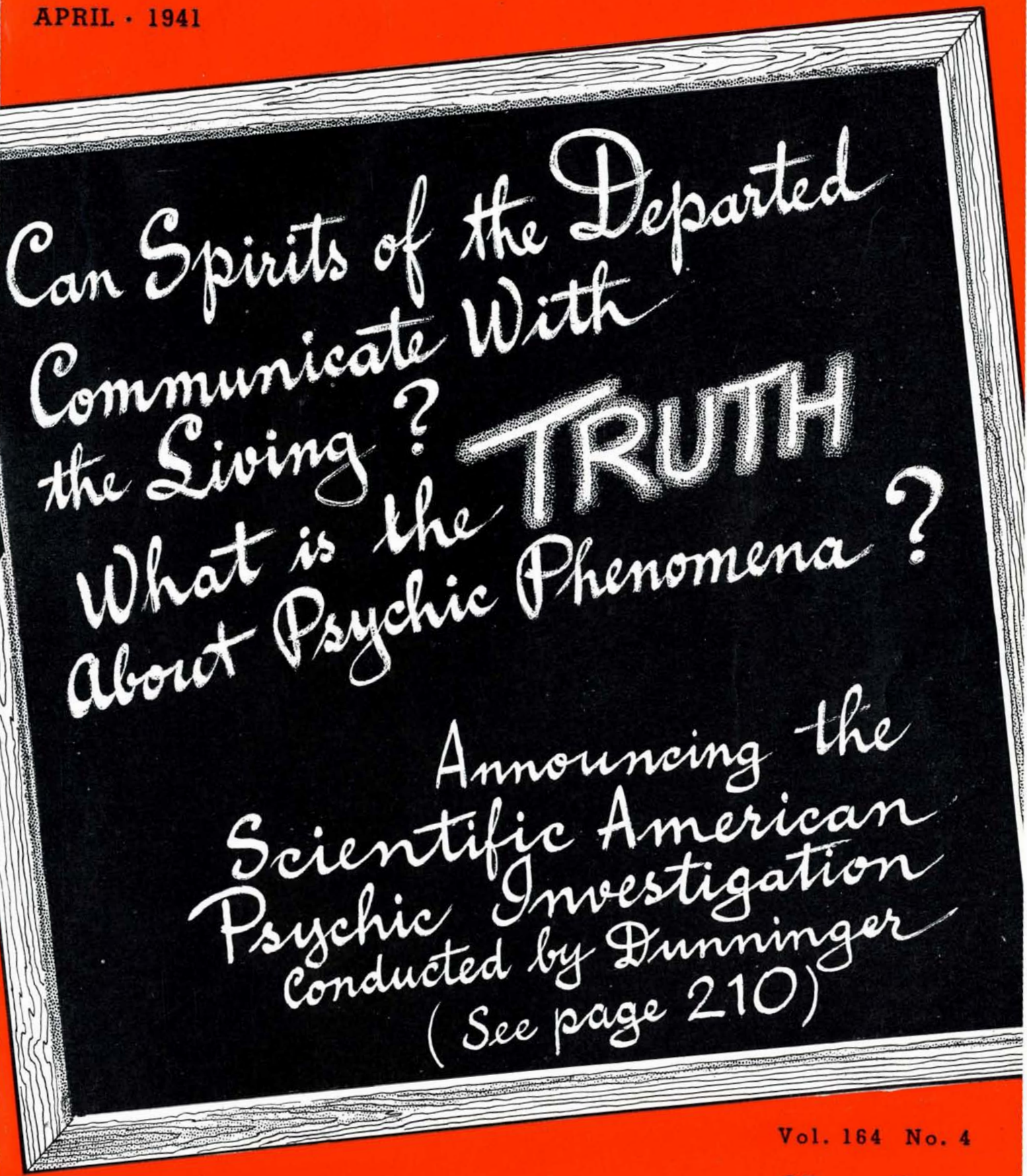
SCIENTIFIC AMERICAN

APRIL · 1941



Vol. 164 No. 4

35c. a Copy
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Feature Articles and Shorter Notes

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Men against fire

(A story of day-to-day progress in automotive research)

ANY FIRE CHIEF will tell you that the speed with which he can get to a fire is as important as the skill and courage of his men in actually fighting a blaze. Today the greatest help in saving vital minutes is modern gasoline-driven fire equipment. Picturesque as was the old horse-drawn fire engine with its smoking boiler, it could not attain the speed of modern equipment nor could it pump the torrents of water required in modern fire-fighting.

Each successive improvement in automotive engines and their fuels has aided not only the fire-fighters of America but also the users of all other kinds of automotive vehicles.

Since the tendency of fuel to knock has been a limiting factor in the design of more efficient engines, the steady rise in the anti-knock (octane) value of gasoline has played and will continue to play a vital part in this progress. Each advance in gasoline anti-knock quality can be utilized by the automotive industry to produce engines of still greater power, performance and economy. Thus the use by oil refiners of Ethyl's product, *tetraethyl lead,* as an anti-knock ingredient in gasoline, contributes to the day-to-day improvement of automotive equipment of all types.

Because engines and fuels are inseparably related in their further development, Ethyl research workers are cooperating with technical men in both the automotive and petroleum industries. The Ethyl laboratories at Detroit and San Bernardino are helping to coordinate the developments of both industries and are contributing the results of many tests and experiments with possible future fuels and engines. At the same time our service engineers in the field are working with many commercial users of engines and fuels in the practical application of laboratory findings.

To engineers in every phase of automotive development we extend an invitation to avail themselves of our research and service facilities. Ethyl Gasoline Corporation, Chrysler Building, New York City.

TO all those who claim supernatural powers—whether they be spiritistic mediums, table tippers, or whatnot—Scientific American offers an opportunity to prove their claims. In a search for the truth regarding psychic phenomena in general, there is offered through this magazine a total of $15,000, under the rules laid down on page 210 of this issue.

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SCIENTIFIC AMERICAN

Owned and published by Munn Company, Inc.; Orson D. Munn, President; I. Sheldon Tilney Vice-President; John P. Davis, Secretary-Treasurer; all at 24 West 40th Street, New York, N. Y.

NINETY-SEVENTH YEAR • **ORSON D. MUNN, Editor**

APRIL • 1941

SCIENTIFIC AMERICAN, April 1941. Vol. 164, No. 4. Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879; additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York City.

Subscription rate $4.00 per year. Canada and foreign $5.00.

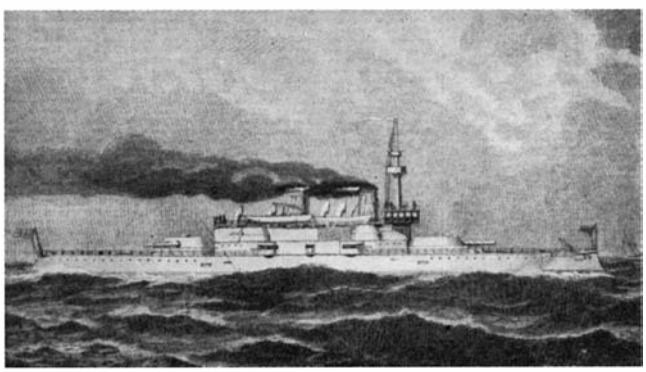
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of April, 1891)

PROTECTION—"No man objects to paying money to have his house insured against fire, though he never expects it to be burned, nor should he object to the slight tax necessary to insure his house, his business, his country, against the transgressions or the possible transgressions of an enemy. . . There is no greater temptation to malevolents than an undefended people; a country with unprotected shores is an invitation to all the thieves and robbers of the world."

BATTLESHIPS—"The unnamed battleships, Nos. 1 and 2, are now in course of construction at the Cramp shipyard in Philadelphia. The contract calls for their completion by Nov. 30, 1893. . . These vessels are to be built of steel; to have a double bottom for the distance of 196 feet, extending the length covered by the machinery and magazine spaces; all the vital portions to be amply protected; every feature being provided to enable them to cope successfully with vessels of the heaviest armor and armament. The forward and after turrets for the 13 inch guns mark the extremities of obstructions upon the main deck. . . Between the turrets for the 13 inch guns there is a superstructure in which are placed the 6 inch guns; and above, or upon the deck erected thereon, are placed the 8 inch guns. A battery of 6 pounders is arranged along the top of the hammock berthing and bridge, and 1 pounders are placed forward and aft on the berth deck. The double-topped military mast is cone shaped, placed on top of the conning tower just abaft of the forward 13 inch gun turret, two 1 pounders being placed in the lower and two Gatling guns in the upper top."



BEST MECHANICS—" 'Americans are the best mechanics in the world.' This assertion was recently made by an English scientific journal of high authority, and so true it was that it has remained uncontradicted. Indeed, European journals abound with descriptions of American accomplishment in the domain of applied science, and the detail of American practice and American criteria prevail to a very important extent in European workshops."

NATURE'S HINTS—"One hundred years ago Galvani published a description of certain phenomena, which were the first indicators of the mode of energy now known as electricity. And a century hence, when our successors look back on our work of to-day, what will most engage their attention is not the great industrial achievements of which we boast, but the conscientious following out of some mysterious hints of nature, as mysterious as were the twitchings of the frog's legs suspended from an iron balcony in Bologna in the year 1787."

CAVALRY—"Too much cavalry, so it is claimed, is a serious defect of the German war establishment. . . 'Cavalry armed with sword and lance, like the uhlan,' says a general of divison, writing on the subject, 'is more likely to encumber an army than to advantage it.'. . . He believes it to be the province of cavalry to reconnoiter and force an unestimated enemy to show his strength, and would have wagons carrying infantry to storm fortified places during aggressive reconnoitering."

SMOKE ABATEMENT—"Something over a year ago the municipal authorities of Chicago began to move in dead earnest against the owners of steam-making plants, manufacturers, railroads, hotels, etc., for their constant violations of the ordinance which declared the emission of volumes of black smoke from chimneys, smoke stacks, etc., to be a nuisance. . . The result has been that the nuisance has been to a large extent abated. This has been accomplished very largely by the use of devices which force jets of air in sufficient quantities into the furnace to secure complete combustion. This method has proved satisfactory on both locomotives and stationary engines, and has helped largely to clear the atmosphere of Chicago from the black smoke which soft coal produces."

NAVAL BUILDING—"As many years are now required as months formerly to build and arm a modern battleship. What folly, therefore, to talk of creating a navy in an emergency. If we are to have a navy at all, let us have one that can whip the enemy if we must fight, and one that will be a school of the highest form of mechanical education if we shall be blessed with peace. The country's naval strength cannot be reached and maintained by impetuous and spasmodic effort; it can only result from a well determined programme of such magnitude and duration as will induce our manufacturers to make the requisite provision for such a supply as will secure and reward their best efforts."

