact the chances are thousands to one against fission taking place.

Neutrons have proved themselves more efficient atom-busters, however, than other projectiles like protons or alpha particles, which are positively charged and hence repelled by the positive nuclei. To get a stream of neutrons, a preliminary bombardment must take place. One common method employs the radioactive gas radon, which spontaneously emits alpha particles (helium nuclei with double charge and mass four). The alpha particles are allowed to fall on a sheet of beryllium, where they join with the beryllium nuclei to form carbon plus neutrons. The reaction is shown by the formula:

$$Be_4^9 + He_2^4 \rightarrow C_6^{13} \rightarrow C_6^{12} + n_0^1$$

where the superscripts are the atomic weights and the subscripts the charge.

The stream of positive particles from the cyclotron may also be used to bombard beryllium and thus produce neutrons. The high energy and great number of cyclotron particles make them more efficient neutron makers than the natural radio-alpha particles.

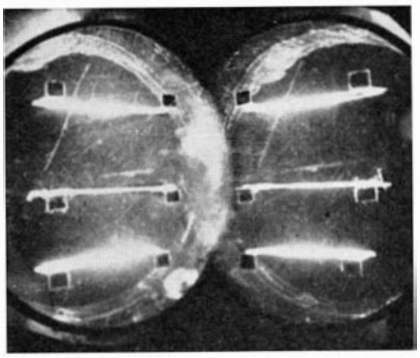
Once created, the neutron beam is directed against a uranium target. The products are studied in various ways. If the investigators want to find the energy of the fragments, the target is placed in an ionization chamber, filled with a gas at low pressure. The fragments rip through the gas atoms, disrupting their outer electron structure to form ions. The gas ions are drawn to a wire where they constitute a tiny electric current, and the magnitude of this current gives a clue to the energy of the fission products.

If the experimenters want the range of the particles—that is, the distance they travel before their kinetic energy is all used up—they may choose a Wilson cloud chamber which automatically photographs the track of ions the nucleus leaves behind it.

If they want to know the number of fissions occurring in a given time, they have an electric counter at their command, based on the same principle as the ionization chamber. A modification of the same instrument is used to look for electrons or neutrons emitted in the fission process or in the chain reactions that follow.

The problem of identifying the products is a somewhat different one, and is complicated by the large number of elements which may be formed. Here the debris is collected on a sheet of Cellophane or paper placed close to the uranium target. Each variety of isotope on the sheet has a definite rate of disintegration—it may be anywhere from a fraction of a second to several days—and this time is characteristic of the element to which the isotope belongs.

To measure this period of decay, the collecting paper is placed near an electric counter. If the activity of one product decays to half its original value in 87 minutes, for example, that product is immediately known as an isotope of barium, Ba_{56}^{139}, which is known from other experiments to have a characteristic "half life" of 87 minutes. The difficulty of this method of identification is, of course, in separating the half-lives when two or more elements are decaying together; and also in classifying a half-life belonging to an isotope previously unknown.



Stereoscopic cloud chamber photograph showing tracks of two heavy fragments recoiling in opposite directions from a uranium nucleus struck by a neutron. The uranium is on a collodion film (one of the broad, bright horizontal lines). The fragment tracks are fainter and nearly vertical. The fork near the lower end of the track resulted from a collision of one fragment with a gas atom in the cloud chamber. The double picture is obtained by photographing the chamber simultaneously from two points of view, to get three-dimensional perspective. Photographed by Corson and Thornton at the University of California

Another method of studying the products is to perform the experiment under water, then analyze the water chemically. Suppose we suspect that a few nuclei of radioactive lanthanum are present. This is too small a quantity to separate directly. But if a larger amount of a stable lanthanum compound is added to the water, both stable and unstable lanthanum atoms can be precipitated out. If this precipitate is then shown to be radioactive, we have proved our suspicion was correct. Similarly the water can be tested for radioactive barium by adding a stable barium compound, and so on.

STILL a third attack on the problem of identification has been made by Philip Abelson at the University of California. He had been studying the natural X rays from the supposed "transuranic elements"; and put on the right track by the discovery of nuclear fission, he quickly showed that these X rays had wavelengths characteristic of iodine and tellurium.

Research along all these lines is proceeding at breakneck speed. Experiments similar to those with uranium have been performed on thorium (Th_{90}^{232}) with similar results, except that only fast neutrons are effective in splitting the thorium nucleus, while both fast and slow work well on uranium. Other heavy elements, such as gold and tungsten, show some slight tendency to undergo fission.

Fermi and others have been trying to determine which of the three uranium isotopes are involved, and how the process is related to the speed of the neutron projectiles. Duke University scientists are investigating gamma radiations connected with fission, and the University of California is piling up data in all branches of the research. Bohr at Princeton, Solomon in Paris, and many another are concerning themselves chiefly with theory.

Irène Curie and P. Savitch, who were responsible for much of the ground work enabling Hahn to identify the products of his fission experiments, have been carrying on the classification work in Paris. Joliot, as well as groups of physicists at Columbia, the Carnegie Institution, and Cambridge University, have concentrated on the study of secondary neutrons emitted at the moment of fission and in later reactions.

The latter problem brings up an interesting and rather disturbing aspect of the case. These secondary neutrons constitute a fresh supply of "bullets" to produce new fissions. Thus we are faced with a vicious circle, with one explosion setting off another, and energy being continuously and cumulatively released. It is probable that a sufficiently large mass of uranium would be explosive if its atoms once got well started dividing. As a matter of fact, the scientists are pretty nervous over the dangerous forces they are unleashing, and are hurriedly devising means to control them.

It may or may not be significant that, since early spring, no accounts of research on nuclear fission have been heard from Germany—not even from discoverer Hahn. It is not unlikely that the German government, spotting a potentially powerful weapon of war, has imposed military secrecy on all recent German investigations. A large concentration of isotope 235, subjected to neutron bombardment, might conceivably blow up all London or Paris.

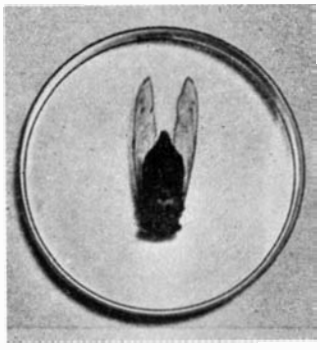
It has been impossible, even in this long article, to mention all the thousand aspects of this fascinating phenomenon. or name many of the able contributors to the sum of information amassed since last January. But the fact remains that nuclear fission is the most important scientific discovery of the year, and holds who knows what promise for the future.

Preserved in Plastics

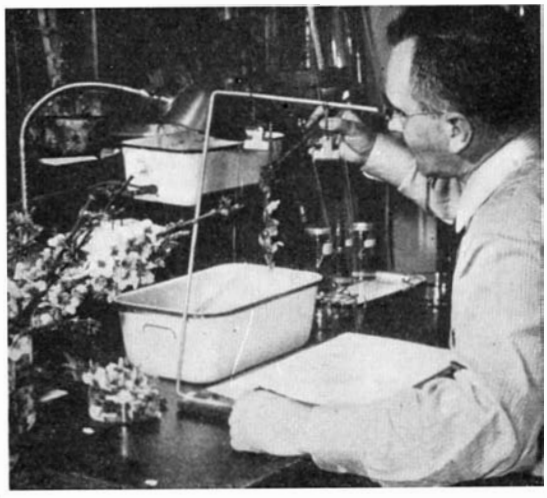
TWO methods of preserving indefinitely in their natural colors such agricultural specimens as leaves, flowers, fruits, seeds, insects, and other biological material have been developed by chemists of the United States Department of Agriculture. The processes, while supplementing each other, have different fields of application—one for dried and the other for fresh material.

In the method studied by Dr. Charles E. Sando, specimens are suspended and embedded in methacrylate, a crystal-clear plastic. In this process, the specimens must be dehydrated to prevent moisture from clouding the glass-like plastic material. They may be air-dried or dehydrated by use of alcohol or ether.

Grains or seeds, insects, or anything that does not lose its color or shape with drying, may be preserved by this method. Once the plastic sets, it can be machined and polished so that the specimen may be viewed from any angle without distortion.

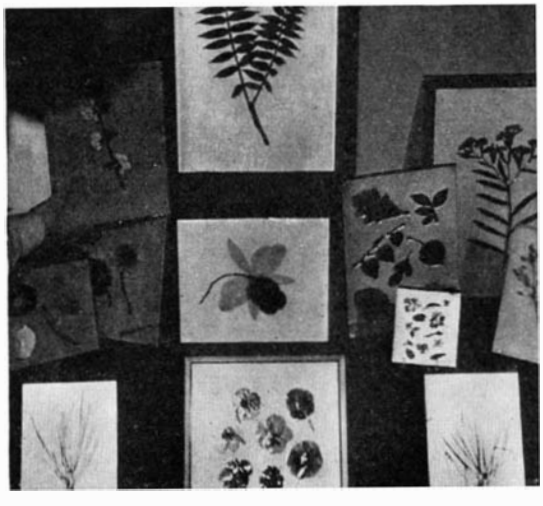


Modern plastics are used to do by intent what the resins that turned into amber did by accident millenia ago—to preserve insects and plant products in full color and natural form. At left and right are specimens embedded in clear plastic



In the second method, specimens are not immersed in plastics but are treated to toughen tissues and set the natural color. At right a spray of peach blossoms is lifted from water-removing syrup after being refrigerated the proper number of days. It will then be placed temporarily between sheets of thin cellulose acetate film and hung up (see left) to cure for a number of weeks. Complete dehydration is accomplished in a drying cabinet

The other method, developed by G. R. Fessenden, is a chemical process for treating fresh plant material in such a way as to toughen the tissues and set the natural color. The natural beauty of flowers, or the exact appearance of either healthy or diseased leaves, can be preserved by immersion in specially formulated water-removing syrups. Each plant species requires an individual treatment which has to be worked out from seven general types of formulas. Specimens preserved by this new method are sealed between sheets of cellulose film.



The curing completed, the specimen loses its temporary film covering and is mounted on a glass plate in a water-resistant, resinous compound. A cellulose acetate film (at right) is then placed over it for protection. It is finally added to the collection (at left) which is being kept for observation to determine keeping qualities of the specimens. If they keep well, the process will prove very valuable as a means of making records for study, research, and exhibition

Due to the expected permanence of specimens preserved by either method, excellent records of both healthy and abnormal plants and insects may be made available for research and study.

Although numerous specimens have been prepared by both methods, there are a number of difficulties to be overcome before the final methods can be released for general use.

High Blood Pressure

Various are the Possible Causes of this Ill, but Worry and Nervous Excitement Probably are Large Factors...Calm Rest the Best Cure...Loaf, Loaf, Loaf

By T. SWANN HARDING

WHEN Sir Marc Armand Ruffer made his medical study of ancient mummies found in Nubia he reported that many of these worthies had suffered from hardening of the arteries. Dr. R. H. Hoffman, commenting on this in his "Struggle for Health," said it was natural to assume that the ancient Nubians had high blood pressure.

Yet, he observed, they did not smoke. Supposedly they did not drink hard liquor, overeat meat, take too much or too little exercise. They did not live the hurried, bustling, frenzied life of modern times. Syphilis was presumably then unknown also. Yet many modern doctors believe these things cause high blood pressure and hardening of the arteries.

In the *Archives of Internal Medicine* for July, 1930, you will find an interesting study by Drs. Walter C. Alvarez and L. L. Stanley of 6000 prisoners and 400 prison guards. The guards had higher blood pressure than the prisoners. The prisoners were both more calm and less obese than the guards. Possibly nervous excitement entered the picture here. The guards' blood pressure was taken when they came to apply for the job, presumably somewhat excited. The prisoners, unworried and calm, would tend to have lower blood pressure.

It was found also that the blood-pressure level did not rise with age. It was affected little if any by habits of dissipation, by the use of tobacco, alcohol, or drugs, or by venereal infection. Cool weather slightly raised the blood pressure. To a considerable extent high blood pressure appeared to be a matter of heredity and "nerves." Even the impassive Chinese usually develops higher blood pressure when he comes to bustling America.

BUT what is "high" blood pressure? What might be high for me might, all things considered, be normal for you. In 1928 Dr. Herman O. Mosenthal declared it was quite difficult to distinguish between normal and high blood pressure by making a single test. The patient must rest and be under close observation for some time.

There are several types of high blood pressure (hypertension) too, some mild and almost harmless, others not so harmless. Patients with a benign type of the ill return to normal blood pressure after a little rest.

Dr. Mosenthal, mentioned above, also tells of curing one woman's high blood pressure (at least for the time) by prescribing freedom from community committee work. This was after she had unsuccessfully taken two sanitarium rest cures and a prolonged trip South, and had had a major surgical operation.

The relationship that should exist between blood pressure and age, contrary to much lay opinion, remains unsettled. Dr. Temple Gray told the British Hunterian Society in 1929 that the expression, "A man is as old as his arteries," had done more harm than any other medical statement. He said some people attain advanced age with their arteries in seemingly hopeless condition; others die young with apparently healthy arteries. He claimed to have seen persons in apparent health with extremely high blood pressures. Other doctors say women can withstand such hypertension well but never men.

Apprehension when the blood pressure is taken may actually cause the pressure to rise abnormally

Some physicians speak of a "low-blood-pressure type." It consists of artistic persons who suffer from lassitude and an inability to do intellectual work. They come to doctors much earlier than the high-blood-pressure type.

Others speak of racial high blood pressure and admonish us to adopt a vegetarian diet because the Chinese and the East Indians have low blood pressures. But the Eskimos also have relatively low blood pressure and no undue affliction with kidney trouble, yet they eat only meat. What part does diet play in producing high blood pressure?

Dr. Mosenthal and his associates reported upon extensive studies of applicants for insurance in *The Journal of the American Medical Association* for April 3, 1937. They wrote: "People with hypertension do not habitually eat more protein or more salt than normal persons. There is no evidence to show that a low protein diet followed by a hypertensive patient, will materially reduce the blood pressure provided there is no anemia."

WOMEN, it was found, tend to adopt diets containing much less protein than those the men eat, but blood pressures do not follow this trend. Neither the salt nor the fluid intake affect the blood pressure. Alvarez has shown in his studies also that, though women are as a whole more prone to constipation than men, men have higher blood pressure. In general, constipation and low blood pressure go together.

There is, then, no average normal blood pressure for persons of a certain age or weight. Each individual must be considered as an individual. The question is: Is this specific blood pressure high for this particular individual at this time?

In an editorial review for the *Journal of Nutrition*, in July, 1932, Dr. Fritz Bischoff pretty thoroughly showed that there is no evidence that diet has anything directly to do with kidney and blood vessel changes. Why, then, do high-blood-pressure sufferers go on diets? Thirty-odd years ago, when high blood pressure was discovered, it was thought to be due to the kidney disease called nephritis and to the loss of elasticity in the arterial walls called arteriosclerosis. These ideas continue to hang over, though it is now known that primary kidney disease is rare and arterial hardening usually moderate. The dietary restrictions came in with these old ideas. Time has proved most of them to be silly and unnecessary. Even restrictions against exercise have been removed, provided the exercise be in mod-

eration. Above all, the sufferers must avoid stress and strain, for it has repeatedly been shown that, in some, a little rest lowers blood pressures almost miraculously.

Salt is often denied high-blood-pressure sufferers, perhaps for insufficient reason. The best medical authorities now agree that, within ordinary limitations, the salt intake does not affect blood pressure. Prolonged investigation of 11 patients was published in *Archives of Internal Medicine* for October, 1929, for example. Sometimes these people got as much as an ounce of salt a day, sometimes only a fifteenth of an ounce or so. This was done after an initial period of rest in bed on a good diet for from ten days to two weeks. Occasionally salt was injected into the veins of the subjects in considerable quantity, but their blood pressures remained unaffected.

Low-protein diets came in with the theory that kidney disease and high blood pressure were related. Today, the very assumption that long-continued excretion of the digestive end-products of excess meat consumed will irreparably injure the kidneys, is questioned. Moreover, even sufferers from degenerative kidney disease must have a minimum of protein or they will start to digest their own tissues. If high blood pressure is uncomplicated by such kidney degeneration the meat tabu seems unwarranted. The diet has been proved to have very little to do with directly causing kidney, heart, and blood-vessel ailments.

WHAT about other conditions associated in the popular mind with high blood pressure? Constipation often accompanies low blood pressure. Obesity tends to promote high blood pressure and is bad for its sufferers.

The death rate of those who suffer from high blood pressure in acute forms is very high. These deaths occur from three general causes, heart failure or cerebral degeneration being commonest, some form of kidney failure more rare. However, the death rate of those with only moderately high blood pressure is about that of normals.

There is a tendency for nervous people and neurotics to have hypertension. Acute infections and intestinal auto-intoxication—assuming the latter exists, which those who appear to know most now deny—do not seem to increase the blood pressure.

Thus, in *The Journal of the American Medical Association*, September 20, 1930, we find a doctor claiming to have gotten excellent results on 200 patients by using bismuth subnitrate. But in the same journal for February 13, 1932, Dr. David Ayman reported his complete inability to get positive results by prescribing this drug for from three to nine months in treating 15 high-blood-pressure patients. Indeed, Dr. Ayman began to think that this drug and perhaps all others used in high blood pressure had only the effect of suggestion. In spite of the treatment used, the investigator always claimed to produce partial or complete relief from the annoying symptoms of high blood pressure. Moderate or marked drop in the pressure was always said to follow. Yet the symptomatic relief was often out of all proportion to the fall in blood pressure, while the blood pressure often fell without relief of the patient's symptoms.

Traditionally, metropolitan life with the strenuous excitement of its stock exchanges and intensive life conduces to high blood pressure but a comparable degree of nervous tension can be and often is developed (for reason) on the farm

The various investigators had used a wide variety of rest cures, low-salt diets, low-protein diets, and regimens, as well as treatments with heat, the application of radium to the skull, watermelon extract, and all standard drugs used in hypertension. Complete failure was seldom or never reported. Yet there was no cure for high blood pressure! So Dr. Ayman decided to try on 40 unselected sufferers from high blood pressure a treatment that he was sure could not only not aid them but would lack all effect. He used a few drops of dilute hydrochloric acid in water. This at least tasted like a drug and it was enthusiastically recommended when given. The results were miraculous. There was definite improvement in symptoms in 32 or 33 cases! Dr. Ayman wrote: "The symptoms associated with uncomplicated essential hypertension may frequently be relieved by the suggestion inherent in any seriously and enthusiastically prescribed drug or method of therapy. This is the probable explanation of many successes reported in the past."

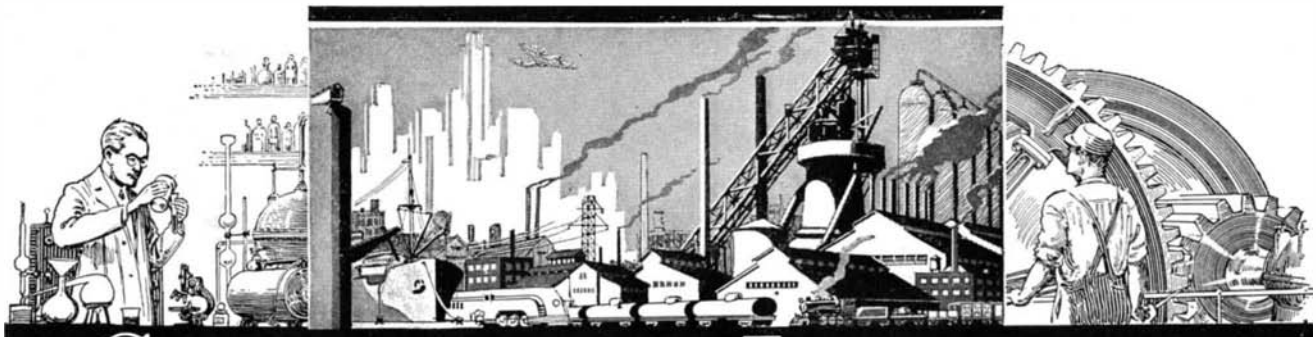
Dr. Ayman also found that two weeks' rest abed worked wonders. He found wide variations in the blood pressure taking place without any effort to treat it at all. Obviously, relaxation was most beneficial, as Dr. Mosenthal said in 1928 and as Dr. Arthur S. Grainger told the American Medical Association in July, 1929.