POPULATION—"If the United States had a density of population equal to that of Rhode Island, the population of the Union, instead of being 62,622,250, would reach the enormous sum of 945,766, 300, or nearly two-thirds of the present population of the world."

FROM AN ADVERTISEMENT—"The American Bell Telephone Co. 95 Milk St., Boston, Mass. This Company owns the Letters Patent granted to Alexander Graham Bell, March 7th, 1876, No. 174,465, and January 30th, 1877, No. 186,787. The transmission of Speech by all known forms of Electric Speaking Telephones infringes the right secured to this Company by the above patents, and renders each individual user of telephones not furnished by it or its licensees responsible for such unlawful use, and all the consequences thereof, and liable to suit therefore."


READY WHEN NEEDED
This country has the best telephone equipment in the world and there's plenty of it.
There's plenty of it for the every-day needs of millions of telephone users — with something to spare for emergencies.
For the Bell System has two things of special value these days. It has experienced, adequate manufacturing facilities and a nation-wide distributing organization.
Both are handled within the Bell System by Western Electric. This has been a good policy for a generation. Never have its benefits been so clear as right now.
BELL TELEPHONE SYSTEM
THE BELL SYSTEM IS DOING ITS PART IN THE COUNTRY'S PROGRAM OF NATIONAL DEFENSE

WHAT ABOUT ALUMINUM?

CHARGES of monopoly, of purposely restricted production, of hindering the defense program of the United States, have been leveled against the Aluminum Company of America, causing some people to doubt the advisability of permitting the production of a single commodity to remain in the hands of one large and coördinated group. But let's take a look at some figures and facts.

When, in 1886, the Hall electrolytic method of extracting aluminum was developed, the raw metal price dropped from some $16 a pound to $5. By 1925 the price was down to 27 cents a pound, by 1939 to 24 cents, and by 1941 to 17 cents. So much for cost. How about production? Without going into history, it is sufficient to state that aluminum production more than doubled from 1929 to 1940; in the former year it was 200,000,000 pounds annually, while in the latter it was 413,000,000 pounds annually. Projected figures show that, contrary to widely published reports, aluminum production is now, and will continue to be, well ahead of demand. In January 1941 this was in the ratio of 52 to 47 (millions of pounds per month). By January 1942, it is estimated that the ratio will be 66 to 61, and by July of the same year 70 to 61.

Where, then, is the discrepancy, the basis for charges of restricted production, insufficient supplies? Apparently it arises in the reports that some projects, both defense and civil, are being delayed by lack of aluminum. Here it must be kept in mind that the Aluminum Company of America is voluntarily following priority instructions from Washington and cannot guarantee supplies to any consumer not properly taken care of under this arrangement. The Aluminum Company is now the only producer of the metal in this country (but Reynolds Metals Company will enter the field next year), while there are hundreds of fabricators producing a wide diversity of aluminum parts. If only a few of these fabricators find themselves without raw material, there will be sufficient complaints to confuse the issue.

From the figures given above it is safe to say that there is no shortage, present or impending, of raw aluminum, insofar as defense needs are concerned. And no shortage can possibly develop unless unforeseen events transpire. True enough, there is definitely a curtailment of aluminum for certain civilian uses during the peak period of the present emergency. If, however, government and all branches of the industry co-operate fully to prevent too much of the metal from flowing into non-essential channels, every requirement of national defense will be met, with a minimum of suffering on the part of those whose business interests lie in civil fields. —*A. P. P.*

EXPERIENCE VERSUS INTELLIGENCE

THE right man for the right job is a problem that has bedevilled business and industry from the very beginnings. In isolated cases some effort has been expended in an endeavor to solve the problem in a sane, equitable manner, but, for the most part, jobs are still filled on the basis of experience on the part of the applicant. If, in the past, he has had experience in the type of position that is open, he probably gets the new job. If experience is lacking, he doesn't.

Is this system fair either to the employer or employee? Not entirely, and on it rests much of the blame for the many square pegs that are trying to fit themselves into round holes. Of far more importance than experience is the prospective worker's intelligence, adaptability, mental capacity. Experience, of course, will allow him to muddle along in a routine job, turning out a mediocre performance. Intelligence, and all that goes with it, however, will enable him to grasp quickly the requirements of a particular job and in a short time do it with greater efficiency than the man with more actual experience but less basic intelligence.

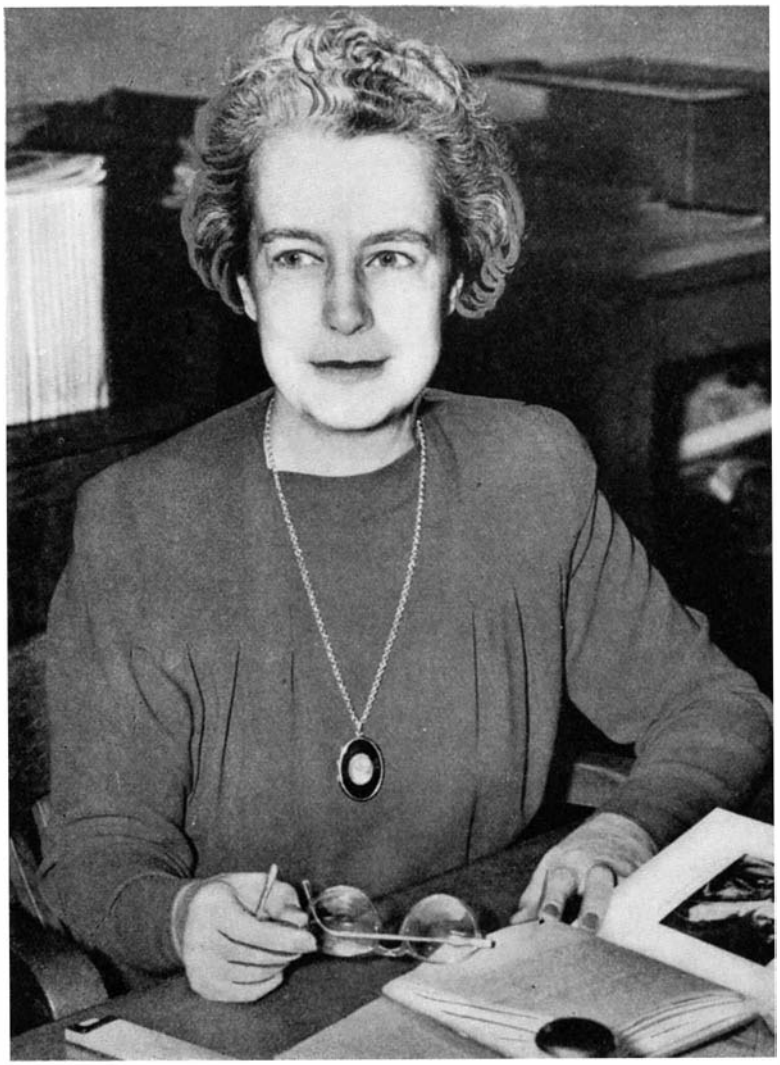
Here is where business and industry too often fall down in the matter of providing themselves with satisfactory personnel. Through their own employment departments, or with the aid of employment agencies, they attempt to fill jobs by the old method of listing the applicant's previous experience. This, coupled with name, address, date of birth, nationality, and other relatively unimportant data, is the sole basis on which a man's fitness for the job is determined.

Applied psychology can do much to change this picture, to serve the best interests of all concerned. School systems of the United States have pointed the way toward methods of determining mental capacities of children, as differentiated from their absorption of knowledge. By methods available it is possible to sort human beings almost as surely as the photo-electric system sorts beans, rejects improperly wrapped cigars, or spots imperfect wrappings in a complicated packaging machine. And by sorting human beings properly it is possible to contribute to all phases of business and industry from the happiness of workers to the happiness of the stockholder when dividend day rolls around.

There can be no question about the lack of economy — in whatever terms one may wish to assign to the results — to be found in the inefficiency of employees who, however experienced, do not bring to the job an intelligence rate that makes it possible for them to accomplish their assigned tasks in the best possible manner. Misplaced talent can do as much to slow up production, increase costs, as can the most carefully planned sabotage.

If employers continue to stress experience of potential employees to the exclusion of innate intelligence, they can have only themselves to blame for inefficient operation. Only by opening their eyes and realizing that there are available far better and more efficient methods of placing the right man in the right job can they take full advantage of the rich source of idle and misplaced talent that is available today.—*A. D. R., IV.*

Personalities in Industry



MARGARET INGELS, M. E.

CREDITED with being the first woman in the world to obtain a mechanical engineering degree, Margaret Ingels claims it was no particular astuteness on her part that led her into the engineering field, but only "plain, dumb obedience to my family's wishes." However that may be, associates who have known Miss Ingels for many years claim that her interest in air conditioning—a direct result of her engineering training—started when she was a youngster. The story goes that when she observed moisture collecting on a cold glass, her curiosity was aroused. Her mother was unable to explain it satisfactorily, so young Margaret resolved some day to find out for herself. When she did find the answer—which is merely the principle of condensation—her interest in science and engineering became even more pronounced.

Miss Ingels' work in the air-conditioning field was recognized recently when she was honored at the Women's Centennial Congress as one of the "pioneers" in the evolution of women's careers in the past century.

Miss Ingels, at present Engineering Editor of Carrier Corporation, Syracuse, New York, is the author of numerous articles on air conditioning for magazines and technical publications. Her lectures on air conditioning, well-known for their clarity and non-technical language, have been attended by thousands all over the country.

Born in Paris, Kentucky, Miss Ingels was graduated from the University of Kentucky in 1916. Known as "one of Dean Anderson's boys" at the University, she later obtained a master's degree in engineering after three years of practical experience and a thesis accepted by Graduate School, University of Kentucky.

The Traffic Engineering Department of the Chicago Telephone Company was the first to employ Miss Ingels, which position she left in 1917 to go with Carrier Corporation in New York. Four years of experience with the pioneer air-conditioning company afforded her a valuable start even over many men engineers.

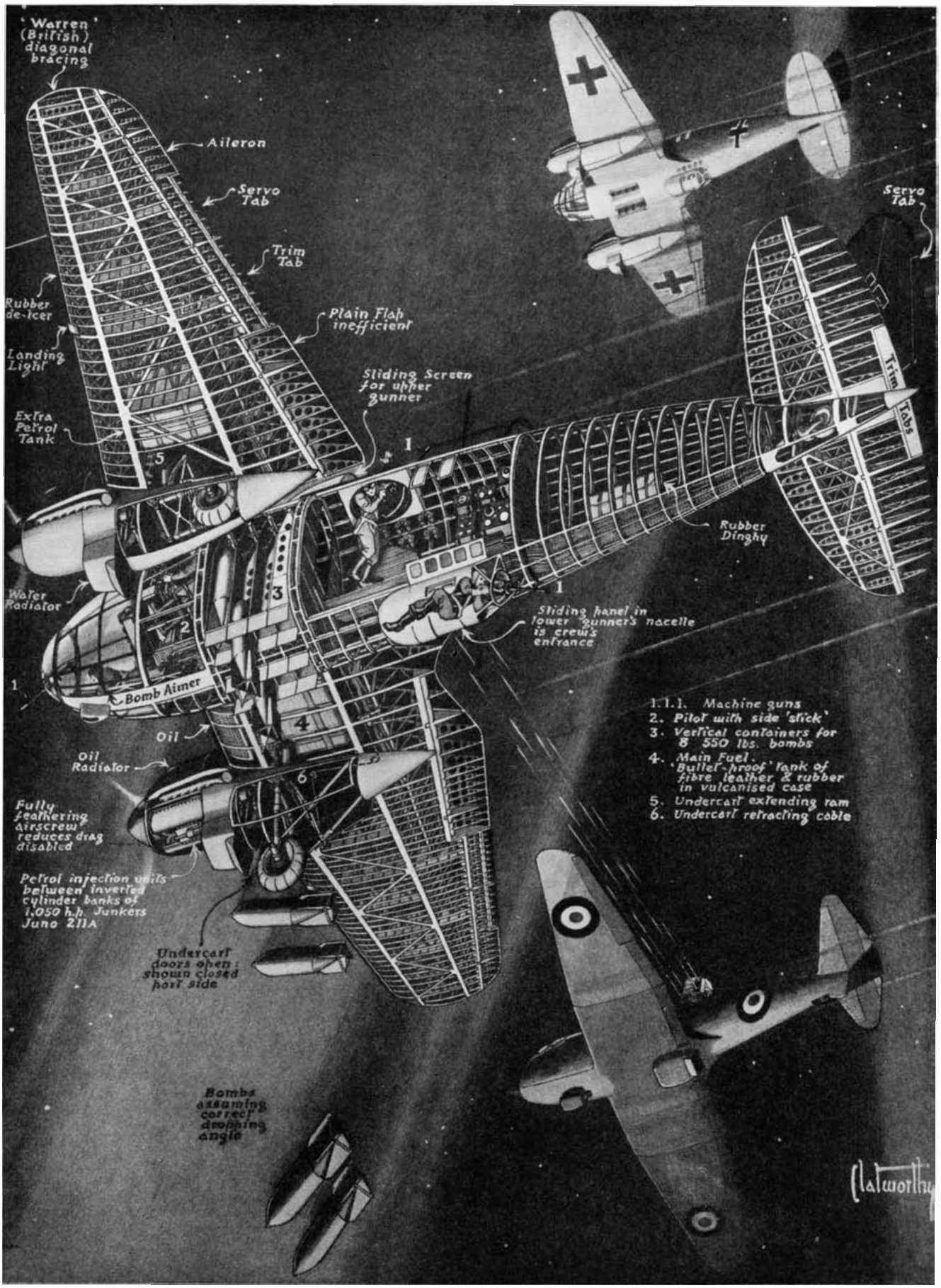
The Research Laboratories of the American Society of Heating and Ventilating Engineers at the United States Bureau of Mines, in Pittsburgh, called her next. From 1921 through 1926, her projects included atmospheric dusts, the infiltration of air through building walls and around building openings, and the physiological reactions of humans in various air conditions. During this time several of her papers on these subjects were published in the transactions of the American Society of Heating and Ventilating Engineers.

Research problems again claimed the attention of the woman air-conditioning expert. This time it was with the New York Commission on Ventilation that Miss Ingels performed field research engineering work in Syracuse, New York. Her study was to correlate health and attendance of school children to various types of ventilating systems.

Since 1929, Miss Ingels has been employed by the Carrier Corporation of Syracuse. Her past experience in the field, added to several years of engineering work in the home office of Carrier Corporation, has provided her with the ability to pass on all engineering information originating in this company.

In addition to these articles and lectures, Miss Ingels' work on air conditioning is cited in the current edition of the "Encyclopedia Britannica," which mentions her findings on the value of the Kata Thermometer in Effective Temperature studies.

Proving that she is not all engineer, Miss Ingels is an expert bridge player and an above-average golfer. An ardent alumna of the University from which she was graduated, she is also a fan and ardent supporter of that school's football team.



A BOMBER TYPE FREQUENTLY SEEN OVER LONDON

MAIN feature of this drawing shows structural elements of a German Heinkel bomber. Further details will be found on page 230.

97TH YEAR SCIENTIFIC AMERICAN APRIL 1941

MILK MADE MORE DIGESTIBLE

Homogenization Eliminates Separation of Cream

BARCLAY MOON NEWMAN

JUST as the Cheshire cat in "Alice in Wonderland" faded until only the grin was visible, so the cream line in homogenized milk is gone—leaving behind, as pleasing though somewhat intangible evidence, a creamy richness spread throughout the milk. The essential change which has been brought about in your bottle of ordinary milk is the perfectly balanced distribution of the cream so that it does not rise to the top but remains in the same concentration throughout.

The cow doesn't give milk with an upper cream layer ready to pour off for your coffee. For this, the baby calf can be thankful; he doesn't have to compete with his brothers and sisters for the cream-layer nutrients which include essential fat-soluble vitamins A, D, and E. It is only afterward, of course—while the milk stands—that the cream line appears. So homogenization is a sort of return to Nature. It provides you, and baby, and the family in general with milk having the nutritious cream and its vitamins as evenly distributed as when first drawn from its source.

The microscope tells the secret. As the eccentric, pioneer Dutch lens grinder and microscopist, Van Leeuwenhoek, remarked in one of his famous communications to his London scientist friends in 1674, milk just as the cow gives it, that is, freshly drawn milk, contains a lot of little globes of fat—fat globules—of different sizes so thoroughly mixed with the rest of the milk that any drop of milk is precisely like every other drop, whether taken from top or bottom of the bottle. Now, allow the milk to stand for a few hours; then examine again through the lenses. The larger fat globules, including those formed by the coalescence of smaller droplets, have risen to ride atop what is now skim milk—milk minus most of the cream and fat-soluble vitamins. This makes it easy for you to rob the milk of the

major part of its creamy richness, fat-soluble vitamins, and best flavor—simply by pouring off the floating globules.

Even in skim milk produced by pouring off the cream layer there are, however, many millions of fat droplets. The very tiniest, still remaining because they are so fine that they do not separate out, are small enough to be held, even after long standing, by weak electrical forces and the weak attraction of the invisible hosts of molecules—protein, milk sugar, mineral salts, water-soluble vitamins—in solution and suspension all around and about.

In freshly drawn milk, the fat globules vary in size from a diameter of 1/250,000 of an inch up to slightly more than 200 times this diameter. The vast majority are less than 1/2500 of an inch in diameter, the average being about 3/25,000 of an inch. The fat globules remaining in skim milk are below this average, and therefore, if you could subdivide all the globules in freshly drawn milk so that their diameters were less than 3/25,000 of an inch, the cream layer would not form. That is, the fat would be in such a fine state of dispersion that the tendency to rise would be counteracted by the weak attractions and electrical forces which hold down the tiny globules left in skim milk.

This idea occurred to the Parisian technologist, Gaulin, and by 1899 he had invented the first homogenizer to break up the coarse fat globules into fine ones and thereby prevent the formation of the cream layer. So homogenized milk—at least as a scientific development—is not new. It is 42 years old, in the technical sense. Hence it has been tried, tested, and perfected, so that, when recently introduced to the public in this country, this newborn infant of the milk industry rapidly grew to giant proportions.

GAULIN'S principle is simple. It may be roughly illustrated by turning on a garden hose, adjusting the nozzle so that the water squirts out with maximum force, and then holding the nozzle close to a wall. The stream of water is "atomized" and a very fine spray flies in all directions. Gaulin set up a bank of hair-fine tubes—capillary tubes—and, using a pressure of 3500 pounds per square inch, forced milk through them and up against a concave metal surface. The larger and even most of the smaller globules were shattered by the force. As later determined, the greater part of the fat was broken into globules of less than 3/25,000 of an inch. To his satisfaction, Gaulin noted that, even on long standing, the homogenized milk formed no cream layer.

Most commercial homogenizers have been developed along similar lines. Several pumps, often as many as six, operating in succession, build up the pressure to 2000 or 2500 pounds per square inch, so that the milk speeds through fine

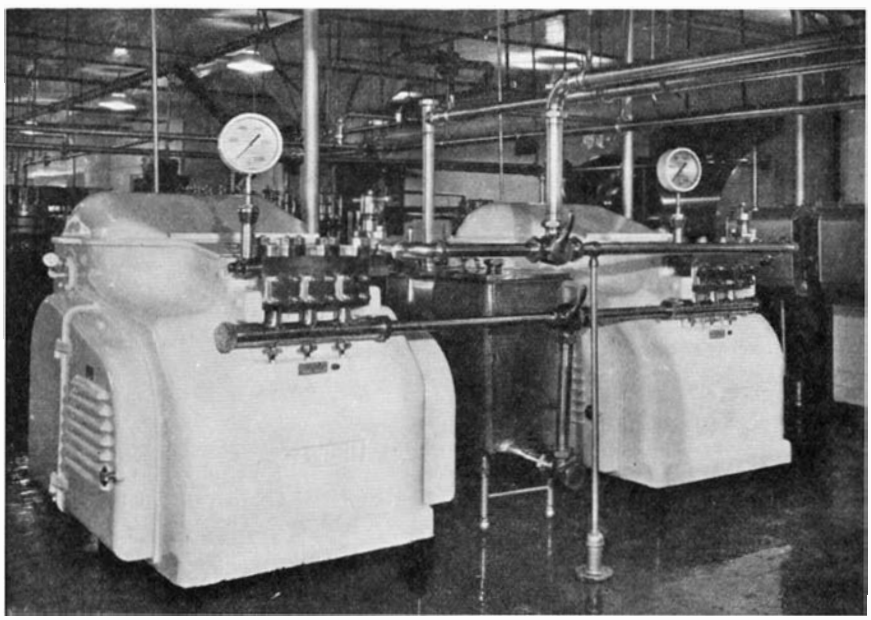
slit-like orifices at a speed of nearly a mile a second, to strike with a globule-bursting momentum against smooth metallic surfaces. The pressure at which the milk is homogenized is regulated by the size of the openings in the homogenizing valves and, because of the scientifically calculated efficiency of the new machines, it does not have to be as great as the pressure originally used by Gaulin.