A year or so ago, Dr. H. C. Gram, of Denmark, tried all the most commonly recommended drugs or regimens for hypertension. He found that rest in bed and freedom from worry did more than all else. If the patient was dieted, then the diet got the credit. If the patient was drugged, the drug got the credit rest should have had. If the patient was simply rested, the results were usually as beneficial. Hence the fall of blood pressure under medical care seemed often half-mythical. The first measurement of the blood pressure also is an alarming event calculated to run it up. Hence the gradual fall after "treatment" is often natural but is credited to the treatment.

THE best treatment probably involves relieving the conditions in the environment that aggravate a rise in blood pressure. This means: Seek to displace an excitable and to adopt a calm attitude. Do all things in moderation. Limit social obligations. Stop worrying. Remember that spontaneous remissions often occur, that no diet is proved beneficial, that some sufferers resist every recommended regimen. No drug cures, hence take no patent medicines or drug remedies for high blood pressure. Seek the care of a competent physician.

It is not wise for every sufferer to try arbitrarily to reduce his blood pressure to an assumed normal. High blood pressure is often a benign, compensatory mechanism. One has to learn to abide it. Each patient can be assisted by his doctor to attain an individual comfort level suited to his needs.

High blood pressure has been called the disease of American life, so cultivate the spirit of leisure, loaf more, dream more.



SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

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

To Determine Moisture Content of Gases

MOISTURE is an elusive agent—all-pervading in nature and difficult to detect, difficult to eliminate or control. When there is moisture in supposedly dry annealing gases, high-carbon steel decarburizes and becomes unsatisfactory for many uses. Razor blades made from it have poor edges; automobile and airplane gears do not hold up in service.

Dew point, and hence moisture content, of gas being read directly

To help eliminate this handicap, General Electric engineers have devised a convenient, portable dew-point potentiometer for determining the moisture content of gases. This is done by measuring the "dew point," or temperature at which moisture will condense from a sample of the gas.

A small stream of the gas is conducted through a compartment of the instrument. The moisture condenses on a thin, metallic mirror which is connected to a thermocouple and then to an indicating instrument. An operator regulates the flow of a cooling medium, usually carbon dioxide, until slight adjustments will cause the alternate evaporation and condensation of moisture on the mirror. At this point, the dew-point temperature can be read directly on the instrument by balancing the galvanometer by turning a knob.

The instrument is expected to prove of special value in steel mills for measuring the moisture content of annealing gases; also in chemical plants, gas plants, industrial and research laboratories, and in shop tests generally where the moisture content of gases must be known for testing or control purposes. The device weighs 16 pounds and is carried in a case 14½ inches long, 8¾ inches wide, and 6½ inches high.

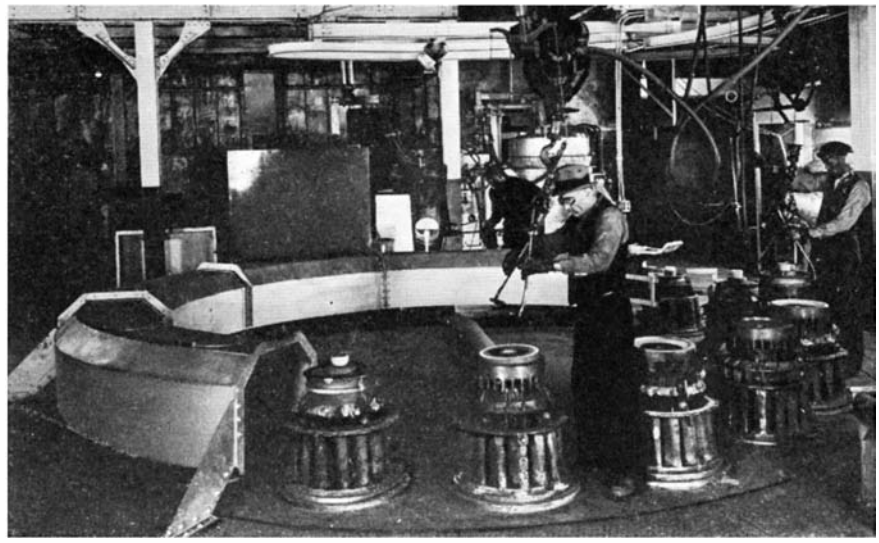
Ring Gears Cast Centrifugally

EXPERIMENTAL work in casting gear blanks in centrifugal dies, first announced by the Ford Motor Company just over a year ago, has been wholly successful, and centrifugally-cast gears now are in regular production.

Greater strength, lighter weight, and faster production are the principal advantages of the gears made by the new method, according to R. H. McCarroll, Ford metallurgist. By using sand cores in the die, undercuts can be made which would be impossible in a conventional forging, and this saves weight and metal.

Still more important, however, is the greater strength of these gears made by centrifugal casting. Etched sections show the reason. In some forgings, lines of metal flow are parallel to lines of greatest stress. Because of absence of all flow lines in the centrifugal castings, this condition does not exist. The metal is equally strong in all directions.

The simplicity of the centrifugal method is especially noteworthy. The dies, which are made of a special low carbon steel, are mounted in units of 18 on a turntable. Each die begins to spin as it approaches the pouring ladle, continues to whirl for the two minutes required for the metal to solidify, and then stops turning in time for the operator to remove the hot blank and prepare the die for the next casting.



Turntable on which gears are centrifugally cast in 18 dies

Sealing Platinum to Pyrex

A SATISFACTORY seal between platinum and Pyrex glass, for use in the construction of chemical and other scientific apparatus, has been developed by Edward Wichers and C. P. Saylor of the Chemistry Division of the Bureau of Standards.

The general problem of joining metals and glasses has been studied by many investigators, but the fact that the thermal expansions of platinum and glass are so different has always caused trouble. Thus, when a platinum wire or rod is coated

with hot glass, subsequent cooling will crack the glass or pull it loose from the metal. This difficulty has been surmounted by using a seamless tube of platinum instead of a wire or rod. If the walls of the tube are thin as compared with its length (a ratio of about 1 to 12), the shrinkage forces are not great enough to crack the glass internally or to pull the metal away from it.

The mechanical principles governing the platinum-Pyrex seals can also be applied to other metal-glass seals of the tubular type. They are simple to construct, and do not require any unusual apparatus or extraordinary skill in glass blowing.

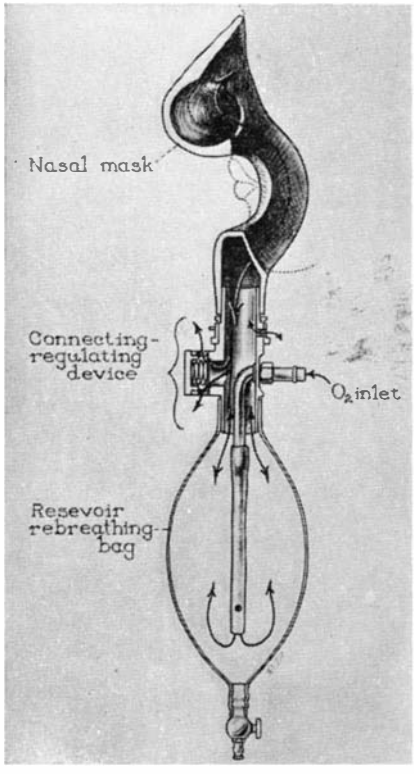
Gas Mask For Oxygen Inhalation

AN invention which promises great ability to save lives and restore health to suffering patients recently was demonstrated by a group of Mayo Clinic physicians at a meeting of the American Medical Association. It is a new gas mask for giving oxygen efficiently and economically. One of the famous Mayo brothers, the late Dr. C. W. Mayo, and its inventors, Drs. Walter M. Boothby, W. R. Lovelace II, and A. H. Bulbulian, described its promising medical uses to the assembled doctors.

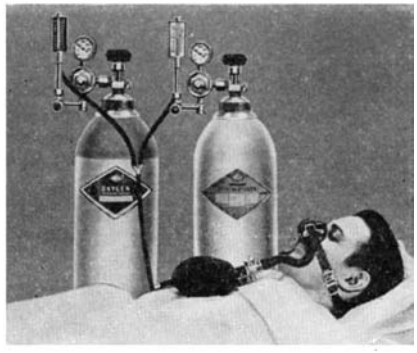
One patient, desperately ill with rheumatic heart disease, began to improve immediately when he was given 100 percent oxygen with the new apparatus, although he had been expected to die. The treatment was not a cure, but an aid to the patient's fight to recover.

Patients suffering with gas gangrene and tetanus or lockjaw have been helped to recovery by oxygen given with this new type of mask. The recovery in these cases is due to the fact that both of these ailments are caused by germs of the kind that cannot live in an atmosphere that contains oxygen.

The mask is also being used to give oxygen to patients in shock or collapse following injury or surgical operation, in cases of abdominal distension, for headaches following air injections into the brain for diagnosis of brain tumors, for migraine, and for a number of lung disorders. The mask has also been installed on an airline for use of pilots and passengers threatened by oxygen-lack at high altitudes.



The reason the new apparatus is finding such a wide field of usefulness is because it can be used in the patient's home as well as in large, well-equipped hospitals and because it reduces enormously the cost of oxygen treatment. The cost of giving oxygen by oxygen tents, the method used before invention of the new mask, is from $12 to $25 a day. This has prevented the use of oxygen except in very few cases, chiefly severely ill pneumonia patients. With the new apparatus the cost of the oxygen should average only $5 to $8 a day, Dr. Boothby stated.



Patients suffering from many types of diseases are relieved by inhalation of oxygen, or an oxygen-helium mixture as shown above, through a newly developed mask. In the drawing at the left, note that the mask covers only the nose, leaving the lips of the patient free

The reduction in price, made possible by the efficiency of the apparatus, will enable doctors to use helium quite generally in the treatment of asthma. Until relatively recently, Dr. Boothby pointed out, helium was never used except for the most severe asthma cases, because of the high cost. With the new apparatus, both helium and oxygen can be used, starting with a mixture of oxygen and helium and, as the patient gets better, increasing the proportion of the less expensive oxygen till the patient is getting all oxygen.—*Science Service.*

Courtesy Lincoln Electric Company

Although arc welding has been used to fabricate the steel frames of numerous residences, the palatial home shown in the illustration above is the most imposing example to date of this type of construction. Built at Wichita Falls, Texas, this 12-room residence contains 96,000 pounds of steel framework, welded throughout by the shielded arc process

Black Electroplating

DEEP black deposits, suitable for automobile hardware, business machines, flashlight cases, and the like, may now be applied by electroplating, according to Du Pont chemists. The solution used contains ammonium molybdate, nickel sulfate, and boric acid. It is said that the process offers attractive possibilities, being superior to black nickel-plating and other similar black coating processes.

REMEMBER 'EM?

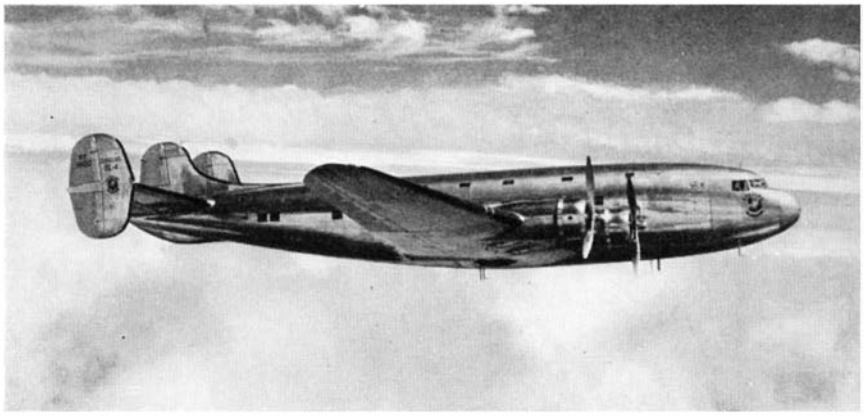
THERE have been more than 4000 makes of automobiles since the first car propelled by an internal combustion engine appeared in France in 1868!

Higher Vitamin Content in White Bread

A LOAF of white bread which has the vitamin-B_1 content of a whole-wheat loaf, some five times as much as ordinary white bread, was predicted to the Massachusetts Institute of Technology food conference recently by Charles Frey, Alfred Schultz, and Lawrence Atkin, all of the Fleischmann Laboratories.

Vitamin B_1, or thiamin, is an important factor in nutrition but it is not stored in the body to any significant extent and thus must be contained in basic foods. Cereal products, mainstay of the national diet, are suitable for this but these products, especially bread, have been increasingly deprived of their natural vitamin content in recent years.

The problem of restoring this loss, sometimes as great as 93 percent, has been tried along many lines, but the latest



A Douglas DC-4 in flight

and most practical employs a new yeast. This yeast contains enough thiamin to produce a loaf of white bread with the vitamin content of a whole wheat loaf but without any loss of palatableness. Although made by a new process, the yeast offers no new technical problems since its baking properties have not been altered. Possibility of such a loaf at a low cost-increase would be a boon to low-income groups, it is declared.—*Science Service.*

Action of Latex on Polished Aluminum

FILMS of rubber, applied in the form of latex, are sometimes used as a means of protecting the polished surfaces of metallic mirrors and similar articles from scratches and dust while in storage and during shipment. When ordinary commercial latex is applied to polished aluminum, however, a bluish discoloration is produced which remains when the film of rubber is stripped off.

Tests made at the National Bureau of Standards indicated that the discoloration was produced, not by the rubber, but by ammonia which is almost universally employed as a preservative for latex. When the ammonia is removed, latex no longer discolors aluminum. Ammonia-free latex preserved by the addition of the requisite amount of pure formaldehyde is likewise without action on aluminum.

A Fleet of DC-4's

QUITE recently the writer had the pleasure of visiting the new Douglas DC-4 at Newark Airport. No matter how blasé one may be, the new airliner gives one a thrill by its size, its superlative finish, and its innumerable modern devices and accessories. It is not at all surprising to learn that W. A. Patterson, President of United Air Lines, has decided to purchase a fleet of six of the new DC-4's, at a cost of $500,000 each, for use in transcontinental sleeper traffic. The decision to purchase six ships was based on a careful estimate of the number of airplanes required to maintain adequate coast-to-coast sleeper service. Analysis of the airline itself, backed by the estimates of independent market research groups, showed definitely that there would be sufficient traffic to warrant this bold move. This year, for example, transcontinental business is running 32 percent ahead of last year's business.

While we have reported the DC-4 already in these columns, it is interesting to present the final specifications in brief, with the changes which the airline has asked for and obtained.

The passenger cabin is supercharged to a pressure equivalent to that of 8000 feet above sea-level when the plane is actually flying at 15,000 feet altitude. The production type airplane will have a gross weight of 66,500 pounds. Maximum speed will be 237 miles per hour; cruising speed. using 74 percent of rated power, will be 210 miles per hour. Range at 191 miles per hour, with 42 passengers and 3000 pounds of mail, will be 1425 miles or approximately one half the air distance across the United States. The eight fuel tanks will carry 2050 gallons of gasoline. Wing span will be 138 feet 3 inches, and overall length will be 97 feet 7 inches.

Cabin accommodations will be liberal. The floor-to-ceiling distance will be 7 1/2 feet and the inside width more than 10 feet. As a day plane, the DC-4 will have accommodations for 42 people. As a sleeper, there will be berths for 32, with double lower berths on each side of the aisle, and upper singles.

Crew will consist of a captain, a first officer and a flight engineer, plus a steward and a stewardess.—*A. K.*

Airline to Help The Private Flier

IT is frequently claimed that the airline operators are inimical to the private flier, and have been responsible for the legislation which limits use of the airways by the private operator. But surely there must be some way of preventing hindrance to scheduled operation by irregular private operation, and in general the transport people are most friendly to the itinerants. United Air Lines announces that the company will help the private owner in many ways: by furnishing weather information at all its stations; by providing hangar space at a number of airports; by selling gasoline and oil wherever such service is helpful; by providing mechanic service wherever such service is helpful and permissible. Nothing could be more indicative of friendly co-operation.—*A. K.*

Why Alloys Are Not Perfect

IT is accepted, at least theoretically, that all atoms in a metal would line up in perfectly ordered arrays like millions of dice which had been carefully stacked on top of one another, provided the metal could be frozen at absolute zero—459.72 degrees below zero, Fahrenheit—the point at which all gases would solidify and all molecular motion would cease. But there just isn't any place on earth as cold as that. Consequently, whenever two or more kinds of atoms are mixed, they arrange themselves in a more or less disordered fashion, because of motion caused by the heat. The result is an aggregation of jumbled groups of crystals, analogous to millions of dice dumped helter-skelter in a box.

Freeze Metal Parts for Expansion Fits

BY utilizing the extremely low temperatures available with a mixture of Solox and dry-ice, a new method for cold-shrinking metal parts for "expansion fits" eliminates both the expensive equipment and adverse chemical effects associated with previous brine techniques.

Dry-ice is solid carbon dioxide at a temperature of −109 degrees, Fahrenheit, which, in subliming, absorbs approximately 247 B.T.U. per pound. Solox is a proprietary alcohol-type solvent and is favored for this application not only because it remains liquid at the low temperatures but also because of its non-corrosive properties.

A mixture of dry-ice and Solox will produce a temperature of −97 degrees, Fahrenheit, which is considered suitable for shrinking internal parts larger than 9 or 10 inches in diameter. The part to be shrunk is immersed in the Solox, and pieces of dry-ice are added to keep the mixture "boiling" (giving off carbon dioxide) until the part is sufficiently cooled to produce the maximum shrinkage.—*Solvent News.*

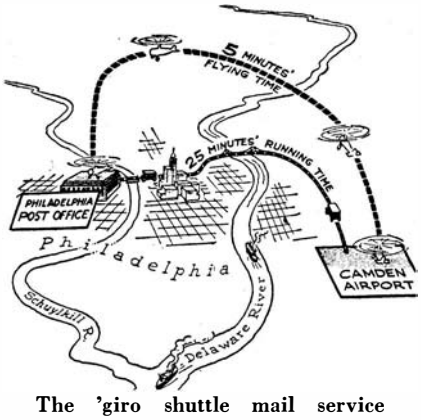
'Giro Delivers Mail on Roof

IT is 25 minutes truck running time from the Camden Airport, New Jersey, to the Philadelphia Post Office at 30th and Market Streets. A Kellett KD-113 Autogiro makes the trip by air in five or six minutes and shuttles back and forth from the Airport to the roof of the Post Office five times daily, carrying a full load of mail each time. Eastern Air Lines, which contracted for this service, receives $3.86 for each mile flown.

Taking off from a post office roof

One of our photographs shows John M. Miller, veteran 'giro pilot, and now a captain in the service of Eastern Air, taking off the roof after a run of less than 150 feet. The service has proved a complete success, and other cities such as Chicago, Milwaukee, Atlanta, St. Louis, Detroit, and Los Angeles are studying the problems and are seeking to establish similar autogiro mail ferries. Certainly its application in such work is a remarkable tribute to the utility of the 'giro.

The Kellett KD-113 is the only government-licensed, wingless, direct-control autogiro. Tilting of the 'giro axis replaces ailerons and elevator, and the small rudder



The 'giro shuttle mail service saves 20 minutes over truck time

is only used for abrupt maneuvers. The ship is a one-place model with closed cockpit, and a large forward mail compartment. With a gross weight of 2250 pounds, 150 pounds of mail are carried and top speed is 103 miles per hour with a 225-horsepower Jacobs engine.—*A. K.*

Aircraft as an Investment

RAWSON LLOYD, of Aeronautical Security Research Corporation, writing in "Flying Facts," gives ten reasons for buying aircraft stocks. Larger air forces are being organized in all countries; unfilled orders amount to $250,000,000; huge aircraft orders of $175,000,000 are to be placed by the Army and Navy during the year; Great Britain and France want to buy another $100,000,000 worth of our aircraft; more efficient production has increased profit margins 37 percent; contractors on Navy orders are now allowed 12 percent profit instead of 10 percent; passenger air traffic has risen 28 percent for first five months of this year; plant expansion has been conservative; labor is not yet unionized; stocks are selling on a low price-times-earnings ratio. Even though these views come from the supposedly dangerous neighborhood of Wall Street, they must be regarded as reasonable.—*A. K.*

Seaplanes Can Use Land Airports

AT least it would appear that seaplanes can alight on land, from the exploits of Al Bennett at a commercial airplane demonstration given by the Aviation Country Club of Hicksville, Long Island. Mr. Bennett used a standard Piper Cub powered with a Lenape motor and fitted with Edo floats. The only departure from "standard" was in the fitting of a steel strip screwed on the outside of the float keels. Yet Captain Bennett was able to land on the field, taxi, and take-off, without any sign of damage or even wear. Apparently seaplane floats have sufficient resiliency in themselves to take up the shock of landing.—*A. K.*

SENSITIVE

A CURRENT-detecting device so sensitive that it will measure the electricity carried by one electron traveling down a wire every five minutes, was recently described by Dr. J. S. Allen, of the University of Minnesota. The best previous device measures 20 electrons per second.

Drowning Takes Its Share

APPROXIMATELY 7500 persons drowned in 1938, and almost exactly 50 percent of them did it during just three months: June, July, and August.

So says the National Safety Council in its 1939 statistical yearbook, *Accident Facts.* About 5000 of the total occurred while the victims were swimming.

Two of every five drowning victims (both male and female) were under 20 years of age.

But listen to this, men: Five of every six drowning victims were men and boys.

Aluminum Luggage

STYLED for the skyways and as trim and modern as the transcontinental airliners themselves are aluminum alloy traveling bags, a part of the newest luggage line of the Metals Division of Erle P. Halliburton, Inc. Strong aluminum alloys which have been so thoroughly service tested and satisfactory in airplane construction, provide a logical material for these light, strong traveling bags and suitcases.

Carefully designed in every detail, the stamped shells are heat-treated to provide strength, and finished in the patented natural Alumilite finish to promote an attractive and durable surface. The interior of the women's cases is done in rich silk, with handy, removable dress hangers, rubber-lined cosmetic and bottle pockets, and a zipper-closing jewelry pocket. All models of the

Moisture-proof, light-weight luggage

Halliburton cases are equipped with rubber seal gaskets to protect the contents from moisture and dust. They have been subjected to submersion and artificial dust storm tests without the slightest damage to their contents. Because they are sealed airtight against changes in atmospheric pressure when closed, high altitudes will not "pop" the stoppers in containers of liquids carried in them.

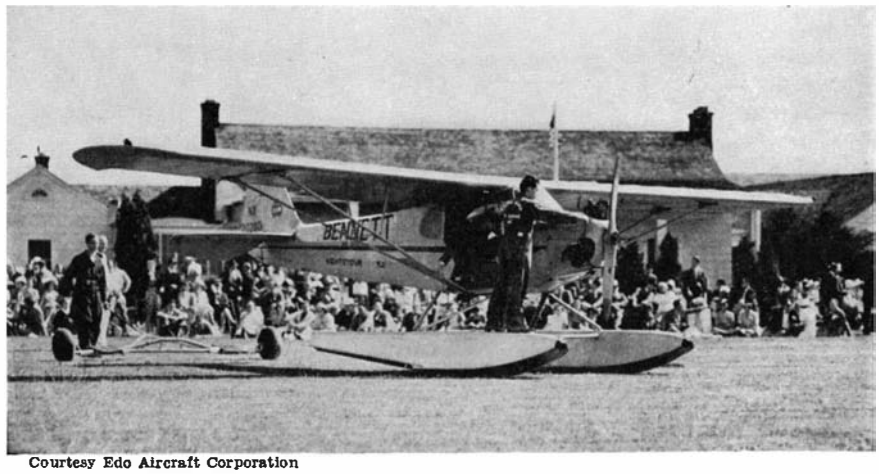
Resin Cement and Heatless Casting Plastic

TWO interesting and important resins which have been named Quick-Set No. 1 and No. 2 have been announced by The Marblette Corporation. Quick-set resins are liquid phenol-formaldehyde condensation products which are caused to harden without heat and pressure by the addition of an accelerating agent.

Quick-Set resin No. 1, when used as an adhesive, forms an insoluble, infusible, transparent joint of tremendous strength. It is used for joining Lucite, Plexiglass, Marblette, wood, leather, casein and cellulose plastics, Formica, pressure molded plastics, and other materials.

Other uses include wood lamination and impregnation, varnish, paper and cloth lamination.

As the hardening of this cement is strictly a chemical reaction, air-drying is *not* neces-



Courtesy Edo Aircraft Corporation

Out of its element, yet this seaplane landed and took off from the ground

sary for this material will set in the absence of air.

Quick-Set resin No. 2, obtainable in black and ivory, is used for producing castings in rubber (latex), lead, and glass molds. After casting, this resin will harden in 24 to 48 hours without the aid of heat or pressure.

Color Determiner

AN apparatus which assures absolutely correct determination of colors at any time of day, irrespective of the surrounding sources of light, has been constructed by Dr. Tryggve Johansson, of Upsala University, in Sweden.

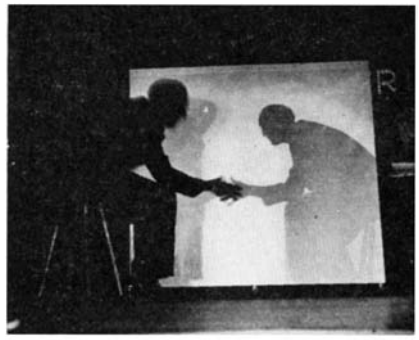
The machine, which is somewhat larger than an ordinary typewriter, produces an unvarying "mid-day light," by which is meant a light corresponding to that obtaining around noon on an overcast day. This result is arrived at by using electric lamps equipped with special filters, by means of which a correct composition of light is achieved. The color tester also excludes all outer light sources, so that no sort of disturbing light is admitted. The samples to be compared—for example, a couple of pieces of cloth—are illuminated at an angle of 45 degrees from two opposite directions, and the observer is forced by the construction of the apparatus to study the samples at right angles. Through this arrangement, no luster or shadow effects appear on the objects, which is often the case if these are lighted from one side only. —*Holger Lundbergh.*

Shakes Hands With Shadow

THE newest addition to the General Electric "House of Magic" at the New York World's Fair enables W. A. Gluesing, director of the show, to say goodbye to his shadow, walk off the stage, and actually leave it behind. And the audience seems to get the biggest surprise when he sits down in front of a curtain, gets up while his shadow remains sitting, and then shakes hands with his own shadow.

The screen on which the shadow is cast is made of a phosphorescent material. The screen stores up the light which it receives from a powerful spotlight and continues to glow after the light has been turned off. And so, when Mr. Gluesing stands or sits in front of the screen, all of it is "charged" with light except the part obscured by his shadow. He turns off the house lights, walks away, and all of the screen glows except the part which received no light because of his shadow.

Given a strong enough light, the screen will continue to glow for as long as 10



. . . With his own shadow

minutes. The shadow can be wiped out and brought back again by turning on and off the red light of neon lamps. This is because the red light does not "charge" the screen, and the phosphorescent light given off by the screen cannot be seen in the intense red light of the neon lamps.

Motoring Eye Health for 1940

ADVANCE information that health is being given important consideration in the design of 1940 model automobiles, along with mechanical perfection, comfort and safety was given recently at a meeting sponsored by Fisher Body division of General Motors Corporation at the Libbey-Owens-Ford plants in Toledo. Those attending the meeting learned that better visibility through laminated safety plate glass is to be stressed by several manufacturers as a factor for eye-health and reduction of nervous fatigue.

Dr. A. H. Ryan, Chicago research scientist, demonstrated how polished *plate* glass transmits true images, whereas objects seen through *sheet* glass sometimes appear distorted.

"The distortion of images seen through sheet glass in a moving automobile is a major cause of eye-strain and consequent nervous fatigue," Dr. Ryan said. "In tests we have found that three hours of driving surrounded by sheet glass causes a 62 percent greater loss in visual efficiency than looking through polished plate glass. We also have found that people blink oftener when looking through sheet glass and that they can read faster through plate.

"These findings indicate that plate glass and the clear view it allows provide greater safety on the highway, which will be recognized as an important factor when it is remembered that approximately 25 percent of all accidents result from faulty vision."

Dr. Ryan described automobile driving as healthful exercise for the eyes, "provided it is done under proper conditions."

"Driving gives the eyes an opportunity for long-range gazing—a desirable change from the constant close work of office and factory. But the eyes should be allowed to see the world as it really is, not as a caricature," Dr. Ryan declared.

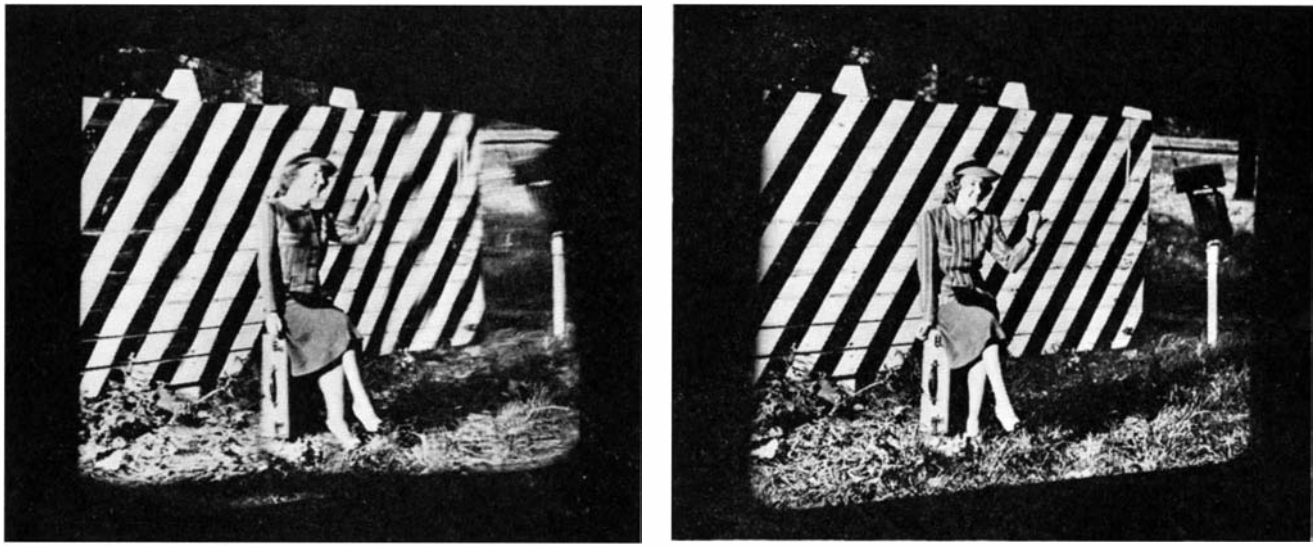
WONDER DRUG

THE new chemical remedies of the Prontosil-sulfanilamide-sulfapyridine group are now being used to treat no less than 33 common disease conditions. They seem valueless, however, in the treatment of influenza and colds.

Coffee Plastic

A NEW plastic, developed by the H. S. Polin Laboratory of Research in Physics, is unique, particularly from the standpoint of use in South America, in that it is made wholly from the green coffee bean and requires no additional raw materials. Coffee-plastic manufacture will be a highly self-contained industry, because the coffee provides its own chemical plasticizers and catalysts, and its own filler material. Its by-products, furthermore, are sufficiently valuable in themselves to defray much of the cost of production.

The new coffee plastic can be produced in a thermo-setting or a thermo-plastic form. It can be produced in green, red, mahogany, brown, yellow, and ebony black merely by the chemical development of its own coloring materials, in which the green coffee bean is unusually rich. (One of its by-



Distortion, caused by looking through safety *sheet* glass *(left)*, and the clear view through safety *plate* glass

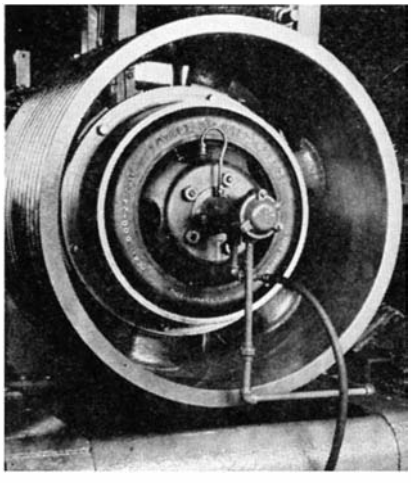
product fields will be that of vegetable dyes and chemical color indicators.) It can be made in varying degrees of hardness and resiliency according to the use for which it is intended. It can be molded, drilled, machined, sawed, and polished, and it can be produced with a wear-resistance superior to wood, cork, or rubber, and comparable with the best grade of linoleum. The thermo-setting material can be produced with a compressive resistance of 8000 to 12,000 pounds per square inch, has good dielectric strength at low electrical frequencies, very slight water-absorption, and good resistance to weak acids, fruit juices, alkalis, oils, ketones, and other chemicals, and complete flame-conductivity resistance. It is odorless and tasteless, and it can be molded at pressures from 2000 to 5000 pounds per square inch.

An important by-product of coffee-plastic manufacture is coffee oil. This oil is rich in chemicals, contains vitamin D, and is suitable for a cooking oil and as a mixing oil for paints. It contains fertilizer and bacterial-growth agencies, and can be used in insecticides, medicines, soaps, and lotions. Other by-products are an emulsifying agent and a chemical for forming colloids, both valuable to chemists and chemical manufacturers. As a source of caffein, of course, coffee is already well known.

Concerning the cost of manufacture, a bag of coffee containing 132 pounds, which it would cost the government an appreciable amount to destroy, can produce 40 square feet of plastic ½-inch thick, and approximately 1.25 gallons of coffee oil. The manufacturing process involves no unfamiliar machinery or special handling.

Rubber Tire Industrial Clutch

THE same engineering principle that today is preventing thousands of motor-cars from skidding on wet and slippery pavements has made possible a new type

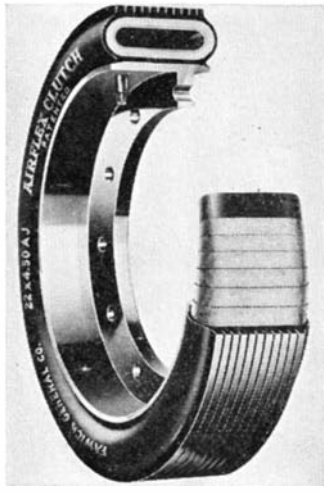


of mechanical clutch that has great promise of wide industrial application.

When the multi-vaned tread of the General Dual-10 and Dual-8 motor-car tires was perfected, it was proved that, under braking pressure, the many narrow vanes or ribs of rubber squirmed into a serpentine form and clung to the road surface with a degree of adhesion never before thought possible. Adhesion being the principal job of a clutch, no matter where it may be used, it was only a step from the multi-vaned tire to the Airflex rubber clutch, the multi-vaned surface of which clings to steel with twice the friction coefficient of asbestos or other conventional clutch lining.

The Airflex rubber clutch, which is shown in accompanying illustration, already has replaced multiple disk and other plate clutches in various installations, with complete success. It has the advantage over the conventional clutch in being much lighter, thus saving weight. It is much simpler, as well, having only three or four parts, as compared with 75 to 100 pieces in the conventional clutch. The Airflex clutch is self-adjusting while other clutches are not.

Two distinct types of lining are used, on both the expanding and constricting types of Airflex clutches. When excessive



Above: **Details of the rubber tire clutch.** *Left:* **An installation of the new clutch in an oil-well rig**

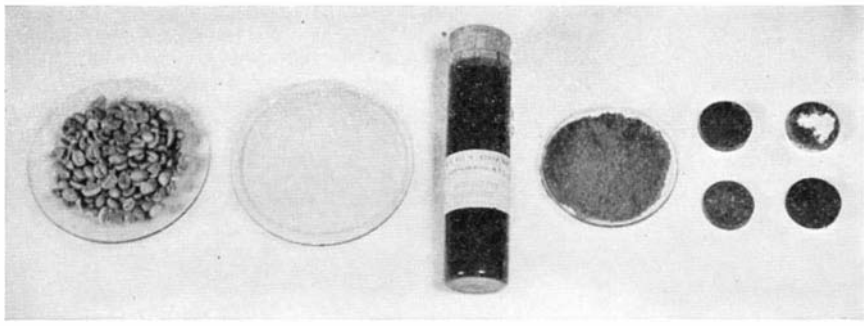
slippage is encountered and where loads are to be picked up gradually, the use of friction lining is recommended. When the plain rubber squeegee-tread is used, a reasonable amount of slippage can be tolerated if the engagements are not too frequent.

The clutches are given special treatment to prevent disintegration by oil fumes. A special rotary seal has been developed to deliver air to the clutch, either by entering the shaft at the end or by a straddle-type seal.

Paint Remover

EXPERIMENTATION with solvents and combinations of chemicals to make a milder paint remover resulted in a recently announced product called Presto. The remover contains no alcohol or caustic solutions but is a combination of seven chemicals and, it is claimed, requires only five or ten minutes to work. The manufacturer also states that Presto seldom requires a second application, will not harm bristles on brushes, raise the grain of wood, or burn through.

Three grades are available; Grade A for fine finishes and delicate woods, AA for general use, and AAA for any finish on metals.



Steps **in producing a plastic from coffee beans.** *Left to right:* **Coffee beans; ground coffee after oil extraction; the extraction product; the reacted coffee plastic compound; and pellets produced by molding the reacted compound**

PROBOSCIS

LITTLE things do count—heavily at times. Consider, for example, the mosquito's stinger, or proboscis. That pleasant little thing weighs just 0.0000006 of an ounce.

Silver Steel

POSSIBILITY of a broad extension of the marine uses of 18-8 stainless steel alloys is suggested by a patent recently granted on protection of the steel against seawater corrosion by addition of minute amounts of silver to the alloys, reports *The Industrial Bulletin* of Arthur D. Little, Inc. The peculiar corrosive properties of seawater have in the past been a serious, unsolved problem for stainless steel. If a portion of a stainless steel plate is covered by, say a barnacle, the difference in oxygen concentration near the exposed and the unexposed surfaces will set up an electrical potential favoring the formation of chlorides of the metals in the alloy. Since these chlorides are soluble, they wash away, leaving the surface exposed for further attack. Thus a sub-microscopic pit forms and, as it deepens, the difference in oxygen concentration between the pit and the body of the metal increases and accelerates the corrosion within the pit. Ultimately the interior is honeycombed with such pits, although the surface may appear entirely unmarred; and the steel becomes subject to sudden and complete failure, almost without warning.

A solution to this problem, recently worked out by Professor R. S. Williams and associates at the Massachusetts Institute of Technology, is based on the insolubility of silver chloride in seawater. Laboratory tests indicate that as little as 0.42 percent silver added to the alloy will reduce the corrosion rate more than 80 percent, since the insoluble silver chloride formed remains as a protective coating. Only in alloys of approximately 18-8 composition (18 percent chromium and 8 percent nickel) does the small amount of silver appear to be ade-

quately dispersed, but these are the most popular of the stainless steels.

Many advantages other than corrosion resistance are claimed for the silver alloys. Probably most important, since stainless steel is now considered unsuitable for many uses requiring high heat conductivity, is the reported increase of 26 percent in thermal conductivity on adding only 0.14 percent silver. Other advantages include improvement in the ease of machining and ability to take a higher polish. A very uniform, highly polished surface in itself inhibits corrosion, since it makes inception of electrolytic activity difficult.