High intensity sound waves are also applied to achieve homogenization. The milk flows over a diaphragm made to vibrate with ultra high frequency, and the big globules become little ones as they explode because of violent agitation set up by the inaudible "sound." This particular type of homogenized milk is known as "sonized milk." Properly processed, the product is in all respects like homogenized milk manufactured by the Gaulin method.

HOMOGENIZATION changes the properties of milk in several different and highly advantageous ways. The whole content of the bottle has assumed a creamier, a richer, appearance. This increased creaminess includes an increased viscosity, just as though the milk were thin cream—as you can tell when you pour homogenized milk from the bottle.

The flavor, too, is altered—improved palatability results from homogenization. Although, of course, "there is no disputing about tastes," since taste preferences are eminently individual, still it has been established by extensive surveys that most people do prefer milk with the new flavor. Taste preferences cannot be measured in the laboratory, but homogenized milk tastes like "cream-rich" milk —just what it is. The best indication of the popularity of the new flavor is to be found in the increased drinking of milk among consumers of homogenized milk. Further, taste idiosyncrasies have kept many persons from drinking much, if any, milk. Now many of these individuals enjoy their milk —homogenized. The universally recognized nutritional and health-promoting values of milk have thus been introduced into the diets of a great number who hitherto denied themselves milk. The health significance is most obvious in the case of children. Health value is attached to any factor that induces a balky offspring to imbibe more of this highly protective food.

Another practical nutritional aspect of homogenized milk has been brought out by authorities on nutrition among school children. One study in schools, where milk is served to children in half-pint bottles, showed that an average of 5.6 percent of ordinary milk is left in the bottle. As the milk specialist, Dr. C. J. Babcock, points out: "This, in itself, would be insignificant, but when we consider that this 5.6 percent of the milk represents nearly 16 percent of the fat in the 4-percent milk served, it throws a little different light on the loss."



Two homogenizers of the type that work on the Gaulin principle. Inside are driving motors, transmissions, and pressure plungers that work in cylinders in the three-part "heads" seen outside. The milk is squirted at high velocity against solid metal, its fat globules emulsified

The curdometer for measuring the degree of softness of milk curds like those in the stomach

These children—as do so many in schools — drank their milk through straws inserted into holes in the bottle caps. The milk at the bottom of the bottle was thus taken first, and then finally only some of the richer milk and cream at the top. Much of the cream with its vitamins was left.

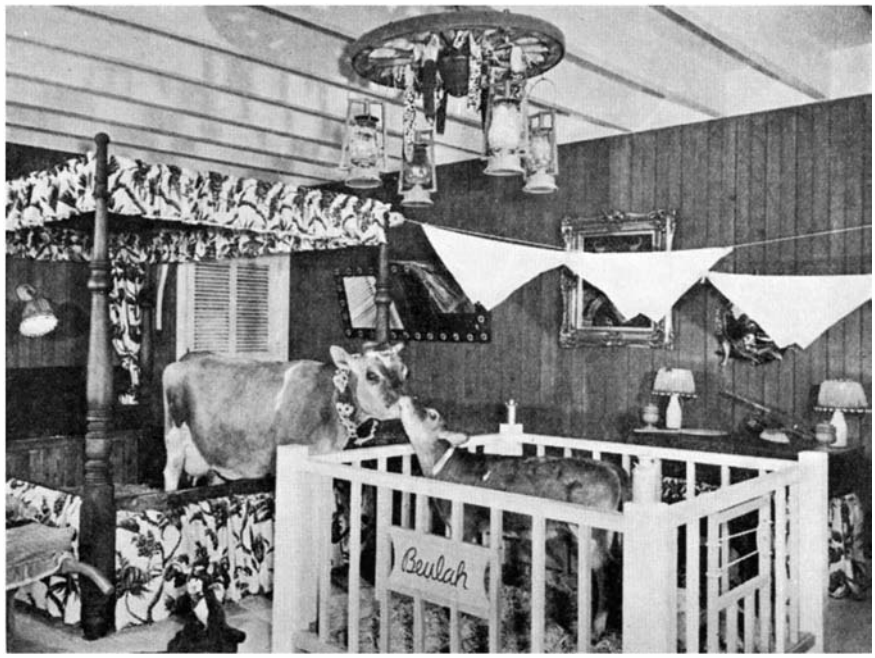
In the home, babies and older children are not so sure of getting their due quotas of *whole* milk and vitamins from unhomogenized milk as from homogenized. Cream is taken for coffee, or the cream goes into the first glass of milk, perhaps to the nutritional benefit of the maid or cook.

OF MUCH greater interest, however, especially to pediatricians, is the problem of curd tension in relation to the advantages of homogenized milk. When milk enters the stomach, the first phase of digestion is a clotting or coagulating process resulting in the formation of curds—hard or soft, depending on the milk and its previous treatment. Milk giving a soft, flaky curd is most suitable for infant feeding and most desirable for adults who may experience an unpleasant feeling of fullness for hours after drinking milk.

The measurement of curd tension provides a means of expressing scientifically the degree of toughness or firmness of the clot or curd. In measuring curd tension, milk is placed in a jar containing a special knife having ten radial arms one inch long and attached to a vertical rod, which is connected with a delicate spring balance.

Clotting is brought about by the addition of pepsin (a digestive ferment from the stomach) and dilute hydrochloric acid. These substances are stirred into the milk, and the mixture is kept warm (35 degrees, Centigrade) for 10 minutes, during which time a clot is formed. Then, with slow, even tension, the knife is drawn through this curd. The reading on the balance, minus the pull of the knife itself, indicates the curd tension, expressed in grams (one ounce being about 30 grams). A curd tension of less than 20 grams (about two thirds of an ounce) is indicative of soft curd milk, according to accepted standards; a curd tension of more than 20 grams indicates hard curd milk. Average mixed milk shows from 50 to 90 grams of curd tension, but curd tension varies in the same cow's milk, is higher in winter than in summer, and may be as high as 200 grams. Less than 1 percent of cows give soft curd milk naturally.

When the curd tension is more than 50 grams, as it generally is in the case of unhomogenized milk, the clot is tough, leathery, and slowly digested. Soft curd milk, on the other hand, is readily made into a loose mush, and therefore is more quickly digestible, as the stomach's motions during digestion can readily intermix the clots with the digestive juices and expose the surfaces of the countless flaky curd particles to the action of the stomach's ferments.



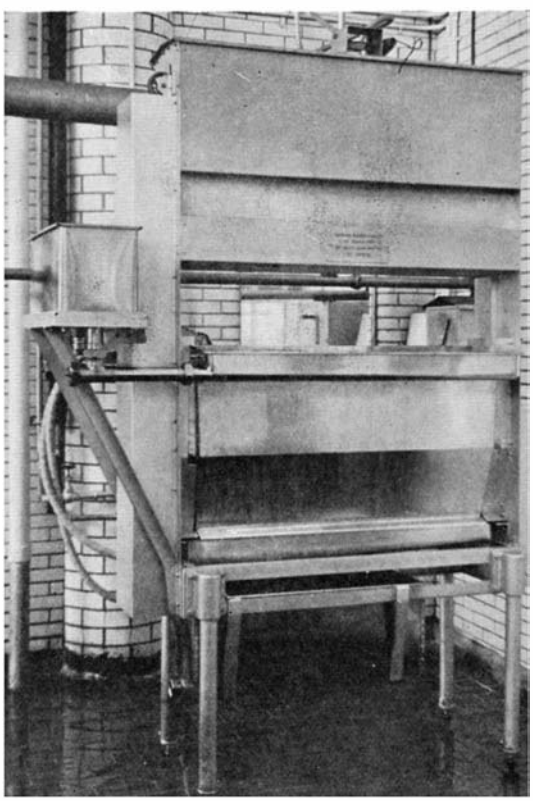
Elsie, the nation's pet, with Hollywood-born daughter Beulah, in their boudoir at the World's Fair. Like all other cows of high, common, or no social rank, Elsie gives homogeneous milk which Beulah thinks ideal, but when filched by man, its fats will soon separate unless homogenized

Dr. Irving J. Wolman, of Children's Hospital, Philadelphia, who has made extensive studies of homogenized milk in infant feeding, tells us: "The process of homogenization reduces the curd tension of milk and renders it of value in infant feeding. But not all homogenized milks are alike. Destruction of the cream line does not necessarily mean a soft curd milk. The homogenization must be done thoroughly and carefully. When that is done, the curds are adequately small, the curd tension comes down, and it is possible to feed such milk with the absence of the symptoms of indigestion attributable to large, tough curds."

Dr. Wolman's associate, Dr. Leslie A. Chambers, of the University of Pennsylvania, has developed a new device for measuring curd tension—a curdometer—and Dr. Wolman himself has invented artificial stomachs made of rubber, wherein digestion can be investigated under conditions closely simulating those in the human stomach. With this new equipment he has been able to demonstrate more clearly the soft curd characteristics of high-pressure homogenized milk, and to show that homogenized milk is even more quickly digested than ordinary milk—all milk being highly digestible, though speed of digestion may vary.

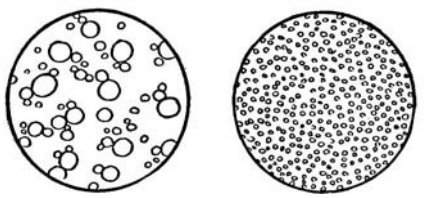
How can you be sure that your bottle of homogenized milk actually has the cream content claimed, since you can't assay the richness of the milk in the absence of a cream layer? Of course, there is the zeal with which the leading milk companies guard their reputations and the health of their customers. There also is the simple test for butterfat content, and there are the health regulations in constant operation.

THE most convincing tests, however, you can perform yourself. Pour out a glass of homogenized milk; note the creamy appearance



Often homogenized milk is also irradiated with ultra-violet rays to increase its vitamin D content. A typical commercial installation (Borden) as developed by the Wisconsin Alumni Research Foundation. From tank, milk flows in thin sheet over inside of sloping metal flow-boards past the internal ultra-violet lamp

and richness. Taste the improved flavor. Drink, and remark the absence of any feeling of fullness while speedy digestion is going on. Feed it to baby and the other children; they, too, like its increased palatability. Let them continue to drink it, and this important addi-



Courtesy The Borden Company

Homogenization breaks up the fat globules into much smaller ones that cannot rise as cream

tion to their protective diet will have its beneficial effects on their well-being, and aid in the attainment of buoyant health.

Noting these qualities, plus the fact that the whole family gets all the advantages of the bottle of milk, you can readily see why homogenized milk has flowed rapidly across state boundaries, and, already in almost every section of the United States, is being poured from increasing numbers of bottles in more households every day.