MILEAGE

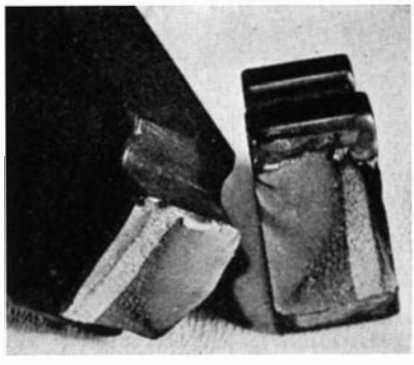
MORE than one third the distance around the earth at the equator—8870 miles—is the distance traveled annually by the average American passenger car and truck.

Torture Machine Throws 2600-Pound Punches

SCIENCE recently added a new punishment rack to its torture chamber—a 600-pound agony maker aimed at survival of only the strongest steel blades for use in steam turbines.

Built in the Westinghouse Research Laboratories at East Pittsburgh, the novel machine subjects test parts to a concentrated dose of the brutal pummelling which full-scale parts must withstand inside a turbine.

The weaklings, those parts that are faulty in design, literally fall to pieces; but the sturdy metal martyrs can "take" as many as 10,000,000 beatings, and that's enough to guarantee them life eternal, for all practical purposes, in the production of electric power. These 10,000,000 blows are delivered in approximately 277 hours at the rate of 600 a minute, according to T. F. Hengstenberg,



research engineer in the mechanics division, who designed the machine.

A motor-driven flywheel throws the punches at the test piece with a force of 2600 pounds behind every blow. Every time the flywheel turns it pushes a heavy spring to snap a steel lever up against the six-inch metal sample.

These metallic blows, Mr. Hengstenberg explains, simulate the force of steam rushing against blades in a turbine with a pressure of about 800 pounds to the square inch.

Simultaneously, the test piece is immersed in a steam bath inside an electric furnace at a constant temperature of 850 degrees, Fahrenheit, identical with the temperature inside a steam turbine at which the steel parts glow a cherry red. To duplicate the centrifugal force of the turbine blades, which often travel around their shafts at speeds exceeding 789 miles an hour, the machine pulls the test piece upward with a force of 9000 pounds by means of levers and springs attached to dead weights.

Common Raw Materials Give Important Chemicals

THE world's most important industrial chemicals are made from a small group of mineral raw materials, although the production of a single chemical may require an amazingly large number of other chemicals, processes, and raw materials.

If the chemist were given three wishes, as in the fairy tale, he would pick these groups of raw materials: 1, coal, petroleum, and natural gas; 2, sulfur and sulfide ores; 3, salt, brines, and sea water. These, with limestone, air, and water are most frequently used in manufacturing our chemical civilization.

Drs. R. N. Keller and T. T. Quirke at the University of Illinois have been looking into the source of 150 important industrial chemicals, ranging alphabetically from acetanilide to zinc sulfate. They can be traced back to only 34 raw materials.

Consider ammonia, for example. It and the materials used in its manufacture include ammonia liquors, nitrogen, hy-

Above: **Adjusting the "punching power" of the machine that tortures steel blades for steam turbines until they fracture as shown at left**

drogen, calcium cyanamide, catalysts and catalyst supports, peat, bones, animal refuse, sugar beets, and the like. Ammonia liquors come from coal gas which comes from coal. Nitrogen comes from the air, hydrogen from water. In fact, all the ammonia sources can thus be traced back to air, water, coal, and limestone.

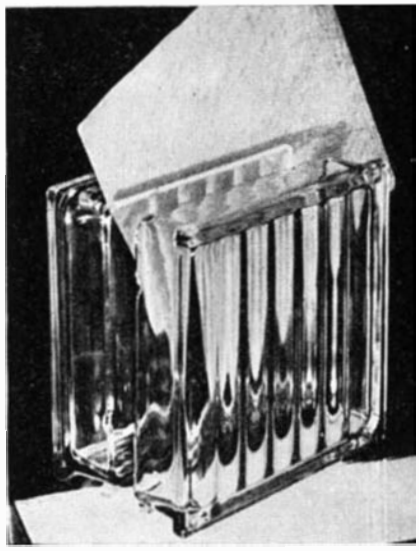
This digging back into origins is not just an academic exercise. It may very well aid a producer or owner of some raw material to plan manufacturing and distribution of a product. Since transportation of heavy raw materials is costly, intelligent knowledge of what is needed ultimately to produce a product may allow shifting of industrial plants to more advantageous locations.

Water and air are the most frequently used ultimate geologic raw materials—used 99 and 96 times, in the case of the 150 chemicals. Next in order are coal, 91; sulfur, 88; mineral salt, 75; limestone, 63; sulfide ores, 32; brines, 24; petroleum, 23; natural gas, 16; saltpeter, 13; potassium minerals, 11; gypsum, 10. The other 21 raw materials are used less than 10 times each.—*Science Service.*

Glass-Sandwich Brick

A NEW glass building block containing an interior screen of glass fiber that sharply reduces the transmission of solar energy was announced recently by the Pittsburgh Plate Glass Company.

The new block, developed by engineers of the Pittsburgh Corning Corporation,



A screen in this glass building block reduces transmitted heat

gives a soft, diffused light that reduces glare of the sun. The decreased solar heat transfer cuts down the cooling load in air-conditioned rooms. The characteristics of the new glass block adapt it particularly to large areas where softer natural daylight is desirable.

Both the new and the conventional blocks are made by fusing, at high temperatures, two pressed, square glass cups into an all-glass welded unit. In the newer design a fiberglas sheet is sealed between the block halves, forming an integral part of the finished unit in the center of the block. As in the older design, the high sealing temperature results in the formation of a partial vacuum in the block interior when it cools. This increases the insulating value of the unit.

Variations in the effects desired may be had by changing the thickness of the fiberglas sheet. A typical unit of the newer design transmits only 55 percent as much energy as the older block, but 75 percent as much light with a marked increase in light diffusion.

Methyl Bromide as Insect "Extinguisher"

METHYL bromide, sometimes used as a fire extinguisher, is proving even more useful as an insect "extinguisher" or fumigant, as it will in many cases kill insects without injuring the plants upon which the insects are feeding.

Methyl bromide is used—in control of the Japanese beetle—in the fumigation of fruits

and vegetables from within quarantined areas. It also has been found particularly useful for treating potted plants and nursery stock which may be infested with the larvae of this insect. After treatment the plants can be shipped outside the quarantined area without danger of spreading the pest.

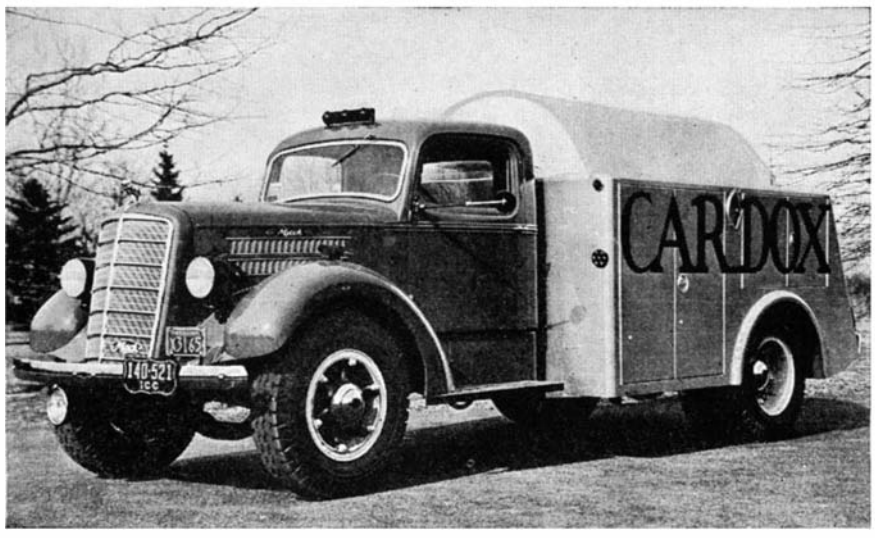
Tank Truck for Liquid CO_2

A NEW model EFH Mack truck recently placed in service by the Cardox Corporation, of Chicago, is an example of the facilities developed by this concern for transporting liquid carbon dioxide at controlled constant pressures and in bulk quantities.

Since CO_2 liquid has a vapor pressure which is dependent upon the temperature of the liquid, the pressure increases as the temperature rises. Prior to this development, liquid CO_2 has always been handled in containers in which the temperature of the liquid would become the same as that of the surrounding atmosphere. Pressures as high as 1500 pounds to 2000 pounds could, therefore, result in the small individual shipping cylinders. Containers for high pressure are necessarily of heavy construction so that large capacity containers were impractical and uneconomical.

Cardox transport equipment, such as that mounted on this Mack truck, consists of pressure vessels with relatively low working pressures as, for example, 300 pounds per square inch. Corresponding temperature at 300 pounds pressure is approximately 0 degrees, Fahrenheit. This container is well insulated so that heat loss will be low and pressure rise in the tank will be slow. The liquid CO_2 is placed in the tank at a pressure appreciably below the working pressure of the vessel, and a pressure relief valve is provided which will open at the normal working pressure of the tank. With the opening of this valve, CO_2 gas is bled off from the top of the tank causing evaporation of liquid within the tank, the evaporation process cooling the contents of the tank and thus lowering the pressure so that the control valve will again close.

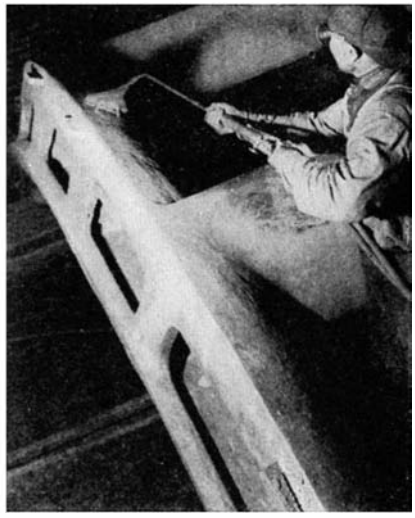
This truck unit can maintain constant pressure of 300 pounds over an indefinite period of time by bleeding off approximately four pounds of CO_2 per hour through the bleeding valve. However, if the truck tank is filled at pressure of 250 pounds, it will require several days before sufficient heat penetrates the insulation to raise the pressure to 300 pounds. A normal haul is of less duration than the time required for the pressure to reach the point where refrigeration by bleeding begins; hence, in actual practice, no loss of gas is experienced in transit. The unit is equipped with a compressor type of liquid pump which enables liquid CO_2 to be transferred in either direction between truck tank and storage tank and additionally makes it possible to fill high-pressure shipping cylinders and containers.



Insulated tank truck for transporting liquid CO_2 at constant pressure

Flame-Descaling

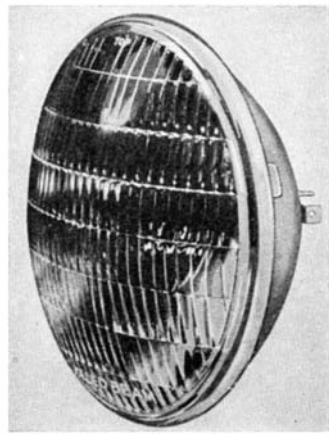
THE operator in the accompanying illustration is flame-descaling an 18,000-pound steel casting for a hydraulic turbine. Flame-descaling is a relatively new process for removing the scale from blooms, billets, slabs, forgings, and steel castings by means of specially designed oxy-acetylene heating heads. The process is based on the principle that when high-temperature is quickly applied to the scale (or oxide skin) on a piece of cold metal, the scale expands and breaks away from the base metal because of differential expansion between the scale and the steel. Descaling has a number of advantages over other cleaning methods such as pickling, sandblasting, and chipping. The casting shown here, for example, was flame-descaled in one fifth the time formerly required for chipping.



Flame-descaling a casting with a special oxy-acetylene heating head

Self-Contained Unit Headlight

ONE of the most significant developments in automobile headlights has resulted from three years of co-operative research and testing by the entire automobile and headlighting industry in collaboration with public authorities. This is the new Sealed Beam headlighting system which has been generally adopted for most of the cars to be announced this fall. The new system promises a great increase in safety for night driving for two reasons: the traffic beam is practically without glare; and, second, the lamps are estimated to give virtually their original illumination throughout the life of the lamp.



Headlight lens, bulb, and reflector in one unit for most new cars

The new headlamp is unique in that the source of light, the reflector, the lens, and the gasket are all assembled in a single, securely sealed unit. In other words, the headlamp is a single light bulb itself, the parabolic reflector surface of which is silvered on the inside and cannot therefore be affected by dust or moisture. Two types of sealed beam units are available—one entirely of hard glass and the other a composite unit consisting of a metal reflector and a glass lens. The two types will be interchangeable in the recesses provided for them in the newer cars.

These units are relatively more expensive than the present bulbs but, considering the light efficiency as the new lamp ages, the increased cost over ordinary small bulbs loses its significance. Other advantages are that the filament is always definitely and permanently focused for best results, a wider and stronger country beam is given, while the traffic beam is thrown more sharply to the right side of the road and gives better illumination even far to the right of the shoulder. When the filament finally burns out the whole unit is thrown away and a new one installed.

For Future Da Vincis

ALWAYS a challenge to designers, world fairs have resulted in the development of a number of new architectural forms, many of which have later become generally adopted. It is perhaps in the bold use of

new materials for decorative and artistic effects that the New York World's Fair, however, makes its most striking contribution to the progress of art and design. In this sphere, the Fair has given an impetus to the technological developments of the last few years which may hasten by years their general adoption.

Outstanding is the decorative use of plastics, most notably the brilliantly refractive transparent varieties now available Domenico Mortellito, for example, has achieved in his mural in the lobby of the Du Pont Building, a design reminiscent of stained glass but with a refreshing balance of colors and textures attained by use of the soft and plastic properties of these new materials. The nine-foot cast-phenolic statues in the Federal Building, designed by E. H. Burdick, lighted from within, provide a considerable part of the illumination in the large hall in which they stand. Many of the tall pylons, whose internal illumination strikingly accents different portions of the grounds, are faced with plastic materials.

The use of stainless steel as a sculptural material has been notably advanced at the Fair, as Dr. Gerald Wendt, Director of its Department of Science and Education, has pointed out. Robert Foster, a pioneer in the use of the welded steel sheet, has two gigantic figures in this medium. His "Winged Mercury," floating in brilliant stainless steel from the veranda roof of the Ford Building, brings out to full advantage the lift, the apparent floating lightness of the speedy messenger of the gods. His heroic figure of a woman is notable for the long fold of cloth draped over her extended arms.

The large mural in the French Pavilion by Jacques Durand is done on wood, with synthetic lacquers containing colloidal gold. In the focal exhibit in science, Allen Saalburg has used a new technique, painting large transparent murals on glass, using alcohol-soluble dyes applied by the air brush. Witold Gordon's mural, "Food," is done in rubber-base paint.

The new tube lights, lined with fluorescent materials, have enriched the color of the Fair and are largely responsible for its nocturnal beauty. Especially striking is the device which sends a vertical beam of light from mercury lamps, set in the sod, upward into the trees. Each quivering leaf glows with a soft green light resulting from the fluorescence of its chlorophyll. To many, the Fair's beautiful illumination is its outstanding new art form and most memorable feature.—*The Industrial Bulletin* of Arthur D. Little, Inc.

DETERMINATION OF COBALT IN STEELS

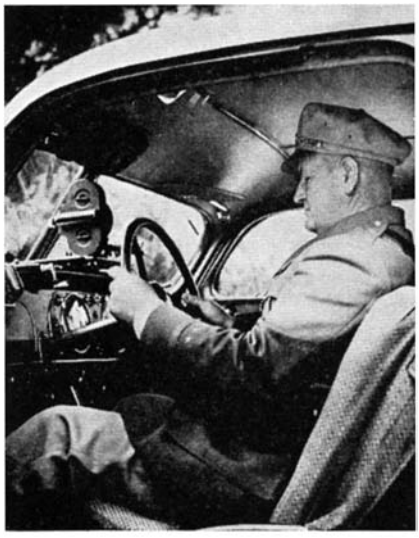
IN the standard method of analysis of steels and alloys, six to eight hours are required by an experienced chemist for a determination of cobalt. By further developments of an electrochemical titration method, chemists of the General Electric Company have made possible accurate determinations of cobalt in alloy heats while these are being held at pouring temperatures by the smelter. Thus a discrepancy in cobalt content of an alloy can be discovered before expensive castings are poured.

In the new method, a sample is dissolved in acid, the cobalt oxidized with a definite excess quantity of standard potassium fer-

ricyanide, and the excess determined by titration with standard cobaltous nitrate solution. The amount of cobalt in the sample is calculated from the amount of ferricyanide used for its oxidation.

Camera Becomes a Police Witness

OFFICER Rollye H. Galbraith of the California Highway Patrol has a positive method of recording the actions of law violators who cross his path in the vicinity of Lancaster, California. On the dashboard of his patrol car Officer Galbraith has installed a "robot witness" in the form of a



The camera that pictures speeders

Filmo 70 camera that records the action of the car being "tailed." A photronic cell exposure meter is mounted in a bracket beside the camera.

"You can't argue with a motion picture," is a statement football coaches have been making for years, and in bringing "witness" movies to the police court, Officer Galbraith is pioneering in a field that promises great results.

For definitely proving a case against speeders, why not fasten a second speedometer in front of the camera, so that its dial would appear in a lower corner of the field, with the speeding car visible in the same picture?

Improved Surgical Sutures Made of Nylon

NYLON mono-filament is now being used to make surgical sutures. Nylon, the same Du Pont material that will enter into fine hosiery, is a man-made, protein-like substance derived basically from coal, air, and water, characterized by extreme toughness and strength, and possessing the peculiar ability to be formed into fibers and into various shapes such as bristles and sheets.

The new sutures have been tested by more than twenty important hospitals and medical centers throughout the country, and declared a marked improvement for dermal sutures. It is said that they are practically non-irritating to the tissues, do not deteriorate in the presence of infection, and

because the filament is non-capillary, the possibility of infection penetrating the suture and being carried into the wound is diminished.

Because of the smooth surface of nylon, there is less discomfort in removing the suture from the tissue. The sutures are fast dyed—an aid to the doctor in locating the surgical stitch readily.

Large Tires to End All Large Tire Stories

GIGANTIC pneumatic tires that stand seven feet high—and considered the largest made for actual use—are now being manufactured by United States Rubber Company, L. D. Tompkins, vice president, announced recently.

The tires are of the size known as 24.00-32, and weigh approximately 1500 pounds each. They are of 34-ply construction, and the rubber tread at places is more than three inches thick. They comprise the tire equipment on large LaTourneau Tournapull earth-moving machines used by the Guy F. Atkinson Company, of Los Angeles, in building the Hansen Dam near San Fernando, California. These machines are capable of carrying 30 cubic yards of earth at a speed of 17 miles per hour.

A giant among tires, compared with an ordinary passenger car tire

Each tire, when inflated—the tube itself weighs 100 pounds—has a load capacity of about 12½ tons. Three men, using a specially designed derrick, require five hours to change one of these tires.

Shipping of the tires necessitated the use of open-end railroad cars, as the doors on the ordinary freight and express cars were not large enough to get the tires through.

Lung Collapse to Control Tuberculosis

COLLAPSE of the lung for persons suffering from tuberculosis has been found by the Chicago Municipal Tuberculosis Sanitarium to be twice as effective a treatment as other measures directed against the control of the disease. A critical study of 7341 cases is reported by Drs. Frederick Tice and Allan J. Hruby of the Chicago institution in the *Journal of the American Medical Association.*

Of the 7341 patients observed, over a

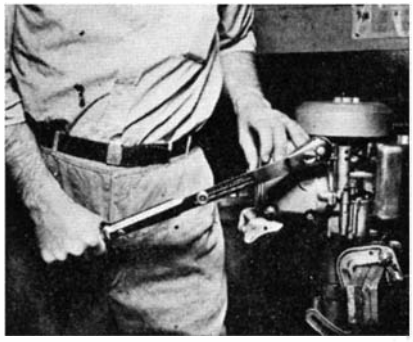
6 1/2-year period, 3090 were subjected to lung collapse for more than three months, 337 for less than three months, and 330 had pneumothorax attempted. The other 3584 patients were controls.

Broadly, the results were twice as good with the treated patients as with the controls and were better still in comparison with the life expectancy of patients with open tuberculosis as revealed in the medical literature.—*Science Service.*

Sight and Sound Torque Indicating Wrench

A NEW type of torque measuring wrench which can be applied to any detachable socket having a ½-inch square drive opening, is now on the market. This wrench is of the reversible ratchet type and is designed to indicate right-hand torque.

With a wrench of this type, it is possible for the operator to tighten nuts or bolts even-



Uniform tension on series of bolts is possible with this new wrench

ly and to any desired tension or torque load. Closely limited torque application is now considered essential in many types of automotive, aviation, Diesel-engine and industrial work.

In application, the wrench may be used by utilizing either the calibrated scale which, by sight-reading, shows applied pressures of 20 to 200 foot-pounds, or by a sharp sound-signal which is given for any desired torque from 35 to 200 foot-pounds. The calibrated scale is read at a point where the index shoulder crosses the scale and the sound signal can be set by a simple device.

Accuracy of the wrench does not depend on gears, levers or dials. Although right-hand torque only is measured, the wrench action reverses for left-hand turning. The 36-tooth ratchet wheel, with twin double-tooth pawl of the reversible ratchet mechanism, makes possible the short operating swing of only 1/36 of a full turn. Wrench action is instantly reversed by a flip of the shifter, located flush with the head.

High Efficiency Railroad Brake

A NEW type of railroad brake which will bring high speed trains to a smooth, comfortable stop within 2500 to 3000 feet from 100 miles an hour—about half the distance now required—was announced recently by Edward G. Budd, president of Budd Wheel Company.

The brake eliminates the century-old principle of a metal "shoe" pressing against the rim or tread of the wheel. Instead, the engineers have patterned the new brake somewhat on those used in automobiles in

that a composition shoe is used. This shoe exerts pressure upon an air-cooled disk or drum, mounted on the axle inside the wheel to bring the train to a rapid, but smooth stop. Special control devices automatically prevent the wheels from sliding when the brakes are applied suddenly.

The new brake solves many of the problems of high speed train operation. The first is the effective control of a train traveling at high speed. "Flat wheels," bugaboo of railroad men, are eliminated. Wheels and braking mechanism no longer will get red hot on long grades.

The new brake was developed in the research laboratories of the Budd Wheel Company under the direction of C. L. Eksergian, chief engineer, who has devoted many years of research to the development of wheels and braking systems, in automotive and other fields.

The first complete train equipped with the new brakes is the *General Pershing* Zephyr, of the Burlington Lines.

PASSENGERS

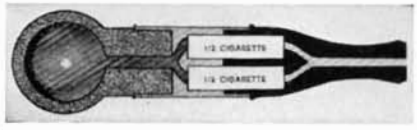
IN a year, the American railroads carry approximately 500 million passengers—or equal to the combined population of North and South America, the United Kingdom, France, Italy, Poland, Spain, and Germany. More than a billion tons of freight are also handled each year by these carriers.

CIGARETTES ARE PIPE FILTERS

THOSE people who started that cut-down-on-your-smoking craze, and showed more than a million cigarette smokers how to do it by using two cigarettes at a time instead of one, are back at it again. This time it's a pipe!

They did the cigarette trick with an aluminum holder in which you smoked one cigarette through another, the second cigarette acting as a filter. Certified tests showed that this removed about 70 percent of nicotine, tars, and other undesirable ingredients of cigarettes.

Now they have succeeded in applying this principle to pipes. With the Zeus cigarette filter pipe you can smoke a "hodful" of



Above: Two half cigarettes, in the broadened stem of the pipe shown below, act as efficient filters

tobacco *through a cigarette,* and this is what you don't get: 80 percent of the nicotine and tars in the tobacco; hot, harsh smoke; that embarrassing gurgle; a nicotine-nipped tongue; a draft of bitter pipe juice.

The appearance of the new pipe and the way two halves of a cigarette are used as filters are shown in two of our illustrations.

Steel Bench for Precision Lathes

A NEW all-steel welded bench designed to provide a suitable support for precision bench lathes, has been developed by the Engineering Department of South Bend Lathe Works. Extreme rigidity, the most essential feature for a bench of this type, has been secured by scientific bracing and generous proportions of all parts.

Smooth, flowing lines with rounded corners show a modernistic trend in shop

Rigidity and durability characterize this new all-steel lathe bench

equipment that is not only pleasing to the eye, but highly practical. There are no sharp corners in which dirt or chips might collect, and no angular projections to form a hazard to the workman.

Around the top of the bench is a deep rolled rim which serves as a chip pan or oil pan. The sides and back of the bench are enclosed in smooth panels securely welded to the frame work. The front is open to permit the operator to take a comfortable working position either sitting or standing. The entire bench is finished in standard machine tool gray enamel.

The lathe motor drive equipment is located in the left side of the bench, while in the right side are three large drawers for storage of chucks, tools, and accessories. Each drawer has an individual tumbler lock combined with a latch and knob.

First Internal Combustion Engine Propulsion

SOME time before 1826 a New England inventor, Samuel Morey, ran a small boat on a lake near his Oxford, New Hampshire home with a "spirits and turpentine" motor. The experiment attracted no particular attention at the time. Morey's boat —probably only a model, although this is not entirely clear—was only a mechanical

curiosity. Not even the inventor could foresee any practical implications to the achievement. He contented himself with writing a letter to the American Philosophical Society in Philadelphia about it.

Looking backward it is different. This was probably the first time in history that propulsion had been achieved and distance covered by means of an internal combustion engine, and the little boat may have been the dim morning star of the motor age. The engine is described by Frank A. Taylor, Curator of Engineering of the Smithsonian Institution, in a descriptive catalog of the mechanical collections of the U. S. National Museum.

Morey's model unfortunately is no longer in existence. The inventor did not even try to get an American patent on it. All that remains is his description of the device, summarized by Mr. Taylor as a vapor engine in which "a vacuum was produced in the cylinder by firing an explosive mixture of air and vapor from common proof-spirits mixed with a small portion of spirits of turpentine." A model of this engine ran smoothly for several hours, but there is no record that a large engine was ever built.

Sunlight and Agriculture

SCIENTISTS in the laboratories of the Hawaiian Sugar Planters' Association in Honolulu are now working on a project which promises to bring the sunlight factor within the realm of predictability for farming. Their experiments indicate that sunlight and its effects upon agriculture can be measured with a fair degree of accuracy. The implications of such a discovery for agriculture are far-reaching.

The inquiry grew out of experiments which the Experiment Station has long been conducting in the water-absorption rate of growing cane. These experiments revealed that there is a direct and calculable relationship between the intensity of solar radiation and the "thirst" of the cane.

Indeed, so sensitive is the plant to the sun that a mere wisp of cloud, passing across the face of the sun, will definitely affect the water consumption of the cane. After sundown, as every farmer knows, the water absorption rate of a plant will quickly diminish. But it is not so generally known that there are similar changes in the rate of "drinking" during the daylight hours. These changes, it was learned, bear a distinct relationship to the variation in the intensity of the sun's rays. From such a discovery, it naturally followed that if sun rays could be measured, agriculturists would be able to plan production with an almost mathematical certainty of plant growth.

Under the direction of Dr. Harold L. Lyon, head of the Hawaiian Sugar Planters' Association Experiment Station, physicist Hugh W. Brodie has been working on this problem since 1930.

An outgrowth of these experiments has been a parallel study of the possibilities of a large-scale control of irrigation based on sunlight data. This work is now in progress at the Hawaiian Sugar Planters' Association Experiment Station.

The value of such an inquiry may be realized from the fact that, for every pound of sugar produced in Hawaii, a ton of water must be used. Several of Hawaii's larger

sugar plantations are operable only by irrigation—some plantations using as much as from 50 to 150 million gallons of water a day.

With such a large consumption of water it is clear that considerable attention may be paid to conservation—and profitably, when the expense of pumping and ditching is taken into account. A natural control of sugar cane irrigation through the employment of solar radiation may have broad and far-reaching effects, in savings as well as in increased yields.

NITROGEN

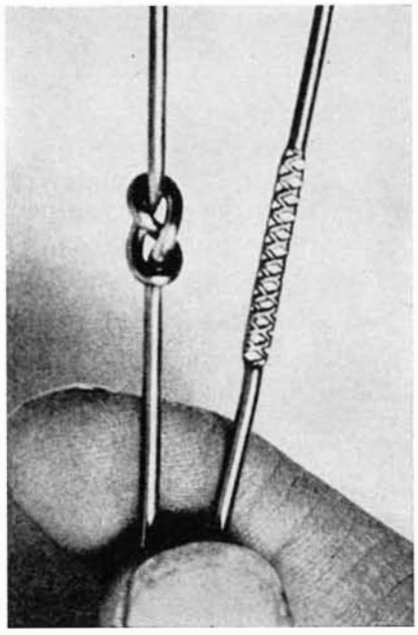
THE nitrogen-fixation process, which recovers that gas from the air for use in our chemical industry and in fertilizers, produces about 4,000,000 tons of fixed nitrogen per year. This amount, however, represents only the quantity of nitrogen over one-fifth of a square mile of the earth's surface.

BETTER MAGNET WIRE

ELIMINATING the need for space-consuming protective coatings in many instances, Formex wire, a new and superior magnet wire, announced recently by General Electric, is insulated with a synthetic resin which is tougher and more flexible than the conventional enamel coatings.

Since Formex wire requires less space for insulation and protection, it gives the designer new opportunities to reduce the size of many products. Further, electrical properties are as good as those of ordinary enameled wires, and tests show that Formex wire is considerably higher in resistance to abrasion and to the common treating solvents. When severely twisted and then subjected to a temperature of 125 degrees, Centigrade, for one hour, ordinary enameled wire cracks but Formex wire is not affected.

It withstands the operations of winding, assembly, and varnish impregnation much

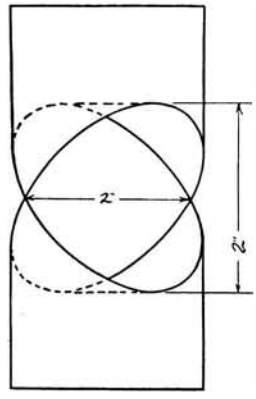


Knotting, stamping do not crack a new plastic insulation for wire

ANOTHER MATHEMATICAL PROBLEM

BECAUSE of the interest shown in previous problems, we offer another by Lieutenant-Commander Kaplan. Any correspondence relative to this new brain-teaser should be addressed to him in care of Scientific American, 24 West 40th St., New York, N. Y.

The problem: A hole 2 inches in diameter is drilled through a solid cylinder also 2



inches in diameter, in such a way that the axis of the drill is perpendicular to, and intersects, the axis of the cylinder. What is the volume of material removed?

The solution will be given in these columns next month. Meanwhile, can you obtain the same answer as the author? His value was $5\frac{1}{3}$ cubic inches.

better than commercially available enameled wire. It can be used to advantage in nearly all applications where enameled wire has been used, and in addition it can be utilized in many applications to replace enamel-cotton, enamel-paper, or other fabric-covered wires where formerly a protective wrapping was necessary.

NEW CASTABLE REFRACTORY

AS a result of its recent development work on castable refractories, Johns-Manville announces a new light weight Firecrete for making special refractory shapes, for replacing difficult brick construction, for lining furnace doors, and for making small monolithic linings. The new product is suitable for working temperatures up to 2200 degrees, Fahrenheit.

Accepted laboratory and service tests have shown that this latest addition to this line of products, widely used by industry for many years, possesses an exceptionally low heat storage capacity. This is of special importance in intermittently operated furnaces, since appreciable quantities of heat are wasted in heating heavy fire brick and then allowing the furnace to cool. Light weight Firecrete has been shown to be four times as effective as fire brick in retarding heat, while having only half its weight. Also, its resistance to spalling is such that it will withstand direct exposure to flame temperatures.

Sixty-five pounds of the material are required per cubic foot of finished construction. It can be used to form any required

refractory shape. This is accomplished within a short period of time simply by mixing light weight Firecrete with water and casting it into a form. Twenty-four hours later the shape is ready to be placed in service.

Versatile Surface Finish

SAID to give a hard, flick-proof finish, with perfect adherence to most metals, a new urea formaldehyde finish, which is called Ultrakote Synthetic, has been announced by C. W. Haynes Laboratories, Inc. The finish it produces has the appearance of porcelain and is much tougher. It will stand denting, bending, hammering, and general abuse.

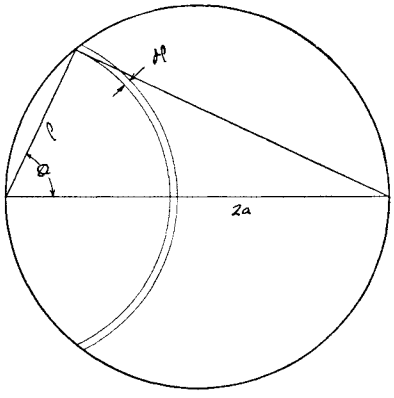
Ultrakote Synthetic can be used on any production metal, ranging from the manufacture of delicate jewelry to heavy machinery, including the following: metal kitchen cabinets, stoves, refrigerators, ironers, washing machines, clocks, office machines, and many other applications. It can be applied by spraying, dipping, or roller coating. It bakes to a tough, flexible finish at 150 degrees, Fahrenheit, in 30 minutes.

It can be furnished in either water-white clear or any other color, and the "clear" is claimed to be non-yellowing.

Solution of Last Month's Problem

LAST month, in response to many requests, we published another problem for our mathematically minded readers. Briefly, it was required to find the length of a rope with one end tied to a cow and the other to the edge of a circular pasture 200 feet in diameter. The rope allowed the cow to graze over half of the total area of the pasture.

The solution of this problem, as outlined below, requires the use of the calculus. Reference to the illustration will clarify the symbols used by the author.



The area encompassed by the radius arm ρ is given by the integral

$$\int 2\rho\theta \, d\rho$$

This may be changed over into an expression involving only the one variable, θ, since

$$\rho = 2a \cos\theta$$

and

$$d\rho = -2a \sin\theta \, d\theta$$

We have, therefore, by making this substitution,

$$\int 2\,(2a\cos\theta)\;0\;(-2a\sin\theta)\;d\theta = -4a^2\int\theta \sin 2\theta \, d\theta$$

If, for simplification, we let

$$y = 2\theta$$

then

$$dy = 2\,d\theta$$

and the expression for the area becomes

$$-a^2\int y \sin y \, dy$$

Integrating between the limits

$$\theta = \frac{\pi}{2} \text{ and } \theta = \theta_1,$$

which for y will be

$$y = \pi \text{ and } y = y_1,$$

$$a^2\left[y\cos y - \sin y\right]_{\pi}^{y_1} = a^2\left[y_1\cos y_1 - \sin y_1 + \pi\right]$$

Since, by the condition of the problem, this area is to equal one half that of the circle,

$$a^2\left[y_1\cos y_1 - \sin y_1 + \pi\right] = \frac{\pi a^2}{2}$$

and

$$\sin y_1 - y_1\cos y_1 = \frac{\pi}{2}$$

The value of y_1 which satisfies this equation may be determined by constructing a table such as that shown below, and successively reducing the error of approximation to whatever degree desired.

From this table, it is evident that

$y_1 = 109°11'18''.9$ (very nearly)

Hence,

$$\theta_1 = \frac{y_1}{2} = 54°\ 35'\ 39''.5$$

and the corresponding value of ρ, using 200 feet in place of $2a$, will be

$\rho_1 = 200 \cos 54°35'39''.5 =$ 115.87 feet

y_1 (degrees)	y_1 (radians)	$-\cos y_1$	$-y_1\cos y_1$	$\sin y_1$	$\sin y_1 - y_1\cos y_1$
110°	1.91986	.34202	.65663	.93969	1.59632
109°11'.3	(By interpolation, $\frac{591}{3143}\times 60 = 11'.3$)				1.57080
109°	1.90241	.32557	.61937	.94552	1.56489
109°20'	1.90823	.33106	.63174	.94361	1.57535
109°11'.3	(By interpolation, $\frac{68}{523}\times 10 = 1'.30$)				1.57080
109°10'	1.90532	.32832	.62555	.94457	1.57012
109°12'	1.90590	.32887	.62679	.94438	1.57117
109°11'18''.9	(By interpolation, $\frac{17}{54}\times 60 = 18''.9$)				1.57080
109°11'	1.90561	.32859	.62616	.94447	1.57063

Conducted by JACOB DESCHIN, A.R.P.S.

What Pose?

ONE of the worst bugaboos the non-professional photographer has to encounter in his camera work is the selection of a pose suitable to the subject, and one that gets away from the usual thing. Generally speaking, the head may be posed in one of three principal positions with relation to the camera—full face, three quarter view, and profile. But such a rule is much too vague, almost too obvious, to be of real use when the purpose is to obtain a portrait that is alive with personality and not merely a likeness, or what is presumed to be a likeness. Moreover, a true likeness is not merely a physical resemblance, but a character impression.

Figure 1

Posing may broadly be classified in two divisions—the formal and the informal. The formal pose is ordinarily associated with the studio or the carefully arranged set-up by artificial light at home. Figure 1 is an example of this type of portraiture. It is the so-called "professional" portrait type, in which the subject is portrayed in conventional style. Both subject and photographer are conscious of engaging in a routine, a sober, methodical routine the end result of which is the familiar "studio portrait." Not that this type of portrait is a poor likeness or lacks character, but the personality is restrained; friends of the subject who see the picture do not quite recognize the person they know in life.

By contrast, examine Figure 2 and see the difference. This is the subject as we know her, smiling easily and gracefully; vibrant, sparkling, alive. Taken in the studio, also, the method employed was radically different from that used for Figure 1. The subject lighted a cigarette and was allowed to act naturally, to converse and generally to be "her self." When things looked ripe, the shutter was clicked and a precious moment was caught forever. Figure 2 is as much of a portrait as Figure 1, but which would you vote for if you had to make a choice between the two for a prominent place on your bureau?

Figure 2 is an example of the modern treatment in portraiture, and so are the others reproduced here. Figure 3 is an outdoor shot in the informal manner. A miniature reflex camera was directed from overhead to record a characteristic pose and expression, entirely unrestrained and completely at ease. It is easier outdoors to make shots of the informal type with success, partly because of the diffuse and all-embracing nature of daylight, which permits exposures without having to be too much concerned with light arrangements, partly because subjects seem to be less camera-conscious outdoors. This is one reason why one frequently hears the comment that "the best picture ever taken of me was a snapshot at such-and-such a picnic" . . . or boat ride or hike.

Figure 4 is another indoor portrait by artificial light. The subject, seated on a bench, leaned back, resting on her hands and turning her head toward the camera. In the final printing it was found that the best result could be achieved by selecting the head alone and enlarging that to the full dimensions of the print, and Figure 5 shows how this was accomplished to the great enhancement of the result. Incidentally, many a portrait negative may be improved by the simple expedient of deleting the non-essentials and concentrating on the

Figure 2

Figure 3

face alone. The angle of the head adds considerably to an impression of liveliness, gayety, movement.

Rules, they say, are made to be broken but here is one that you will do well to follow: never have the portrait subject facing the camera with both shoulders on a line with the lens. Have one shoulder nearer the camera than the other. When

Figure 4

the subject then turns her head toward the camera, the result will be much more agreeable. Thus, Figures 1 and 4 were posed with one shoulder toward the camera, and Figure 2 with the shoulders at a slight angle.

The lighting arrangement for Figures 1 and 4 consisted of a main, diffused light, combined with a soft spotlight; Figure 2, a spotlight and a soft main light from below, and Figure 3, daylight, with the sun furnishing both general soft illumination and a spotlight effect.