• • •

ACID BOGEY

We Do Not Eat Too Many Acid Foods

"WE EAT too many acid foods" is an unfounded idea in which many persons have firm faith. They proceed accordingly, and shun oranges, tomatoes, and other good foods—for fear of acid. The taste is acid, but actually these foods and most other fruits and vegetables have the opposite effect when eaten. They tend to counteract acidity. There is no need to worry about acid-forming and base-forming foods, say the nutritionists of the Federal Bureau of Home Economics, if you have a well-rounded diet that includes plenty of milk, eggs, fruits, vegetables, and cereals with some meat, fish, or poultry. It is better, they emphasize, to focus attention on adequate diets than to fret about acid-forming diets.

Along the same line is the fancy about the danger of eating acid fruits and milk at the same meal. It is true that the acid fruits may curdle the milk, but the digestive juices of the stomach have the same effect. So it is perfectly safe to eat cherries and drink milk at the same meal, and to use orange juice in a milk drink.

Another false food idea is that you should not eat different kinds of fruits together because there is danger in combining the different acids. Nutritionists explain that there is no possible harm in fruit combinations. Nature even combines different acids within a single fruit.

POLIOMYELITIS

Infantile Paralysis Victims Helped by New Operation

USELESS muscles of infantile paralysis victims may be given strength for work by a new muscle-splicing operation recently reported by Dr. Herbert E. Hipps, of the Crippled Children's Hospital, Marlin, Texas, to the National Foundation for Infantile Paralysis.

Muscles paralyzed by infantile paralysis sometimes fail to work because of bands of diseased tissue within the muscles, Dr. Hipps and associates discovered. To repair such muscles, he cuts out the bands of diseased tissue, or weaves through them strips of tendon from the bulky part of the muscle, sewing these strips into the good muscle bulk below and above the paralyzed muscle. In six out of 12 cases, good results were obtained with the operation.

Dr. Hipps suggests that if the muscles of an arm or leg are large and firm, yet graded "poor" or "trace" in respect to function, they will probably show the irregular degenerative changes that might be helped by the operation. If, however, the muscles are soft and small, or if no knots are felt, a general degeneration may be present, and the splicing or grafting operation probably would be of no avail. —*Science Service.*

CUT NERVES

Cuff Made From Artery Used to Mend Cut Nerve

THE ends of small nerves that have been cut can be reunited by holding them tightly together in a cuff made from a fragment of an artery, Dr. Paul Weiss, of the University of Chicago, reports in *Science.*

In the case of very tiny nerves, Dr. Weiss states, neat stitching to hold the cut ends together "becomes a mechanical impossibility." Holding these little nerve ends together by ordinary sewing can never be precise enough, he says, to prevent masses of nerve fibers from "escaping into the surroundings and straying off to uncontrollable destinations." These undesirable results, he says, can be avoided by the use of the artery cuffs.

GERM-FREE BATHROOMS

Ultra-Violet Rays Insure Cleanliness

TAKING use of the now well-known sterilizing properties of ultra-violet rays, a device has been developed in the General Electric Company's laboratories for use in sterilizing bathrooms of hotels. First put to practical application by the Hotel New Yorker, this sterilizing device consists of a number of ultra-violet ray generating tubes mounted in a portable unit of the type shown in one of our photographs.

After a guest checks out of the hotel, and the bathroom has been

Sterilizing the hotel bathroom

cleaned by conventional methods, the portable unit is wheeled into the bathroom and placed in operation for 10 minutes. It is then withdrawn from the bathroom and the door is sealed shut by a strip of cellophane, insuring that the bathroom will remain sterilized until the next occupant arrives.

It is claimed that laboratory tests have shown that the Protecto-Ray, as the device is called, is more than 99 percent effective in killing airborne germs.

BROWSING with the Editor

THROUGH THE SCIENCE LITERATURE OF THE WORLD

RATIO OF TWELVE TO ONE—Facts indicate [See also page 214.—*Editor.*] that for each pilot of an airplane in the air, 12 men are needed for ground maintenance work. A defense program involving 50,000 pilots would therefore necessitate 600,000 mechanics, of which only about one in five need not be highly skilled. With a national requisition for a half million real aviation mechanics facing the country, and with only about 40,000 now in the army, the personnel problem becomes tremendous and of vital importance.—*The Tech Engineering News,* January, 1941.

TRACTORS DONT EAT—An estimated increase of 500,000 tractors on American farms during the next ten years will replace approximately 1,500,000 horses and mules. This, in turn, will release for other uses over eight million acres of ground that are now used for pasturage and for raising the necessary hay and grain to feed these animals. —United States Department of Agriculture.

MUSKRAT CROP—The State of Louisiana contains 3,000,000 acres of marshland which produce as high as 10,000,000 muskrats annually. There are 2000 trappers, almost all Acadians, few of whom can read or write, and even fewer of them can speak English. The law allows each trapper 250 traps, and the total income from the Louisiana muskrat industry reaches the fabulous sum of nearly six million dollars a year.—"The Geese Fly High," by Florence Page Jacques.

FROST DOES DAMAGE—Concrete attacked by frost before it has set will harden, but loses up to 50 percent of its strength.—*Highway Research Abstracts,* January, 1941.

YARDSTICK FOR PROGRESS—"Conservation of our national resources" is a phrase applied to methods of preservation and rehabilitation of both inorganic and organic wealth of the nation. As evidence of progress in the latter field, in 1939, the last year for which records are complete, 6,000,000 farmers, operating farms comprising 78 percent of the country's cropland, improved their soil by putting back into it 640,000 tons of phosphate. They applied nearly six million tons of lime, planted 26 million acres of cover crops and green manure crops, planted 41 million acres of new seedings of legumes and grasses, and protected 26 million acres of cropland by contour farming, strip cropping, and modern fallow methods. In addition, they built 354 million feet of terraces, enough to reach two and one-half times around the world.—United States Department of Agriculture.

MATTER OF TIME—If five gallons of gasoline in the tank of your car were an explosive, such as is used in bombing, it would contain much less energy than the gasoline contains; but, since the energy of an explosive is expended in about a twenty thousandth of a second, its rate of expenditure is something like 4,000,000,000,000 horsepower *while* it is actually expending energy.—Prof. D. Bernal, *Engineering* (London) December 27, 1940, page 514.

PHONE CALLS—One phone call a second, 35,000 each working day, are handled automatically by what is conceded to be the world's largest private telephone exchange, located in the East Pittsburgh Works of the Westinghouse Electric and Manufacturing Company. There are 3000 dial phones in the system.

SQUARE OF THE VELOCITY—Striking a solid object at 25 miles an hour will do a car about the same damage as if it had been driven off a two story building. Encountering a stone wall at 50 will be just as serious as if the car had dropped eight stories. A car can make only one fourth as sharp a turn at 50 as at 25, one ninth as sharp at 75 as at 25.—*Stone and Webster Bulletin.*

BEST ASTRONOMICAL CLOCKS—A Shortt clock ran a year so accurately that its accumulated error was only seven tenths of a second, which represents an accuracy of one part in 30,000,000. Another, in the Paris Observatory, had an accumulated error for the year 1927 of only one tenth of a second.—*Journal of the Franklin Institute,* from F. Hope-Jones, "Electrical Timekeeping."

SALVAGING OLD TIRES—A plan is under consideration whereby old used tires are to be salvaged through dealers to economize on raw materials. If consummated, users of tires will be asked to return old tires through their dealers to manufacturers where the old tires can be reconstructed in the original molds at nominal cost.—*India Rubber World,* December 1, 1940.

TINY TUBING—Ingenuity of American technicians has resulted in the production of the world's smallest metal tubing. The outside diameter is less than .0019 of an inch, wall thickness .00075 of an inch, and inside diameter .0004. One pound of the tubing would reach eighteen miles.—*Rose Technic,* October, 1940.

THAT ANSWERS THAT—In his book, "Forecasting Weather," Sir Napier Shaw illustrates a typical atmospheric depression, or "low," of the kind which is involved regularly in our weather changes, and states that its formation required the removal elsewhere of 190,000,000,000 tons of air, the Sun, of course, being the ultimate prime mover in such instances. Commenting on this fact, D. Brunt states that this affords the appropriate answer to the question so often asked, "When shall we be able to control the weather?"—the answer being, "When we are able to stop a mass of 190,000,000,000 tons from going on its own way."—*Nature* (London), December 28, 1940, page 819.

NATURE'S PRODIGALITY FOILED—The female trout scoops a bed in the sand and lays her eggs, but the process is wasteful, for it is doubtful whether more than a fraction of 1 percent of the eggs hatch. In the commercial fish hatchery, however, at least 85 percent of the eggs will hatch.—*Oil Power,* January, 1941.

SHIP BUILDING—A report from the American Bureau of Shipping states that on September, 1940, there was under construction in United States shipyards, to Bureau classifications, vessels to the extent of 1,558,720 gross tons.—*Engineering,* November, 1940.

It's Done With Melamine

Plastics, Surface Coatings, Improved Paper and Fabrics, Stem from Laboratory Curiosity

A. P. PECK

YESTERDAY a rare chemical available only in minute quantities at a nominal price of $40 a pound; today an important industrial chemical available in carload lots at a cost of about 40 cents a pound. Yesterday of no known value; today the base of a whole group of plastic products that are invading a broad range of industrial fields. That, briefly, is the story of melamine. And behind its spectacular rise to fame is a story of industrial accomplishment that may be considered as typical of modern applications of science to industry.

Available today are melamine plastic dishes that are non-shatterable, light in weight, resistant to the effects of foods and beverages: at the time of writing one of the major airlines is waiting delivery of a full complement of dishes for their ships. The use of melamine resins in finishes for automobiles makes possible enamels which are quickly applied, inexpensive, stand up remarkably well under the abuse to which the average motor car is subjected. Paper treated with melamine resin can be made waterproof, as strong when wet as when dry. Fabrics are rendered crush-proof, are given fine finishes and the "handle" of far more expensive goods, by the application of melamine emulsions.

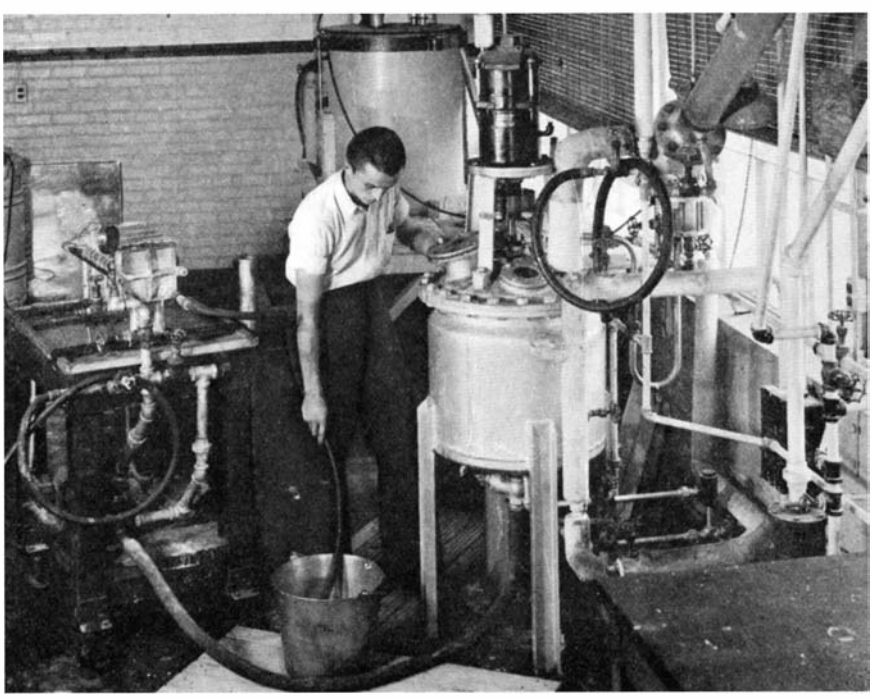
BACK in 1834, Liebig produced a crystalline material which, analysis showed, contained only carbon, hydrogen, and nitrogen, and behaved as a weak base. He called it "melamine," and promptly turned his attention to other and perhaps, to him, more important researches. For over a century melamine remained a laboratory curiosity about which little more was known than had been found by Liebig. Only during the last five or six years has any particular attention been paid to this chemical, and only within the past two years has it been considered as a possible chemical of industry.

Several years ago however, one of the chemists of the American Cyanamid Company, studying the possibilities of the amino group of chemicals, procured a small quantity of melamine and started to put it through its paces. Here was no hit-or-miss research, no groping in the dark, however. The chemist was working toward a definite end, although at the start the path was far from clear. American Cyanamid had, for many years, been producing "heavy" chemicals for use in mining, as well as fertilizers and other materials based largely on calcium cyanamide. With this background of knowledge, research was being conducted toward the end of finding new fields, new products that could be made from this basic raw material or from by-products of manufacture. Chemically, melamine offered possibilities.

Melamine crystals photomicrographed, reflected light, 15x

Easy as it is to tell of this research, the actual processes were far from simple. Soon, however, two important facts were determined: Plastics with highly desirable characteristics could be made from melamine; melamine could be made in commercial quantities from calcium cyanamide by the initial production of dicyandiamide. In the beginning, melamine offered obstacles that seemed to be a definite bar to ultimate success. It is only slightly soluble in water (0.5 percent at 25 degrees, Centigrade); it melts only at the relatively high temperature of 354 degrees, Centigrade; it is insoluble in inert solvents. Here were properties that, highly desirable in a finished plastic, presented immense difficulties in development work.

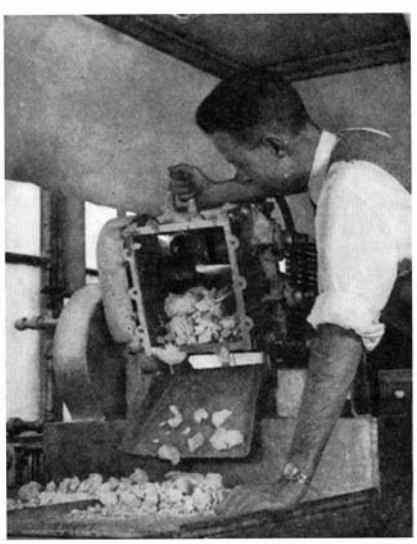
It was soon found that by combining melamine with an aldehyde —formaldehyde, for example—a plastic material was obtained that could be shaped and set under heat



Pilot plant where melamine resin is made on a small manufacturing scale

and pressure. And the resulting plastic had in a still greater degree those properties of heat resistance and insolubility that had, for a time, made the research so unpromising. By adding color pigments to the plastic, which is colorless, it is possible to produce an almost unlimited range of colors in the finished product. In commercial practice, a filler, usually of a fibrous nature, is added to the melamine plastic before heat and pressure are applied. This filler serves to reduce final cost, to add strength and bulk, without detracting from the desirable properties of the pure plastic.

WHEN the research laboratory had established the practical possibilities of melamine plastics, the job was only partly finished. Now that they had it, what could be done with it? What use could be made of its advantages? What were its limitations? The laboratory could produce only small quantities of the material, sufficient for its own experimental purposes but far too small to study the problem in all its ramifications. And right here is ample proof of a statement attributed to Charles F. Kettering, dean of research workers. "The chemical industry," said Mr. Kettering, "is the only one that has learned how to bridge the gap—the shirt-losing zone—between science and production by means of the pilot plant." Working on a small scale, it is possible to solve in advance many of the problems of commercial production, long before large and expensive plants are built. With these problems solved, production can be started on a large scale with full assurance that a minimum of trouble will be encountered.



Preparation of melamine molding compound in the pilot plant

Melamine is a case in point. The laboratory had proved its worth. A foundation had been laid. With the knowledge acquired in the laboratory, melamine passed to the pre-pilot plant stage in the Stamford, Connecticut, laboratories of American Cyanamid. Here it was produced on what might be termed a large laboratory scale. Where the research men produced grams of melamine, the pre-pilot plant produced pounds. With relatively inexpensive equipment sufficient production could be established to make possible an expanded study of the plastic and its possibilities. The output of this section was delivered to fabricators, manufacturers of plastic products, so that they could see for themselves how best to handle this newcomer in the plastics field.

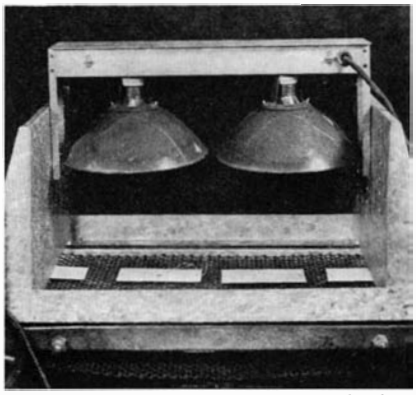
Melamine plastic drinking glasses being molded in small press

Thus were questions answered, production problems solved. Even yet, however, full commercial production of the raw plastic material was not ready. The pre-pilot plant was merely a large-scale laboratory. How would certain types of equipment behave when production was stepped up from the pounds of pre-pilot production to the tons of commercial manufacture? Next step, then, was the pilot plant, actually a factory in miniature. Here it was still possible to experiment on a relatively small scale, to avoid huge investments in equipment that might have to be changed, rebuilt, even junked. Here, too, it was possible to make the larger quantities of the material demanded by fabricators as they developed uses for the new material. From the pilot plant to full commercial production is the last step of the chemical engineer, the last plank in the bridge over the shirt-losing gap.

Test panels are automatically sprayed with melamine enamel

EVEN after the laboratory passed along to the pre-pilot plant the knowledge that it had unearthed about melamine, its job was still not complete. A plastic material had been produced, but was that the end? Could anything else be done with this material? A promising field was that of surface coatings, paints, if you will. Many years ago the automobile industry abandoned paint-and-varnish finishes for motor cars in favor of nitro-cellulose lacquers. Production was speeded up, finishes were improved. But nitro-cellulose lacquer is expensive; the solvent, which is not even present in the surface coating of the finished job, had to be a material which, even in mass production, could not be reduced in cost below a figure that was still high. Melamine resin, on the other hand, could be made into paint, by the use of a cheaper vehicle, that would bake quickly to a surface coating that was virtually scratch-proof, was resistant to all of the deteriorating factors to which the motor-car body is exposed.

Gas stoves and refrigerators offered another field for melamine. Here, again, the time-honored porcelain enamel finish is expensive, not too durable when Junior wields his toy hammer. It must be baked for long periods of time; if temperatures are raised to decrease



Sprayed test panels are baked under infra-red drying lamps

baking time, discoloration appears, which increases production costs. When properly compounded, melamine resins can be used to produce white baking enamels that have definite advantages of short baking periods. Where porcelain enamels require several hours in the ovens, melamine resin enamels can be baked in half an hour at only 250 degrees, Fahrenheit. Yet this enamel, in service, will resist prolonged exposure to temperatures of 425 degrees without loss of either gloss or color.

Still another new use for melamine resins is in the treatment of paper. Outstanding water resistance can be obtained; paper towels, treated with melamine resin, are as strong when wet as when dry, yet their absorption of water is hardly affected.

In the fabric field, melamine resins can do a variety of jobs. By applying emulsions of the resin to cloth that has already been dyed and printed, it is possible to obtain a wide variety of finishes. For example, one result with spun rayon and velvet is an uncrushable fabric that can be twisted, knotted, or otherwise crushed and that will, when released, spring back to its original form with no creases whatever, or with only minor creases that will shortly disappear if the fabric is hung up. Then, too, these same resins, differently compounded, will produce fabric finishes similar to the well-known sizes, yet that will not wash out or disappear under the rigors of dry-cleaning. Or the finish may be so made that it can be inexpensively applied to cheap goods, giving the appearance and "handle" or feel of a much higher priced material.

It must be understood that melamine resins are not alone in the fields that have been described. Other synthetics have been developed and experimental work with them is being conducted in similar fields. Melamine resins under the Melmac trade mark, however, are products of which you are going to hear much more in the near future. Their development is still so new that their ultimate place in industry can hardly be evaluated at this early date. That they have certain advantages over other plastics is clear; that they will find their own level and contribute their part to consumer satisfaction is equally clear.

• • •

INSULATION TEST

Mechanical "Finger Nail" Checks Wire Insulation

A NEW, portable, testing device for the rating of film-type wire insulations depends upon the time required for a needle acting as a mechanical "finger nail" to wear through to the metal underneath. Contact between needle and wire closes an electric circuit and the device stops automatically. J. A. Weh, of the General Electric general engineering laboratory, designer of the instrument, is pictured with it.

The side of the needle, of the ordinary sewing type, is used. It is held firmly against the wire by small weights and is driven back and forth by an eccentric mechanism connected with a counter to record the number of scrapes. An electric motor furnishes the power. Only a few inches of wire are required for a test. The instrument may be used to study any kind of enamel or films used on wire.

Power-driven sewing needle acts as human finger nail in tests

In previous tests of this character, the wire was either pulled under a scrape edge or attacked by an abrasion drum. In the latter case, it was difficult to maintain a constant abrading surface and the former gave inconsistent results with the new tough films, due to alternate gouging and skipping.