But why is the subject always smiling, one might ask? The answer to that one is: the subject is most characteristically presented in this way. She is at her best

Figure 5

and most revealing when she smiles. Another subject might be untruthfully photographed while smiling, but whether the subject should smile or not is entirely an individual question. One cannot make generalizations; study the subject and record the most favorable and attractive pose and expression.

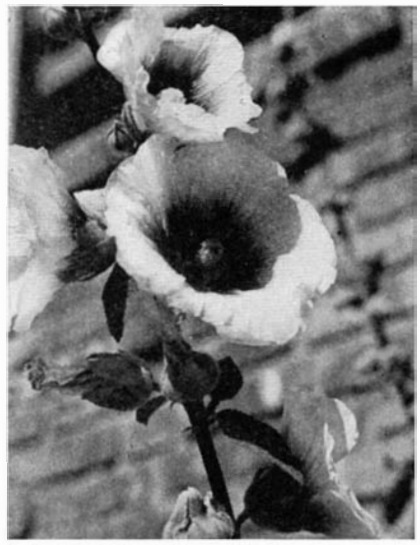
Why a File?

YOU do not *have* to have a regular photographic filing device of any kind. You may store your negatives in ordinary envelopes and keep them in the bureau drawer, or in a cardboard box of some sort. This kind of makeshift arrangement may be good enough for your purposes. But for those industrious workers who accumulate large numbers of negatives, particularly where the negatives vary in size, a somewhat more elaborate system will be found not only convenient but essential. Especially will this be true for the man who intends now and then to dabble in journalistic photography where the ability to find negatives quickly when needed is

of the utmost importance. The lack of a good system may frequently mean the difference between a sale and a missed opportunity to cash in on one's hobby.

Flower Close-Up

FOR rendering details in flowers, the close-up supplementary lens is frequently employed to advantage. The picture of hollyhocks reproduced here, for example, was made with a miniature reflex equipped



"Hollyhocks"

with a proxar supplementary lens which permitted an approach to the subject much closer than that possible with the unaided lens. Incidentally, the picture shows the flower in several stages of development, from the closed bud onward. In the present instance, some foreshortening may be seen in the near petals of the largest blossom, although it does not appear to be objectionable.

Fifth Rochester International Salon

ENTRIES are now being invited for participation in the Fifth Rochester International Salon, to be held at the Rochester Memorial Art Gallery, Rochester, New York, from January 15 to February 25, 1940. The closing date for the submission of entries is December 14. Entries are divided into commercial and pictorial groups. Fee is $1 which includes the right to submit to the maximum of 6 colored lantern slides, 4 monotone prints, 4 color commercial prints, and 4 color pictorial prints.

View Cameras in Demand

RECENTLY we have been noticing a considerable revival of interest among amateurs in the use of the view type camera. Particularly does this seem to be true of the 4 by 5-inch view, such as the Korona and the newly introduced Crown. Second-hand view cameras of this type that appear in the stores do not seem to stay very long and one frequently hears favorable comments concerning the use of a type of camera that has usually been associated only with professional studio workers. While the

view camera, even the 4 by 5, is limited because it has to be used on a stand, many find it ideal for indoor portraiture and other subjects; even landscapes. The 4 by 5 size, the "miniature" of the 8 by 10 and 11 by 14, is easily carried in a small fiber case, together with the necessary film holders and so on.

Photographing the Toy Pomeranian

A WALK in the park for the express purpose of making a photograph of Sandy offered an unforeseen problem. Sandy was obedient enough and would stay in one place for minutes at a time, but he seemed

"Sandy"

to be frightened at the sight of the camera and would not behave normally. Sometimes he cowered; at other times he was fidgety and nervous. One of the difficulties was getting his ears to stay up. This was finally accomplished, after many attempts, by someone standing just behind the photographer and, by one sign and another, convincing Sandy that he should bring his ears up. Several snapshots were made with a reflex miniature, one of which is reproduced here.

The Camera Sissy Philosophy

PERSONALLY, we like to buy a camera in a brand new condition, never handled before outside the photographic store. We like to have the feeling that any wear and tear accruing to a camera has come as a result of having been handled and used by us in the course of our picture-making activities. As time goes on and the camera assumes a worn condition it is comfortable to know that it became so because we had used it frequently. The camera, by these signs of wear, becomes associated with our personal experiences and the pictures we made with it.

We admit that, like other camera users, we desire occasionally—and, when we can afford it, fulfill the desire—to trade in our camera for a new one, one equipped with the newer gadgets. They are hard to resist, these handsomely contrived, new camera models, not only because they are good to look at but the new gadgets are real improvements and signify advances in camera design. Nevertheless, no matter how

long or how short the period during which a camera is actually in our possession it was a new one when we bought it and that, for us at least, is important.

There are persons, however, who look upon this camera sissy philosophy with disdain. They prefer an old camera, a used camera, and they don't care how many people had used it before they took possession. A camera is a camera, they say, and what's the difference so long as it works? Well, that's one way of looking at it, and maybe we're wrong. But we know that many people agree with us and would rather save up the few extra dollars required to make the sum asked for by the dealer than to buy an old camera now, because they do not have the few extra dollars, for the mere sake of immediate acquisition.

Book Plate Suggestion

THE backlighting of the leaves and the simplicity of the arrangement were the things that attracted us to the subject of the hanging rambler branches. A red filter was used for the sky and the moment was awaited when the cloud mass moved along

Design for a bookplate

into the desired position behind the subject. Because of the near view, the clouds were naturally rendered very soft-edged so that the purist might object to the picture on this account, declaring that the clouds have too much the appearance of a piece of cotton pasted in the sky. However, clouds do not always have to be rendered sharp. One does feel, however, that the picture is somehow incomplete. A solution that immediately comes to mind is the use of the print for a bookplate, with the usual wording lettered in the roomy space in the lower left part of the print.

Carrying Filters

IN carrying filters and supplementary lenses of the proxar and distar types, provide yourself with individual cases of hard leather or Bakelite, if these are not furnished with the filters and supplementary lenses when purchased. Carrying these items in the vest pocket or carelessly in the pocket without any protection whatever is bound to result in dust-covered elements that are also likely under these conditions

to be scratched or broken. You should be as careful of these as you are of the camera lens itself, for it must never be overlooked that the filter or supplementary lens is placed over the taking lens and that any damage suffered by these elements will have its effect on the negative.

WHAT'S NEW
In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.

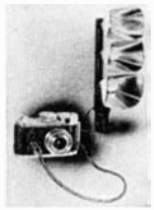
ZEISS 6 BY 6CM IKOFLEX III ($199): 2¼ by 2¼-inch twin-lens reflex camera equipped with Carl Zeiss Tessar *f*/2.8, 8cm (3⅛ inches) lens. Spring pressure plate assures film placement in focal plane of lens. Tessar matched with *f*/2.8 finder lens of same focal length, projecting image of subject on plano-convex focusing screen. Illumination uniform over entire screen area. Four-times magnifier covers entire focusing screen. Quarter-turn wheel focuses four feet to infinity. Scale on focusing wheel shows depth of field. Albada eye-level finder in which front element tilts forward and back as lens is racked out and in, correcting for parallax at all distances. Operating lever, with one smooth movement, simultaneously winds both film and shutter. Counter dial shows number of exposures made. Half-turn of lever advances film, spacing negatives evenly and winding shutter with one motion. Shutter is Compur-Rapid with speeds from 1 second to 1/400, bulb and self-timer. Signal shows whether shutter is discharged (black), wound (red), or set on self-timer (white). Shutter release adjacent to operating lever. Shutter speed and lens aperture settings controlled by levers on each side of shutter and visible in separate windows on top of camera. Double exposures and skipped frames eliminated by coupling of film-transport and shutter-winding mechanism. Tripod socket accepts standard American screw. Eyes for carrying strap. Standard 37mm slip-on filters and lens shade, as well as new Zeiss Ikon 35.5mm screw-in filters, fit lens. Film is loaded in usual way, then advanced until arrow (on paper leader of all film) lies between white dots on inside of camera. Hinged back is then closed and automatic counter mechanism goes into action.

BEE BEE ATLAS TRIPOD ($7.50): For all types of cameras, including 5 by 7 view and cine cameras. Three sections, all chrome with satin finish. Has reversible feet, peg on one side and rubber tipped on other. Weight three pounds. When closed, legs 23 inches long; open, extend to 60 inches. Tripod guaranteed against mechanical imperfections. Packed in weather-proofed tubular container which may be used as carrying case.

UNIVEX MICROGRAPHIC ENLARGER ($27.50): Incorporates automatic film pressure release, which permits sliding negatives with-

out scratching, and double lens condenser system for uniform flat field illumination. Enlarger supplied with both double and single frame masks; other masks available. Enlarger uses standard Mercury f/3.5, 35mm lens, focused by smooth-acting, quadruple thread, focusing adjustment. Adjustable ruby filter and holder of die cast construction with chromium trim, supplied. Adapters available for Leica, Contax, and other lens makes.

ROBOT SEQUENCE FLASHER: Comprises base containing flat type dry battery plus automatic mechanism which causes one flash bulb after the other to be connected with synchronizer of Robot II camera. On top of base fits interchangeable bank holding three flash bulbs and reflectors. Electric cable connects entire unit to camera. Fitted with standard American tripod bushings for attaching to tripod or camera by means of bracket. Device 19 inches high, weight 22 ounces. Exposure and flash are simultaneously released every time button is depressed. Three bulbs may be fired before reloading. Additional banks may be purchased for quicker reloading. Also possible to connect several flashers to obtain more than three sequence shots. Button in base of flasher permits instant change of connections to fire three bulbs simultaneously.



LAFAYETTE FERROTYPE AND CHROMIUM POLISH: "A little goes a long way" in new polish for black enamel and chromium ferrotype plates. Applied sparingly to plate and wiped dry, it is said to provide an even wax coating to aid in avoiding mottled effect common in glossy prints and indefinitely prolonging useful life of plates. Non-inflammable.

BEE BEE CHROME TILT-TOP ($2.50): Tilting and panoraming tripod head made of steel, brass, and aluminum, plated with chromium. Reversible tripod bushing for domestic or foreign cameras. Five-inch handle controls movement. Weight 14 ounces.

CINE-KODAK OUTDOOR GUIDE (10 cents): Exposure data for all Cine-Kodak films, 8mm and 16mm, black-and-white and Kodachrome. One dial adjustment yields simultaneous exposure reading for all films, and for light, average, and dark subjects with Kodachrome. Four daylight conditions (from "bright sun" to "cloudy dull") and four angles of lighting (back, side, flat front, and open shade).

SOLAR 4 BY 5, 5 BY 7-INCH ENLARGERS: (4 by 5, without lens, with bulb and baseboard, $49.50; 4 by 5 wall type, without baseboard, with wall mounting brackets, $59.50; 5 by 7 wall type, without baseboard, with wall mounting brackets, $59.50. Upright standard of heavy chrome-plated metal 36 inches high, 1¾ inches in diameter; reflector head seamless, double wall construction providing circulating air jacket; 5 by 7 models equipped with foot switch; focusing by newly designed double braced, double metal track system adjustable from either side of unit; wide bellows adjustment permits focusing over wide range of sizes; metal negative carrier con-

sists of 5 by 7 slide-through wood frame into which reducing, dustless type, metal negative carrier is inserted; negative carriers available in all standard sizes from double 35mm to 4 by 5 inches; wide range of adjustments for lenses up to 7½ inches focal length.

GROSS PHOTO MOUNTS: Selected assortment now available specially made to meet amateur requirements. Sample package offered by factory for $1 postpaid.

KODAK HOME LIGHTING GUIDE (10 cents): For still and movie users of Super XX film. Pocket card guide with movable dial offering complete data for indoor shooting by ordinary room light from 60 watts to 400. Covers light-to-subject distances 12 feet to two feet; lens apertures *f*/2 to *f*/22; "still" exposures 1/50 of a second to 64 seconds; and both normal and half-speed for movie cameras.

ROBOT FILM REWINDER: Chamber of plastic material permits transferring film from any standard 35mm cartridge into Robot II magazine, and vice versa, in broad daylight. Device also serves as carrying case for two loaded spare magazines, furnishing reserve supply of film sufficient for 100 Robot pictures.

FEDCO PRINT DRYER ($2.95): Has polished lacquer surface giving prints smooth finish when dried. Accommodates removable ferrotype plates. Compact, measuring 14⅛ by 10 by 1⅝ inches. Uses 105 watts; operates on either A. C. or D. C. Equipped with an Underwriters Approved cord. Canvas washable and held in place by new type stretching device that holds prints firmly in place. Heating element gives uniform distribution of heat that is kept at even temperature.

PERUTZ ULTRA FINE GRAIN DEVELOPER W 665: New developer compounded according to formula described in the photographic handbook, "The New Photo School," by Hans Windisch. Said to combine advantages of paraphenylene-diamine formula with non-toxic, non-staining characteristics. Each container holds 20 ounces of developer, sufficient to process approximately 15 rolls of 35mm film. Recommended working temperature 65 degrees.

BEE BEE NECK-POD ($2.50): Measures 6½ inches long when closed; extends to 12 inches. Chromium plated. Head holds camera either horizontally or vertically, as desired. Complete with adjustable leather strap.

HYDE OPTICAL SLIDE RULE ($1.50): Made of engraved stainless steel, 6 1/2 inches long by 1 inch wide by 1/8 of an inch thick, this rule gives photographers necessary information about lenses, focal lengths, magnifications, and measurements. For example, rule gives depth of field obtained when focal length of lens and aperture are known, assuring sharp enlargements of great diameter. Rule also contains conversion tables—fahrenheit to centigrade, ounces to cc, mm to inches, grains to grams.

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

Q. **I would like to get a picture of the moon, using a 3-inch refractor made by Bausch & Lomb prior to 1900. The objective is clear and I would use a 1-inch eyepiece. It is my understanding that if I should use a camera, it would be used simply as a film holder and the lens would be removed from the camera. I would like your advice as to the mechanical arrangement of the equipment; also as to the type of film to use.—J. C. C.**

A. The procedure sometimes employed is to remove the eyepiece of your telescope and attach in its place the lightest ground-glass camera you can find. The camera lens is removed and focusing and exposure is done as normally. Very fast film, such as Super XX or Superpan Press is required and an exposure not exceeding one half second.

The correct focus must be found by trial and error because astronomical telescopes are corrected for the visual, not the chemical (photographic) rays. This experimentation is done as follows: Focus with the eyes as usual, getting the image as sharp as possible. Now, moving 1/16 of an inch at a time, rack the film plane forward, making an exposure each time you have moved the film plane to a new position. Develop the negatives and study the resulting pictures, from which you can select the one that appears to have been focused the most sharply. Mark the point of correct focus in some permanent way so that all you will have to do in future is to set the film plane at this point without further focusing. Incidentally, the negatives will provide a test of the required exposure. If the negatives are too dense, this will mean that a shorter exposure than one half second may be given.

Another method, using a reflecting telescope, is described by Harold A. Lower in his article on "Celestial Photography" in "Amateur Telescope Making." "The image of the moon at the focus of a six-inch mirror," writes Mr. Lower, "will be about half an inch in diameter, but it is so bright that it may be magnified by an eyepiece to about an inch, and still be bright enough to photograph with an exposure of less than a second. Use an eyepiece of about one-inch focus, and project the image of the moon on a sheet of ground glass. Determine the distance from the eyepiece which is required to produce an image one inch in diameter. Then make a box to mount over the eyepiece, which will hold a plate-holder or ground glass focusing screen at the proper distance. There should be a door in the side of the box, so that one can adjust the eyepiece until the image of the moon is sharply focused. A small reading glass is quite a help in determining when the image is the sharpest. When the focus is the best obtainable, replace the ground glass with a plate-holder. Have an assistant hold a sheet of black cardboard in front of, but not touching, the telescope. Then remove the slide of the plate-holder, look through the finder and make sure that the telescope is centered on the moon. The exposure is made by moving the cardboard edgewise from in front of the telescope, and replacing it as quickly as possible. Be careful not to jar the telescope. If the exposure is short enough, the motion of the moon will not be rapid enough to cause a blur, even if the telescope is not equipped with a clock drive." For further details we suggest you consult the article, which appears on page 254 of the 4th edition of "Amateur Telescope Making."

Q. **I have a camera with *f*/4.5 lens. Unfortunately, there is a nick on the rear element. Due to the fact that no branches of the German manufacturer are in New York, I am unable to have the lens polished. Do you know of an optical concern which will polish it? Also, if worse comes to worst, under what conditions would the nick be the least discernible on the negative? That is, should I attempt to fill it with Canada Balsam, or blacken it to avoid reflection?—T. F.**

A. Although there is no manufacturer's "branch" in this country, the importer of your camera can undoubtedly help you.

Concerning your last question, Arthur Lockett, author of "Camera Lenses," a standard work on the subject, advises that "a cracked glass may not impair the performance of the lens unless the outline of the crack is, so to speak, markedly prismatic or iridescent in effect." Even then, he suggests that the lens may be made to work satisfactorily by painting a narrow line of opaque black varnish around the crack or

nick. "This most probably will not show at all on the screen," he adds, "and will only subtract infinitesimally from the amount of light. Similarly, a broken lens may be cemented, preferably with Canada Balsam; but if this is difficult, the 'Diamond' cement used for mending china, etc., will answer, or even a strong, hot gelatine solution." We would suggest you make several exposures with your lens as it stands and carefully examine the resulting negatives; if you can detect no real fault continue to use the lens as it is. Otherwise, ask the camera importer to recommend a good lens repair firm.

***Q.* Occasionally I have to turn out a large number of prints and prefer to keep them all in the wash water until I get through with the entire batch. This may take several hours and the first prints will therefore have to stay in the water all that time. Will excessive washing hurt the prints?—L. K. M.**

A. Excessive washing sometimes causes frilling. An effective preventive that has been used with large prints, such as photomurals, that have had to be left in wash water overnight, is to add to the wash water about 5 percent of sodium bisulfite.

***Q.* Please advise what model or number motion picture camera made by Eastman would be most suitable for a beginner—also projecting equipment.—T. S. C.**

A. Queries concerning the equipment of a particular firm should be addressed directly to that firm as they are in the best position to give advice concerning cameras and equipment of their own manufacture. Accordingly, we have forwarded your inquiry to the Service Department of the Eastman Kodak Company.

***Q.* I have heard it said that when photographing at high altitudes, it is necessary, because of the increased brightness of the light, to decrease the normal exposure. How much shorter should the exposures be?—S. E. L.**

A. That depends on the altitude. For a general example, at 2500 feet, give three quarters the normal exposure; at 5000 feet, two thirds; at 10,000 feet, one half, and at 15,000 feet, one third.

***Q.* In developing roll film in a tray by the see-saw method, I frequently have trouble in getting the film into the solution evenly. Can you suggest a remedy?—W. B.**

A. Simply immerse the film in water before starting development. This will have no effect on the latent image but will make the film limp. Developing will then be even and you will avoid the possible danger of having air bubbles form on the film.

***Q.* I would like to study photography, especially motion picture work. Will you please suggest some schools? I would also like to know what company sells motion-picture equipment.—S. C.**

A. Two schools which have special departments for the study of motion picture photography are the New York Institute of Photography, 10 West 33rd Street, New York, New York, and the American School of Photography, 3601 Michigan Avenue, Chicago, Illinois. Both schools offer resident and correspondence courses. A card addressed to the schools will bring literature and complete information.

Motion-picture equipment may be purchased in practically any photographic supply house. Some of these companies are listed in our advertising columns. They will be glad to send catologues and prices if you will write them.

***Q.* Do you know where I might find a table showing emulsion speeds of various films recorded in both Din and Weston, or a table to convert Din readings?—W. W. M.**

A. In the United States, film emulsion speeds are rated either in Scheiner or Weston. Din ratings are used in Europe. A conversion table that includes American Scheiner (as distinguished from European Scheiner ratings, uniformly six points higher than the American), Weston, Din, and H.&D. speeds, is included in "Practical Speeds of Films and Plates," a list of film speeds rated in American Scheiner degrees. It is enclosed with copies of the Exposure Meter Manual, by Joseph M. Bing, F.R.P.S. published by Photo Utilities, Inc.