SHELLAC FORTIFIER

Improves Results With This Coating

SHELLAC has one major fault and particularly when used as a coating on surfaces that are to be abraded, such as floors. Adding to shellac an equal quantity of a new compound called Master Shellac Fortifier increases the resistance to abrasion more than four times. The resultant mixture will also dry harder in less than half the time required for ordinary shellac.

The mixture has particular value in foundries since the Fortifier prevents sand sticking even when hot sand is used; patterns and coreboxes on which Master Fortifier has been used are from three to five times more moisture-proof than they would be if regular shellac were used.

SAFETY GLASS

Tougher, Can Be Nailed in Place

A NEW safety glass having a strength of ten or more times that of ordinary automobile safety glass has been developed by the Pittsburgh Plate Glass Company.

The new glass, called Flexseal, was developed initially for use on sub-stratosphere airplanes, whose pressurized cabins require strong and tightly sealed windows, which, if broken, will not leave the frame or release the cabin pressure. Because of its unique properties and many possible variations, use of Flexseal should prove advantageous in many other applications.

In Flexseal laminated glass is combined the toughness, strength, and elasticity of a special plastic, and the hard surface, good vision, and rigidity of a special heat-strengthened glass. Like ordinary safety glass, Flexseal is a glass

sandwich in which one or more thick slices of vinal plastic serves as the "meat," but in this case the "meat" extends beyond the edges of the glass and serves as a flexible and rubber-like edge that can be bolted, screwed, or even nailed into window openings.

If the glass is broken, the thick plastic layers securely attached to the frame serve as an air-tight diaphragm, maintaining the inside and outside pressure differential, an important factor in the airplanes mentioned previously.

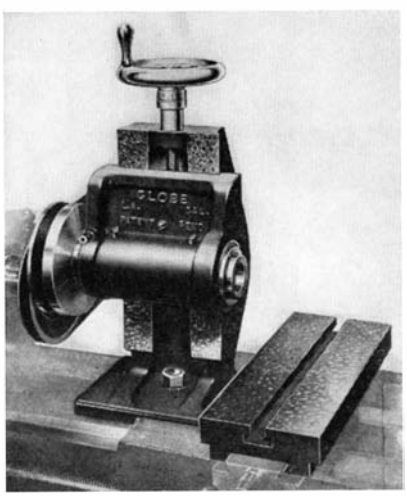
Flexseal laminated glass is the realization of a long dream by the glass industry for a mechanical method of fastening glass to other materials with a strong and air-tight seal. Flexseal, when bolted tightly in a frame, is not affected by localized stresses as has always been the difficulty with rigid glass.

In effect, Flexseal is a plastic window on both sides of which is "floated" a light of glass. When installed, Flexseal has the appearance of an ordinary home or automobile window, but, unlike present windows, it does not tend to break when the frame is twisted.

MILLING ATTACHMENT

Head Mounts on Lathe Bed, Table on Lathe Carriage

SHOWN in one of our photographs in position on a lathe bed, a new milling attachment employs the lathe spindle for its drive and makes use of the carriage movements to operate its table. The spindle is carried on a vertical slide so the spindle can be positioned, or moved up and down. Among other accessories, enabling the operator to cover a wide variety of work, is a ball-bearing arbor support for attachment to the lathe tailstock spindle so a cutter arbor can be applied in a manner similar to that on a standard plain milling machine with an overarm. It also is possible to mount a chuck on the end of the arbor at the milling head in raised position and set a standard lathe tool on a block on the carriage to swing larger work in a turning operation than the lathe will take on its own headstock.



Milling head makes vertical, horizontal, and longitudinal cuts

Originally developed in 1939 and distributed in the Southern California district only, this tool is now available nationally for Atlas and Craftsman lathes (other than 6-inch sizes), 9-inch and 11-inch South Bend lathes, and 10-inch and 11-inch Sheldon lathes. The milling head may also be attached to other makes of lathes, and larger sizes of lathes, by the use of a special adapter base plate, a slight change in the crossfeed screw nut, and necessary machining of the base of the column and the table.

ENGINE COOLING

Airplane Cylinders Cooler When Enameled

CONTRARY to an idea that coatings of paint and enamel act as insulators and keep heat in cylinders of airplane engines so treated, the coatings actually increase their rate of cooling. This fact has been brought out in experiments made by Dr. Myron A. Coler, technical director of the Engineering Products Division of the Paragon Paint and Varnish Corporation, reports *Science Service.*

Many factors entered into the cooling efficiency, Dr. Coler found. The color of the enamel proved important. One that was clear raised the cooling rate as much as 13 percent, though even a black enamel produced an improvement of 7 percent.

Another surprise was found in the effect of more than one coat. "If the coating material functioned as a simple insulator, we would naturally expect the cooling efficiency to drop with increasing coat thicknesses," said Dr. Coler. "However, it must be remembered that the properties of such materials in the form of thin films may differ considerably from those of the same materials in massive forms."

While a layer of asbestos paper around a test cylinder reduced the cooling by 4 percent, one coat of enamel increased it 13 percent, two coats 20 percent, three coats 23 percent and four coats 24 percent.

BALANCING

Sensitive Machine "Feels" a Minute Unbalance

IN THE manufacture of spinning buckets for use in making rayon filaments, it is necessary that the buckets themselves be accurately balanced in order to produce satisfactory operation. To achieve the required degree of accuracy a machine has been developed in the Micarta Division of the Westinghouse Electric and Manufacturing Company which "feels" an unbalance of as little as 3/1000 of an ounce in the bucket. One of our photographs shows this machine in operation. As the spinning bucket rotates at a speed of 8000 revolutions per minute, the large meter at the top of the balancing machine indicates any error that exists and tells where the plastic bucket must be trimmed to bring it into balance.

Sensitive to 3/1000 of an ounce

MAGNETIC GAGE

Tells Thickness of Auto Body Enamel

SCIENCE has produced many delicate precision gages in recent years to help the automobile industry build better cars. Not the least ingenious of them is a magnetic device that measures the thickness of the paint film on the car body and fenders.

This instrument is now being

used by the Ford Motor Company as a new means of insuring surface luster and color for the life of the car. It measures the total thickness of the paint and unless the film is sufficient for maximum durability, the paint job is rejected.

Although measuring the thickness of paint without damaging it would appear to be a complicated task, the principles involved in the gage are simple. Two electric cords

Finds thin spots in auto enamel

lead from a small metal case. One is connected to a power line and the other has a small spool-like measuring head attached to the end.

By touching the measuring head to a flat or curved painted surface, an indicator is activated on a meter in the case. The strength of the magnetic field, which varies according to the amount of paint between the magnet and the body metal, is registered on the meter. The thinner the paint, the greater is the magnetic field, and vice versa. An accurate reading on coatings as thin as one thousandth of an inch is obtained instantly.

RUBBER SUBSTITUTES

Difficulties Encountered in Practice

SYNTHETIC rubber cannot "be universally substituted for the natural product," report L. B. Sebrell and R. P. Dinsmore, of the Goodyear Tire and Rubber Co., according to *Science Service*. It is, they stated, "a material having special properties which, when properly handled, will give improved results as compared with natural rubber. On the other hand, we should look upon it as a material whose development and perfection will liberate us from the threat of embargo of natural rubber during the time of national emergency and as a guarantee that the price of the natural product will never again reach the peaks which have characterized it in the past."

Although synthetic rubbers possess elasticity and resilience, they differ considerably, it was said, in molecular makeup, and it ought not to be expected that they will process just the same way as natural rubber. Their study, they qualified, is limited to synthetic rubbers capable of vulcanization.

"By far the most serious aspect of the successful use of these rubbers is their difficult processability," Messrs. Sebrell and Dinsmore averred.

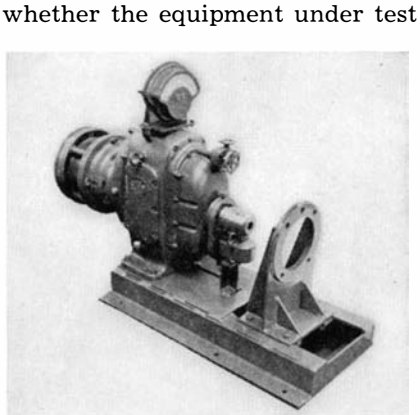
For severe service in tire treads, certain synthetic rubbers were recommended by the authors, who added that they cannot, at present, be expected to equal natural rubber. None of the synthetic rubbers, they said, is the equal of natural rubber in rebound. "Synthetic rubber," they declared, "cannot be substituted for natural rubber on a quantitative basis or on an equal cost basis without examining carefully the physical properties which are to result from such a procedure."

TEST RIG

Variable Speed for Wide Use Range

TESTING generators, governors, vibrators, pumps, bearings, and a host of other specialized equipment, is one of the problems of present day industry that has been recently solved by a new variable-speed test rig developed by the Link Belt Company.

With this device, which is completely adjustable to take almost any type of machine to be tested, tests can be made for determining whether the equipment under test runs true, functions efficiently, carries the load properly, and for calibrating.



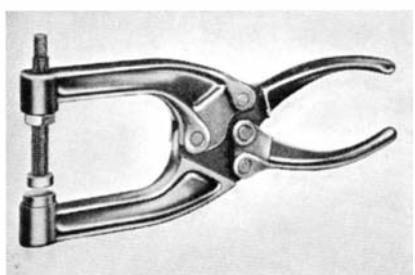
For industrial testing

The mechanism to be tested is connected to a power source through a variable speed transmission which is capable of an infinite number of adjustments.

PLIERS

Automatic Lock Holds Position, Releases Instantly

GREAT length of throat on a new rapid-action toggle pliers permits work being held several inches from the edge of a sheet or board.



Deep throated, automatic locking

In the model 450, illustrated in these columns and recently announced by Knu-Vise, Inc., the throat has a capacity of 1½ by 3 inches.

This type of pliers has a pressure ratio of 93 to 1 and is made of hardened and tempered forged steel.

In operation, the toggle pliers are not bolted or welded to a fixture, but are manually applied by squeezing the handles. The handles automatically lock in position, thus holding the jaws with a positive grasp, yet the pliers can be instantly released when desired. The jaws will not "walk" or "creep" and can be adjusted to accommodate different thicknesses of material by means of a screw in the upper jaw.

NEW PAINT

For Highly Corrosive Conditions Has Synthetic Base

A NEW grade of paint, named "Koroplate," developed to protect metal surfaces against chemical reactions and recommended for service wherever extremely corrosive conditions disqualify any other kind of paint or coating, has been produced by The B. F. Goodrich Company.

Base of the paint is Koroseal, a

(Please turn to page 237)

INDUSTRIAL TRENDS

THE VITAMIN INDUSTRY

No passing fad or fancy is the growing emphasis on vitamins. Freakish dietary fads come and go, frequently doing far more harm than good, but the health-promoting properties of vitamins have been so definitely established by medical science that vitamins have long since passed the stage where even the most sceptical might look upon them askance. And around these still mysterious elements of our daily diet has grown a thriving industry founded upon a solid base of scientific research.