***Q.* I have an old 9 by 12cm Bakelite film-pack adapter in which the grooving has broken off, causing light leakage. I understand that it cannot be repaired. What would you advise?—A. H. W.**

A. Since the adapter was molded in one piece, special grooving machinery would be needed to put it in working order again and this is obviously out of the question because of the cost involved. The only remedy is to have a repair man fit a 3¼ by 4¼ kit into the broken adapter. While the size of the negative is thus reduced, the difference is rather slight.

***Q.* Can you supply a formula for making a gum similar to that used on postage stamps which I can apply to the backs of small prints and which will need simply to be moistened before use?—H. C. M.**

A. In five ounces of heated water, stir:

10 ounces of fish glue or liquid glue
5 ounces of liquid glucose
5 ounces of denatured alcohol
Few drops of carbolic acid

Thin the resulting solution with water to the desired consistency and brush the backs of the prints. If the prints are to be trimmed, apply the gum before trimming and trim after the gum has dried.

***Q.* I am undecided whether to purchase a camera taking only roll film or one equipped only for filmpack and cut film holders. Can you give pros and cons as to which is more advantageous, roll film or filmpack?—R. S.**

A. Filmpacks are relatively easier to load than roll film, although with practice the latter may be loaded almost as quickly; furthermore, the roll-film type of camera requires opening the camera to load. Roll film is easier to develop because an entire roll may be developed at the same time. In the case of filmpacks the films have to be handled individually, although tanks are available for developing them all at once. Filmpacks are more expensive, but the camera will also take cut film which is usually cheaper than filmpack and affords a greater variety of emulsions than roll film.

Our Book Corner

THE Book Department of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

THE GLASS GIANT OF PALOMAR

By David O. Woodbury

MAINLY this most readable book concerns the human side of the 200-inch telescope; what went on behind the scenes within the broad circle of scientists and engineers who conceived it, planned it, gradually evolved its details and then built it. The swiftly moving narrative begins with Hale, the prime mover, and proceeds steadily down through to the present year (completion of dome and of mounting, grinding and polishing of mirror up to final parabolizing). For two special reasons it is authentic: first, the author, an outstanding contributor to first-rank magazines, is a telescope maker, hence closely comprehends his subject; second, he spent long periods at the site on Palomar and at the California Institute of Technology, also living with those who designed and are making the telescope, and set down their oral accounts in lively style. They also checked the book for accuracy. He also scoured the country from end to end in search of every root from which the telescope has sprung. Very much of the text consists of personal narrative within quotation marks revealing the actual dealings, the daily give and take, and the differences and compromises of the principals. The book, though largely about people, does not skip the scientific or engineering detail of the huge undertaking. Thus it answers both the personal and astronomical questions which outsiders have often asked in vain. (380 pages, 6¼ by 9¼ inches, 66 illustrations.)—$3.10 postpaid.—*A. G. I.*

THE SCIENTIST IN ACTION

By William H. George, Ph.D., Royal Society Research Fellow, Lecturer in Physics, University of Sheffield

FROM this book the thoughtful, studious reader may obtain a picture of the scientific method in some of its most searching, rigorous aspects and see how the scientist applies it. Not an elementary book. (354 pages, 5¼ by 8½ inches.)—$3.10 postpaid.—*A. G. I.*

COMPOUNDING IN THE ENGLISH LANGUAGE

By Alice Morton Ball

IS it all one word, two separate words, or is it hyphenated? Worst bugbear of writing in our illogical English language is word compounding. If you think that even editors understand it, watch any two of them fight. Everybody tears out hair, however, about compounding. Here is a book containing a 103-page alphabetical list of nearly 13,000 of the word compounds that cause the most trouble, worked out by an author who has prepared the writing style manual for the U. S. Department of State. When in doubt, you flip it open and there is your answer. Also, for those few who want really to learn the principles of compounding, there is an exhaustive study of the underlying basis of the whole matter. (226 pages, 6¾ by 9½ inches.)—$2.60 postpaid.—*A. G. I.*

MAN MAKES HIMSELF

By V. Gordon Childe

IN which a noted British archeologist presents an account of human progress from the Old Stone Age, without inflicting on his readers the technical terminology and jargon of the specialist. He describes three great revolutions in human history—the Neolithic, the urban, and the recent revolution in knowledge. (275 pages, 5 by 8 inches, 11 illustrations.)—$2.60 postpaid.—*A. G. I.*

ESSAYS FOR THE STUDY OF STRUCTURE AND STYLE

By Leo E. A. Saidla

ONE of the largest industries in America is that of writing for publication. It is said that everybody is writing a novel—or something. This collection of essays with its lengthy discussion of types and style of writing and its discussion of grammatical questions is intended as a guide for these writers. As such it may be highly recommended for slow and careful reading. (717 pages, 5½ by 8⅝ inches.)—$2.35 postpaid.—*F. D. M.*

THE PROPERTIES OF GLASS

By George W. Morey, Geophysical Laboratory, Carnegie Institution of Washington

AS *Nature* patly put it, "an eminently scholarly and exhaustive monograph which is bound to be of immense value to the wide circle who have to do in some way or other with glass." Chapters treat respectively the history and definition of glass, devitrification, composition, chemical durability, viscosity, annealing, surface tension, heat capacity, heat conductivity, density, coefficient of expansion, elastic properties, strength, thermal endurance hardness, optical properties, electrical conductivity, dielectrics, magnetic properties, constitution. This is not an elementary book but is definitely technical. A veritable storehouse of very compact, solid, dependable information on which the author, a member of the staff of a laboratory which has given much attention to glass since the World War, has been diligently at work since 1924. (561 pages, 6 by 9 inches, 20 illustrations.)—$12.60 postpaid.—*A. G. I.*

THE MODELMAKER

Volume 15

A YEAR'S issues of *The Modelmaker* magazine bound in permanent form, of particular interest to the hobbyist who has a well-equipped shop and is sometimes at a loss as to what project to start next. It is particularly concerned with advanced work in such things as the construction of model railroad equipment, model engines of various types, and improved equipment for the home shop. (210 pages, 7 by 10 1/2 inches, well illustrated and indexed.—$2.00 postpaid.—*A. P. P.*

PROJECTION PRINTING WITH THE PHOTOMETER

By A. J. Haynes

EXPOSURE in projection printing is a stumbling block for many amateur photographers. Without correct exposure it becomes impossible to obtain the finest possible quality from the negative. It is because of this stumbling block that exposure meters for enlarging have come into rather wide general use in recent years. To guide the photographer in the use of these meters, the author of the present book has prepared what might be termed a manual for this particular phase of photographic endeavor. The chapters deal with exposure meters, paper speed ratings, negative density range, paper exposure scale, and so on. (48 pages, 5¾ by 8¼.)—$1.10 postpaid.—*A. P. P.*

ABOUT PETROLEUM

By J. G. Crowther

WHAT petroleum is, where it comes from, where it is obtained, and how it is processed, is the scope of this book written for the motorist, aviator, mechanic, business man, and others, by a technically trained writer who treats the subject neither lightly nor very technically. (181 pages, 5 1/2 by 8 1/2 inches, 24 illustrations.)—$2.35 postpaid.—*A. G. I.*

THIS EARTH OF OURS

By Victor T. Allen, M.S., Ph. D.

EITHER as a readable textbook or a somewhat textbookish popular work, this treatise covers geology, both physical and historical, in a scientific manner, the

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author being a professional geologist. The treatment is condensed rather than detailed, thus avoiding the chief difficulty which bedevils those who seek to learn geology—confusion in a morass of detail and terminological jargon. (364 pages, 5 1/2 by 8 1/2 inches, 257 pages.)—$3.60 postpaid.—*A. G. I.*

HANDBOOK OF CHEMISTRY AND PHYSICS *23rd Edition*

Edited by Charles D. Hodgman

NUMEROUS additions and revisions make this 1939 edition of a familiar reference even more valuable than its predecessors. Important additions are tables of Melting Point Index and Boiling Point Index of Organic Chemicals. The tables of Physical Constants of Inorganic and Metal-Organic Compounds has been thoroughly revised. The page size of the volume has been slightly increased over that of former editions, giving the book better proportions. (2221 pages, 4½ by 7 inches.)—$6.10 postpaid.—*L. B. P.*

BACKGROUND TO MODERN SCIENCE

Edited by Joseph Needham and Walter Pagel

TEN British writers—Dampier, Rutherford, Bragg, Aston, Eddington, Ryle, Nuttall, Haldane and other outstanding scientists—lectured at Cambridge University on physics, astronomy, physiology, parasitology, tropical medicine, evolution, and genetics, presenting these subjects historically (mainly, however, reviewing advances during the past 40 years alone). These are the lectures. Informative reading. (243 pages, 5½ by 8 inches.)—$2.10 postpaid.—*A. G. I.*

CASEIN AND ITS INDUSTRIAL APPLICATIONS

By Edwin Sutermeister and Frederick L. Browne

WHATEVER the chemist wishes to know concerning the chemistry and uses of casein will be found in this very complete study. It discusses and explains in detail for the chemist interested in plastics the background facts in the use of this milk product, its manufacture, testing, analysis, storage, and its use in plastics, glues, paper making, paints, the leather industry, medicine, and other applications. Extensive bibliographies and references to articles are given. (433 pages, 6¼ by 9¼ inches, numerous illustrations.)—$6.60 postpaid.—*F. D. M.*

FASCINATING FAKES IN PHOTOGRAPHY

By Marcel Natkin, D.Sc.

SHADOWGRAMS, smears, screens, bas-relief, photomontage, distortions, infra red—the text runs the whole gamut of photographic tricks that can be accomplished by the average amateur photographer who does his own processing. Many of the effects described are old, in the photographic sense, but they are so well depicted and so thoroughly explained that the book represents genuine value to the serious-minded camera fan. (72 pages, 7 by 11 inches, thoroughly illustrated with a large number of photographs and diagrams.)—$2.10 postpaid.—*A. P. P.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

LURKING in the rearmost cell of the average amateur telescope maker's brain is the hope that someday he may work up to a full 20″ reflector, and a number of telescopes of that size are known to be in the making. The clean-cut Cassegrainian reflector shown in Figures 1, 2, and 3 was built by William Buchele, 2832 Sagamore Road, Toledo, Ohio, who previously had made two smaller sizes. Modestly, Buchele at first sent this magazine but one small photograph accompanied by a mere 57 words of description. The instrument shown by that photograph looked so good that he was invited to put modesty aside and write down the details about this telescope, since these will be of value to other amateurs who plan telescopes of this size.

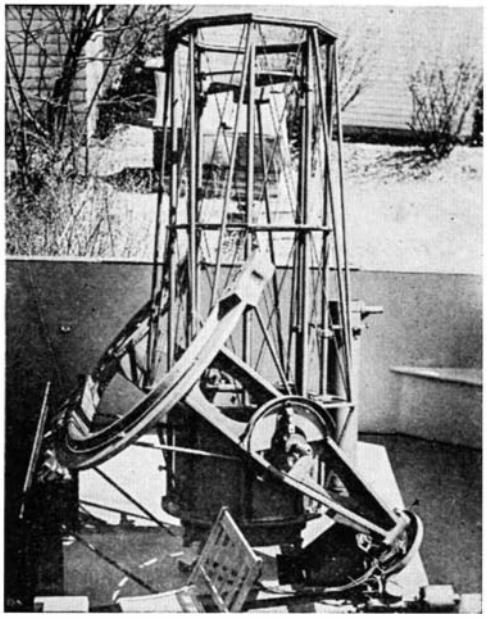

Figure 1: 2200 pounds of trim telescope

"Your letter," he replied, "puffed me up a bit and, if I do any bragging, it's your responsibility. I started telescope building about three years ago, using a borrowed copy of the first edition of 'Amateur Telescope Making.' That's when my trouble started, and I haven't been the same since. After making the two smaller instruments I obtained a 21″ Pyrex disk weighing 100 pounds and, at the end of about 40 hours' work, I had it roughed out to *f*/5. Fine grinding took six hours, polishing nine. This was all done by hand, the 100-pound mirror face-down over a full-sized tool and polisher, and I would not advise any one to attempt this unless he has an elephantine physique. [A. W. Everest also did this.—*Ed.*]

"Figuring was done with small tools, mirror face-up. The correction is within 1.5 percent of a full paraboloid and the figure is smooth and regular, the performance good.

"Both the convex secondary and the diagonal flat are of Pyrex; I turned down 8″ disks to 6½″ to gain extra thickness. In correcting the convex I used Hindle's method, and a sphere to figure the flat.

"Hindle's 18-point flotation system (Figure 4) was also used to support the mirror, though I doubled its number of inner edge supports. Figure 4 also shows the outer edge support shoes. The cell is a combination of steel plate and castings, welded, as is the lower part of the tube.

"The lattice-type tube (Figures 1, 2, 3) is bolted to the solid part. Its eight pieces of tubing are of 1¼″ diameter, 20-gage wall, cold-rolled steel. The 3/16″ tie rods and the perforated octagon hoops also are cold-rolled steel, the latter (Figure 3) being made of 16-gage channels. A 1¼″ washer was brazed into each corner of the octagon and the tubes were then pressed through these holes and brazed, making a very stiff job regardless of the angle at which the tube rests. Figure 2 best shows the pairs of additional tube braces stretched over the squared ring at the top of the solid part of the tube. These give added rigidity. I can detect no flexure by visual inspection of the mirror reflections.

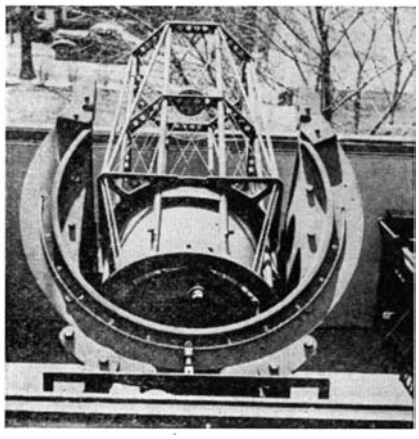

Figure 2: The Porter split ring

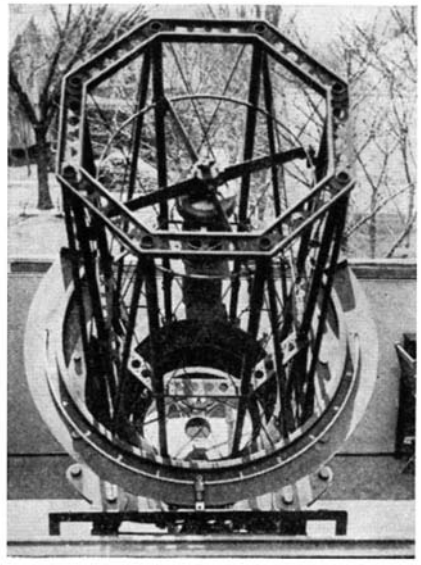

Figure 3: Octagon hoops and spider

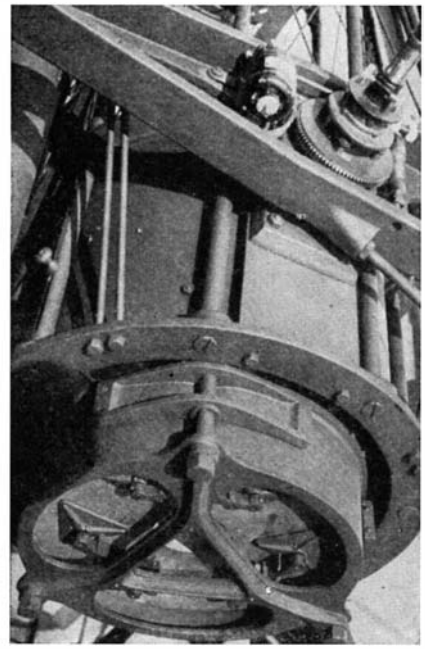

Figure 4: Cell. Flotation system

"For the spiders (Figures 3 and 5) to support the secondary mirrors I used saw-blade steel.

"The declination axis trunnions (Figures 1, 6, 7) are castings of special material, (cast iron, nickel steel), as are the four other large parts of the mounting. All were normalized before machining. I made my own patterns.

"As I own no lathe or drill press I was forced to have the lathe and similar work done outside.

"The declination bearings are used truck ball bearings (radial thrust, 5″ O.D.). They had to be large because the trunnions were to be hollow to allow the reflected rays to pass through to the eyepieces.

"I placed the declination circle with its shielded light (Figure 6) on the west side. It is divided into half degrees. The index con-

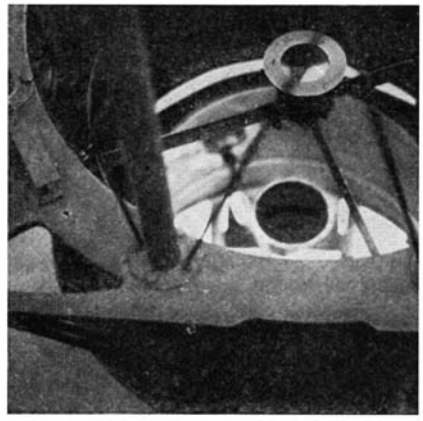

Figure 5: Lower spider. Cell. Prism

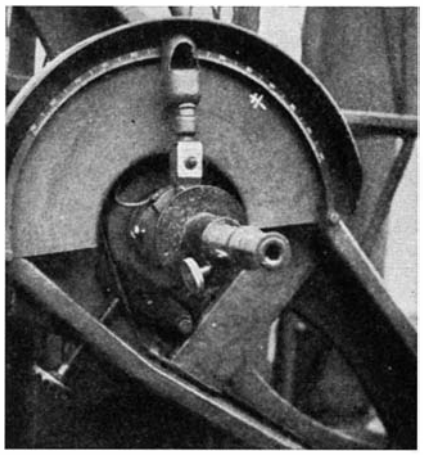

Figure 6: Declination circle. Eyepiece

sists of a bright copper wire. On the east side is a reversible slow-motion motor with gearing (Figure 7), mounted on rubber. A small clutch allows this axis also to be moved manually without adjustment or disengagement of gears.

"For the south polar axis I used a radial thrust, self-alining type of bearing (Figure 8). The bearings under the split ring (Figures 2, 3, 9) are used auto parts. The inner race is stationary, while the outer race rotates under the big ring. This gives a four-point support, spread over a large part of the ring. Each pair of rollers is pivoted, and this tends to cancel out possible irregularities on the bearing face of the ring.

"The R.A. setting circle (Figure 9), is divided into minutes.

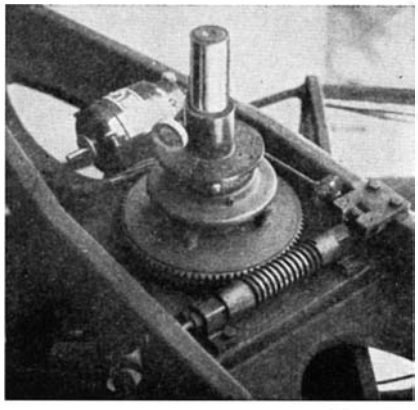

Figure 7: Dec. slow motion motor

"The principal gear train for the drive in R.A. has a 1/8 H.P. synchronous motor (Figure 8), mounted on sponge rubber. Slow motion in R.A. is obtained by a reversible motor operating through a clutch, as in the declination axis drive. This is mounted on the under side of the large worm wheel beneath a housing. The large circular object in Figure 8, near the worm wheel, is a guard to protect the gear, also the clothing.

"A 2½" prism, shown dimly beneath its cell ring and above the spider in Figure 5, is used to divert the image to either of the eyepieces at the respective ends of the declination axis, simply by turning the prism east or west one half turn. Very comfortable observing position is thus made possible.

"As a finder I use a 6", *f*/6.5 reflector with rotatable tube (Figure 1).

"My observatory (Figures 10, 11) was made by adding 8′ to my garage. The telescope rests on piers (Figure 12), with footings 6′ deep. The observatory floor is 6½′ above the

THE BEGINNER'S CORNER

LITTLE ways of doing common operations, devised and used by different workers, are extremely numerous; scarcely any two do a job alike, in fact. Ed. C. Rizzo, R.F.D. 1, Cold Spring, Ky., tells how he makes laps. In a wooden mold 1" wide, 24" long, ¼" deep, lined with wax paper, he pours melted pitch, lets it cool, removes it, peels the paper off and, in a warm room, cuts the strip into 1" squares. Each of the four sides of each square is then cut with a re-entrant curve, the result being a prepared facet, shaped like a four-pointed star. These are attached to the warmed tool with turps. The object of the star-shaped facets is that, after cold-pressing and swelling out, such a shape becomes a square; while a square, as commonly used, tends to become a circle. (Whether a lap made of squares is superior to one made of circles is a separate question.)

To make a pitch lap free from bubble holes, Edward Lenard, 4854 N. Austin Ave., Chicago, heats the pitch in a double boiler, stirring it often; then removes the inner receptacle and holds it 6" above a low flame until the pitch is thin enough to pour readily, stirring all the while.

TELESCOPTICS

(*Continued from preceding page*)

garage floor and is 11' square, giving ample room. The housing for the telescope rolls off on a gantry (Figure 10), and is so compact that, when closed, it is scarcely noticeable from the street.

"The sidereal clock (Figure 13) was made from an ordinary pendulum clock. For the pendulum I substituted a longer and compensated pendulum, thus reducing the speed of the hour hand to one revolution per 24 hours. On the dial face is a star map, and stars at the zenith are indicated at all times by the hour hand.

"For the benefit of any faint-hearted aspirant for a 20", you may say that I am not an engineer, neither am I a mathematician: my school training was very elementary.

"Our local Toledo Astronomy Club is an active one. Professor Winslow, of the University of Toledo, is our skipper and we meet monthly at the University."

LETTER from an author:
"In our article, "Some Applications of the Schmidt Principle in Optical Design," by D. O. Hendrix and myself, in the August number, it was certainly far from our intention to deny credit to anyone to whom credit is due. The meaning of our offending sentence would have been clearer had it been phrased to read '. . . little that was not known to Schmidt' instead of 'little that is new.'

"Through private sources we know that Schmidt himself had derived the fundamental equation and had considered various modifications of the principle to meet the requirements of special problems. Had we been concerned with the history of the matter, which, as our title suggests, was not the case, a complete bibliography naturally would have been included. The methods of polishing and testing used at Mount Wilson for several years were developed independently by Hendrix and described by him in a public lecture in 1933."

—*William H. Christie.*

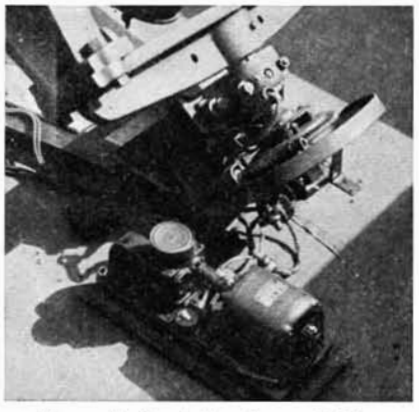

Figure 8: South bearing and drive

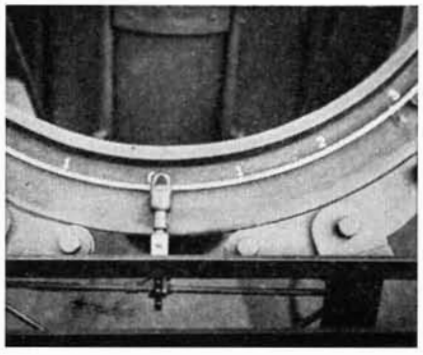

Figure 9: North bearings. R. A. circle

Figure 10: Garage. Observatory. Gantry

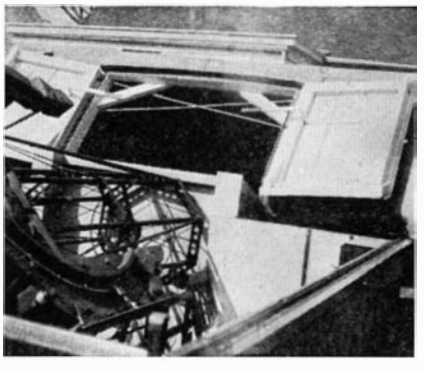

Figure 11: It all folds up snugly

SURVEYING the durability of aluminized and chrome-aluminized mirrors, in

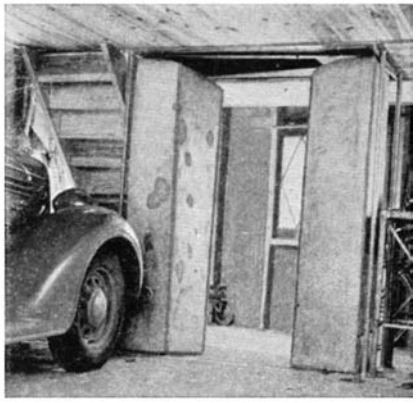

Figure 12: The two massive piers

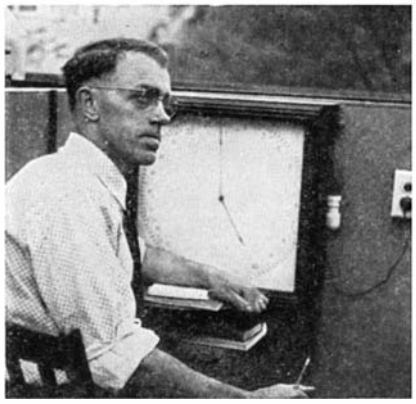

Figure 13: Buchele. Sidereal clock

the June, 1939, *Astrophysical Journal*, Robley C. Williams of the University of Michigan, after questionnairing 16 observatories, states in an 11-page article that "the most probable useful life of a coating of either of the films is from 2½ to upward of five years, depending upon the excellence of the coating, its care, and the degree to which it is subjected to condensed moisture and dirt particles."

In the July number of the same journal—a professional astronomer's journal than which there certainly is no whicher—occurs the statement that the new Skilling and Richardson "Astronomy", reviewed in Scientific American for August, is "the best single book available for teaching a large amount of astronomy to the uninitiated student," in flattering agreement with our own review.

Dave Woodbury, a T.N. whose book, "The Glass Giant of Palomar," on the 200″, is reviewed elsewhere in the present number and who lives in Ogunquit, Maine, is now lecture-touring here and there among clubs of amateurs, using a heavy assortment of lantern slides. He has also lectured before Rotary Clubs and even Women's Clubs, but here he tempers his technicalities to the shorn lambs.

WHO can excel the record of C. P. Dayton, Lyford, Tex., for telescope pier? His is 2200′ deep! Because his locality is underlain by a 40′ stratum of quicksand, trains moving within five miles of the telescope caused serious shimmying. An 8′ concrete pier made it worse. He felt whipped. Then came an oil company, drilled a 9000′ well on his land. Dry hole. But it wasn't a total loss, for Dayton found that, when he set his telescope on the 2200′ of 10¾″ casing the drillers had left cemented in the bowels of the earth, the telescope had the stability of Palomar. Seismoscope becomes telescope.

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

AUTOMOBILE FACTS AND FIGURES is the twenty-first consecutive issue of the annual statistical review of the automobile industry. It is essentially a series of tabulations covering such things as factory sales and wholesale value, retail sales of new motor vehicles, replacement parts values, capital invested in manufacture, motor vehicle registrations, taxes paid by motorists, state legislation, and so on, covering the year 1938. 96 pages, thoroughly illustrated. *Automobile Manufacturers Association, Inc., 366 Madison Avenue, New York City.—Single copies gratis, quantities 25 cents per copy.*

QUIETONE RADIO NOISE FILTERS describes and lists a complete line of radio interference filters. Catalog No. 166-A. *Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.—Gratis.*

ENGINEERING DATA ON FLUORESCENT MAZDA LAMPS is a 16-page pamphlet which gives information regarding lamp operation and performance factors, operating characteristics, color quality, and application considerations. It is illustrated with photographs and a number of diagrams which give in compact form all of the engineering data so far available on this new source of light. *General Electric Company, Nela Park, Cleveland, Ohio.—Gratis.*

LEICA PHOTOGRAPHY, 25th Leica Anniversary Number, is a special edition of a regular monthly magazine which is of particular interest to owners of miniature cameras. The feature article in this issue deals with the renaissance of photography and presents a number of interesting and informative illustrations. *E. Leitz, Inc., 730 Fifth Avenue, New York City.—10 cents.*

LAFAYETTE 1940 MASTER CATALOG covers, in 188 pages, all types of home and automobile radio sets and accessories, public address equipment, servicemen's materials, and apparatus for the ham and television experimenter. *Radio Wire Television, Inc., 100 Sixth Avenue, New York City.—Gratis.*

COLORS AND THEIR MATCHING, by Roger K. Taylor, Ph.D., is a four-page brochure that presents a brief description of colors and the procedure for their matching. It should be of particular interest to anyone concerned with paints or enamels. *The Porcelain Enamel & Manufacturing Co., Baltimore, Maryland.—Gratis.*

THE SOARING CYCLE is a typed report applying dynamics to soaring. The combined momentum of sailplane and wind as viewed from the earth cannot be changed by forces from the air or gravity. The sailplane must be a mechanism capable of receiving wind momentum by one set of airfoils and returning this momentum to the air by another set of airfoils in equal momentum value but not in equal energy value. Energy not returned supports the flight. "The Soaring Cycle" sells for $5.00; "The Dynamics of Soaring," 24 pages, a resumé of "The Soaring Cycle," is $1.50. *The Soaring Flight Co., 1115 15th Street, N. W., Washington, D. C.*

WATER CORROSION CONTROL describes the use of silicates for the protection of water mains and service pipes, and for the elimination of "red" water. Bulletin No. 373. *The Philadelphia Quartz Company, 121 South Third Street, Philadelphia, Pennsylvania.—Gratis.—Request this bulletin on your business letterhead.*

INTERCHANGEABLE GROUND-GLASS JOINTS, STOPCOCKS, AND STOPPERS. Revised commercial standards for interchangeable ground-glass joints. Includes requirements for master plug and ring gages. Publication CS21-39. *Superintendent of Documents, Government Printing Office, Washington, D. C.—5 cents.*

UNDERSTANDING THE AUTOMOTIVE DIESEL is a 64-page pamphlet, illustrated with pertinent drawings, which surveys the entire Diesel engine field from the standpoint of American operators and operation. Much of the information (and misinformation) which has been spread regarding Diesel use has been based upon European experience. This booklet has been prepared to dissipate the confusion that has arisen in the minds of many and to present the facts in a way that will permit those who are interested to draw their own conclusions. *Mack Trucks, Inc., 34th Street and 48th Avenue, Long Island City, New York.—Gratis to libraries and educational institutions in quantities up to 25; larger quantities at 10 cents per copy.*

A GUIDE FOR TRUCK DRIVERS is an 8-page folder designed to acquaint fleet owners and operators with the wide range of factors which affect economy and safety in motor-truck operation. It covers briefly yet succinctly the care and treatment of engines, tires, clutches, brakes, and transmissions. It stresses highway safety and courtesy and a number of other topics important to truck drivers. *Dodge Truck Division, Chrysler Corporation, Detroit, Michigan.—Gratis.*

MOST MOTORISTS EARN LESS THAN $30 A WEEK is a 20-page booklet which details a series of facts regarding motor car taxation. These facts are driven home most forcefully by the use of the cartoon method of presentation. *American Petroleum Institute, 50 West 50th Street, New York City.—Gratis.*

THE AMERICAN WAY IN PHARMACY, by George D. Beal, is a nine-page reprint of an article that deals largely with the care exercised by drug manufacturers in the production of materials which find their way into the home through doctors' prescriptions. It is illustrated with a number of photographs that show various steps in manufacture. *Mellon Institute, Pittsburgh, Pennsylvania.—Gratis.*

LEGAL HIGH-LIGHTS

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

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

Crawling Baby

THE representation of a crawling baby, when used as a trade mark, is deceptively similar to a representation of another, even though different, crawling baby, according to a recent decision of the Court of Customs and Patent Appeals.

A prominent manufacturer of babies' rubber pants sought to obtain the registration of a trade mark featuring the picture of a crawling baby and in which a second baby was pictured in stooping position holding and stretching the garment of the first baby. The registration of the trade mark was opposed by another manufacturer of babies' pants who owned a registration featuring a baby in crawling position. The Court recognized that the two marks were different in detail but held that the dominant feature in each mark was the representation of a crawling baby and that unless the marks were placed side to side there was a danger of confusion. Under the circumstances the opposition was sustained and registration of the first mentioned trade mark was refused.

Chinese-American

FEW Americans realize that the United States maintains a court in China where certain of the rights of American citizens and of American corporations in China are determined.

One of the recent cases decided by the United States Court for China involved the well-known American trade mark Coca Cola. Suit was brought by the owner of the trade mark Coca Cola against a competing manufacturer selling a somewhat similar product under the name of Eddie-Kola. The Court concluded that the name Eddie-Kola was confusingly similar to the trade mark Coca Cola and granted an injunction restraining further use of the name.

In the Court's opinion it also appeared that the name Coca Cola was registered as a trade mark in China in Chinese characters and the Court pointed out that the defendant had voluntarily agreed to discontinue the use of the registered Chinese trade mark.

Siphon Capsule

THE configuration of an article is not proper subject matter for the registration of a trade mark, where the configuration serves a useful purpose. This is illustrated by a decision of the Court of Customs and Patent Appeals involving a capsule containing compressed carbon dioxide to be used for carbonating water in rechargeable soda siphons. The capsule consisted of a tubular bulb having a peripheral groove on one side of the central portion. The manufacturer of the capsule contended that the groove constituted a trade mark and he attempted to register it in the United States Patent Office. The Commissioner of Patents denied the registration on the grounds that the groove served a useful purpose and the decision of the Commissioner was affirmed by the Court.

In reaching its decision the Court referred to a mechanical patent disclosing a capsule of this character, in which it stated the groove served to hold the capsule in proper position in the holder provided on the soda bottle. Under the circumstances the court stated:

"We are unable to escape the conclusion that the groove as an entity possessed utility and, for that reason, under the authorities, is not a proper subject for registration as a trade mark."

Cleopatra

THE personal habits of the famous Egyptian queen, Cleopatra, were discussed in a recent suit for patent infringement. The suit was filed by the owner of a patent for a cleansing cream containing milk and it was charged that the defendant had infringed the patent by making similar cleansing cream. One of the defenses raised was that milk served no useful purpose in the cleansing cream and that in order to be patentable an invention must be useful rather than frivolous. In answer to this defense the patentee contended that milk applied to the skin tended to whiten it and referred to the legend of Cleopatra taking daily milk baths claiming that this made her "the only white woman in a dark-skinned race."

The Court, however, rejected the legend as a myth, held that milk did not have a whitening effect on the skin, and declared the patent invalid. In this connection the court stated:

"But it is well known that milk does not have a whitening effect; that the story of Cleopatra and her milk baths is a pure myth."

Mein Kampf

THE well-known book, "Mein Kampf," by Adolf Hitler, is at present involved in a legal struggle in the Federal Courts. The publisher of an authorized edition of the book owned the United States copyrights thereon and brought suit against the publisher of an unauthorized edition. Pending the final determination of the suit the Court was asked to grant a preliminary injunction restraining any further distribution of the unauthorized version. The injunction was opposed by the publisher of the unauthorized version on the grounds that at the time that the copyright was obtained Adolf Hitler was not a citizen of any country but, on the contrary, was stateless and on the further grounds that Adolf Hitler had not formally assigned his copyright.

The trial court denied the injunction but an appeal was taken to the Circuit Court of Appeals which held that the United States Copyright Law broadly extended the right of copyright to both aliens and citizens and that no restrictions were placed upon a person who was stateless. The only restriction or limitation was placed upon an alien who was a citizen of another country. Under those circumstances it is necessary that the alien author either be domiciled in the United States or that he be the citizen of a country which extends reciprocal privileges to American citizens.

With regard to the title to the copyright the Court of Appeals held that Adolf Hitler had delivered the manuscript to the publisher's predecessor in title and that the delivery of a manuscript under such circumstances constituted a transfer of the legal title to the manuscript. The injunction was accordingly granted pending the outcome of the trial.

Co-pending

WHAT is the effect of an earlier patent, which discloses but does not claim an invention, upon a later patent granted to the same patentee which does claim the invention? This question arose in a recent suit involving a patent for a method of forming rubber tires. It was contended by the defendant that the patent in suit was invalid because the same invention was disclosed in an earlier patent granted to the same patentee. The Court rejected this contention, however, pointing out that the applications for the two patents were copending in the Patent Office and accordingly the earlier patent did not form part of the prior art and did not affect the validity of the patent in suit.

Contempt

ORDINARILY, a person violating an injunction restraining the infringement of a patent cannot be placed in jail but is merely subject to a fine which is intended to indemnify the patentee. This is illustrated by a recent suit involving a patent for a frozen confection. On consent of the defendant an injunction had been entered restraining the defendant from infringing the patent. Thereafter, the owner of the patent contended that the defendant had violated the injunction by continuing to sell infringing articles and instituted proceedings to have the defendant adjudged in contempt of court.

The trial court found that the defendant had violated the injunction, adjudged he was guilty of contempt of court, and committed him to jail. An appeal was taken to the Court of Appeals and the decision of the trial court was reversed. The Court of Appeals pointed out that the contempt proceedings were prosecuted by the attorney for the patentee and accordingly were proceedings for civil contempt as distinguished from criminal contempt. In civil contempt proceedings the court held that a party could not be committed to jail.

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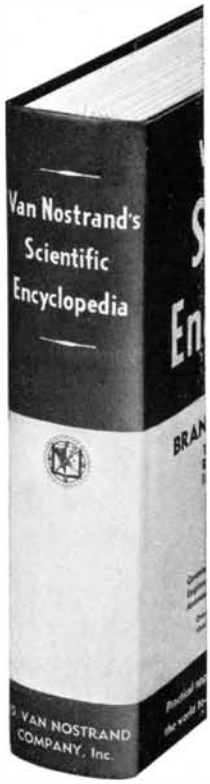

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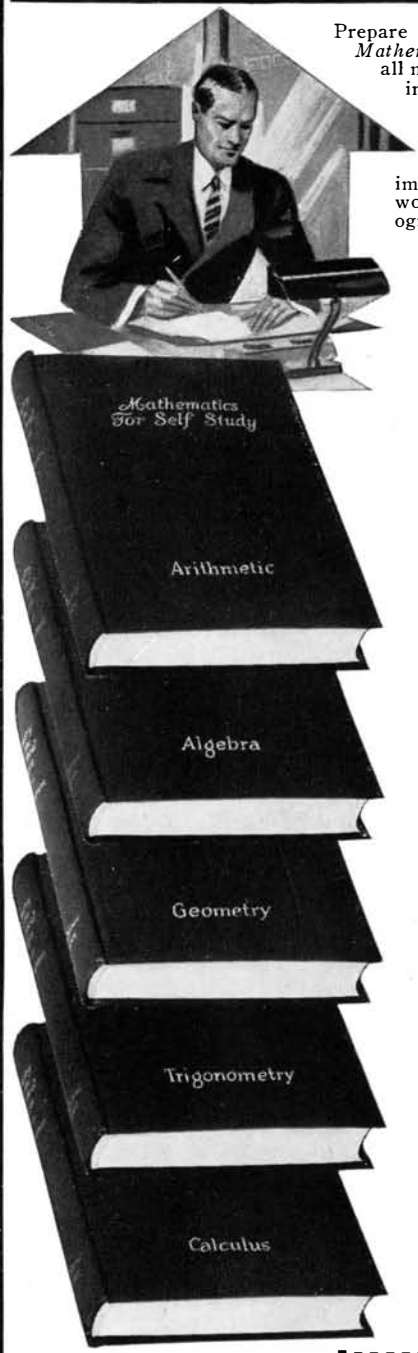

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