It is not the function of this page to inquire deeply into the medical aspects of any subject, but it might be well to review briefly some of the salient facts regarding vitamins. These organic substances themselves contribute nothing to the human body in such matters as energy or building materials. Nevertheless they are indispensable to normal nutrition. Only minute quantities of them are needed by the body but, strangely enough, the body itself cannot manufacture even these small requirements. On the other hand, green plants and certain animals can produce vitamins in the natural course of events and vitamins can be manufactured synthetically. It is the latter fact that is of the greatest interest at the moment.

Vitamin A, the substance that helps to build resistance to infection and prevents certain forms of blindness, is present in some vegetables and in the livers of animals and fish. Vitamin B, which is in reality at least six different substances that occur together in varying proportions, has been found necessary for the health of the nerves and the heart. A deficiency of vitamin B affects the appetite and the whole digestive system. In this group are included thiamine, nicotinic acid, pantothenic acid, and other chemicals. Then there are vitamin C, which prevents scurvy, D which prevents rickets, and E and K.

All these vitamins are now available for general use, either in the form of synthetically manufactured chemicals or as concentrations of natural products. And the end is by no means in sight. It is certain that other vitamins will be discovered and synthesized; as they are found they will add that much more to the vitamin industry.

Stellar example of the effect of research on the production of vitamins is thiamine, known as vitamin B_1. Only a few years ago a gram of this chemical cost $700. Today the same quantity can be produced for only 80 cents. Better still, from the consumer's standpoint, is the fact that only a gram of this substance is needed by the human body in the course of a year. Similar cost reductions have been made in other vitamins, bringing directly to the public the beneficial results of scientific research conducted in co-operation with reputable manufacturing concerns.

The vitamin industry is not to be confused with any of the mushroom growths that have, from time to time, been built up around quackery and nostrums, only to die off rapidly or to find a level where none but the uninformed could be persuaded to buy. No high-pressure tactics are used by the few ethical drug manufacturers who, in collaboration with the medical profession, are making these products available to the general public.

Not only are vitamin concentrates available for use where deficiencies occur, but they are also being used in foods to insure that a balanced diet will provide the body with the nutriment needed for health. Thus, it is promised that soon—probably by the time this note is being read—there will be available, in most localities, bread made from vitamin-enriched flour. This flour, according to a report from the National Research Council, "will contain thiamine, nicotinic acid, and iron in amounts corresponding to or even higher than those in stone-ground flour from high-vitamin quality wheat."

Although knowledge of vitamins dates back to about 1881, no real progress was made until early in the present century and it has been only a relatively few years since that progress was translated into results that touched the lives of nearly everyone. Some statistics will reveal the recent phenomenal growth of the vitamin industry and give indications of the trend that may be expected in the future. In 1925, according to *Barron's*, vitamin products to the value of $343,000 were produced, representing 0.1 percent of the entire drug and medicine industry. By 1939, these figures had climbed to $41,645,000 and 11.7 percent, and every indication is that 1940 (figures not yet available) will show further substantial increases.

ANOTHER SYNTHETIC FOR MILADY

Vinyon yarn, a synthetic that emerged from the laboratory several years ago, is about to make its bow to the consumer's market. This material, product of research in the laboratories of Carbide and Carbon Chemicals Corporation, has so far been used only in industrial fields where its qualities of high wet and dry strength and resistance to acids and alkalies have found wide applications.

Report has it that this yarn has been used experimentally in women's hosiery and in bathing suits, but as yet none of these products has reached the ultimate consumer. More definite, however, is the promise of Vinyon gloves, to retail at about a dollar a pair. The fabric will resemble heavy silk and will be easy to clean.

Thus will another trend of the synthetic chemicals industry provide one more stepping stone in the path to the completely synthetic costume for milady.

DIESELS FOR FREIGHT

In the short space of seven years, over 100 Diesel locomotives have been placed in high-speed passenger service on American railroads. Now these challengers to steam enter another phase of their development. Electro-Motive Corporation has built for the Santa Fe railroad two freight Diesels that are in mainline service through the arid and mountainous sections of the West. Advantages that these locomotives hold over steam are elimination of locomotive changes on long runs, fewer stops for fuel and water. Just how far this trend in railroad practice will continue can be determined only after definite cost figures have been accumulated over a period of time. Passenger Diesels have injected new life into the railroads; perhaps these two freighters will do the same for freight traffic.

—*The Editors*

Our Search for the Supernatural

Scientific American Launches an Investigation of the Reality of Psychic Phenomena

IN JANUARY, 1923, Scientific American inaugurated an exhaustive two-year exploration of the subject of psychic phenomena, both in Europe and in America, in an endeavor to discover a basic, scientific truth upon which the wide-spread belief in spiritism might be solidly founded. Those efforts were fruitless in that no objective spiritistic manifestation of physical character, in the form of a psychic photograph or otherwise, was produced which bore sufficient authority to warrant approval by the co-operating committee, or which was not capable of duplication or explanation by Houdini, then the world's most noted conjurer, and a member of that committee.

Despite the failure of two decades ago, neither science nor the interested public is satisfied today. Although the findings of the earlier inquiry were completely negative in all occult fields investigated, including necromancy, theurgy, pneumatography, and all manner of mediumistic enterprises, both science and spiritistic efforts have materially changed in the past score of years. The sciences of physics, chemistry, and electronics, not to mention many other branches of systematized knowledge, have so expanded their scope as to produce and perfect more accurate methods and instruments of investigation into the unknown. On the other hand, spiritists have laid claim to advancement. Their attempts to converse with the dead, to peer into the occult, have been legion. Outstanding among these, only because of attendant publicity, were the efforts to communicate with Houdini, following his death in 1926, and the use of the medium, Mary Cerrita, in the Lindbergh kidnapping case.

Although both of these instances of so-called spiritistic achievement were later conclusively proved to have no scientific value as mediumistic demonstrations, they served to accentuate man's most basic instinct—to see into the future, to delve into the mystic, in a struggle to determine possible survival after this life. Ever since the dawn of human history man has striven to look beyond the present in a desperate, ever-hopeful venture to learn just what is to come after death. That humans have always been so constituted has given rise down through the ages to belief in the occult, the supernatural. Pre-christian era history, both Biblical and heterodoxical, is replete with evidence of man's attempts to see into and to prognosticate his destiny, to establish contact with fellow beings who had passed on, and the records of the ensuing centuries cite countless efforts to practice necromancy and spiritism in many and varied forms.

History shows that this movement is invariably enhanced in time of war, or during periods of national and international economic and social unrest. Evidence that mental distress and uncertainty is wide-spread in the United States and throughout the world is apparent on all sides. It has reached the editors of Scientific American in varied forms and in increasing volume. Underneath the constant query concerning what lies ahead next week, next year, lurks a dangerous public trend toward futility—a hesitancy to exercise our long-prized national charactistic of shaping our own destinies. This public attitude, in turn, tends to drive the human mind to extremes in the search for an answer. Failing to find what he feels are satisfactory prognostications in the fully acceptable informative channels of

$15,000.00 AWARD

● SEVERAL years ago The Universal Council for Psychic Research posted an award of $10,000.00 to any medium who can produce any effect in spiritism or any supernatural manifestation, which its Chairman, Dunninger, cannot duplicate or explain through natural or scientific means. To this still standing award, Scientific American now adds $5,000.00 as a further incentive, the Scientific American Committee on Psychic Research (to be announced in the near future) to determine the authenticity of the demonstrations. This combined award of $15,000.00, which will not be divisible or broken up in any way, will continue to be available for two years from March 15, 1941, under the following conditions:

(1) Mediums or others engaging in spiritistic enterprises, who desire to become eligible for the award, must file a written statement with Scientific American's Committee on Psychic Research that any phenomena produced by them are accomplished solely by supernatural, spiritistic, or psychic agencies, and not through trickery, abnormal physical development, legerdemain, or mechanical devices.

(2) Actual demonstrations or attempted demonstrations must be performed in the presence of the Scientific American Committee on Psychic Research, or such of its members and others as may be designated by the Chairman of the Committee.

(3) If subsequent demonstrations or seances are requested by the Committee, or its Chairman, the demonstrator must comply with this request to be eligible for the award.

(4) Demonstrators of psychic phenomena will be permitted to name and to work under their own conditions during the first seance or demonstration, so long as such conditions are compatible with the best interests of the aims of the Scientific American Committee on Psychic Research. However, this Committee reserves all rights to request repetition or duplication of the demonstration or seance under its own conditions, at such time and place as it may designate, and will undertake to the best of its ability to see that its conditions do not hinder or inconvenience the medium or demonstrator. Failure of the demonstrator to comply with the Committee's request to reproduce or to attempt to reproduce phenomena under the Committee's conditions will nullify any claim the demonstrator may file for the award.

(5) The publishers of Scientific American reserve the right to publish any or all of the findings of its Committee on Psychic Research.

(6) Since experiments by Dunninger and others have proved telepathy to an acceptable degree, demonstrations of this nature are not eligible for the award.

The sole purpose of the Universal Council for Psychic Research and of Scientific American in posting this joint award is to offer incentive for co-operation by any person who may be able to assist the Scientific American's Committee on Psychic Research in its endeavor to discover a basic, truthful, scientific explanation of spiritistic phenomena. ●

WATCH forthcoming issues of Scientific American for full reports on this research.

normal times, man inherently or instinctively turns to alleged mystic and secret rites of cults or individuals in a desperately hopeful —but altogether futile, according to scientific investigations to date —endeavor to satiate his desire.

Therefore, because the cycle of human interest in things psychic, motivated by these abnormal times, has again reached the height of its orbit, Scientific American once more undertakes to discover the factual truth concerning mediumistic and spiritistic manifestations. Can we, through mediums, communicate with the dead? Do such things as ghosts, spirits, phantoms, and vampires actually visit us from a supernatural world? What are the facts concerning ectoplasmic demonstrations? Scientific American seeks the scientific answer to these and other spiritistic phenomena.

In this, its second systematic search for the truth, not only is Scientific American continuing its explorations of 1923-1924, but also it will be aided and assisted by close co-operation of the man who guided and advised Houdini in those earlier studies, and who, as Chairman of The Universal Council for Psychic Research, has for 20 years consistently maintained a searching probe into supernatural manifestations. This man, known the world over as the foremost authority on imaginary and illusionary effects, for his phenomenal mental powers, and for his psychical investigations, has completely succeeded in mystifying such masters of science as the late Thomas Alva Edison and Charles Steinmetz.

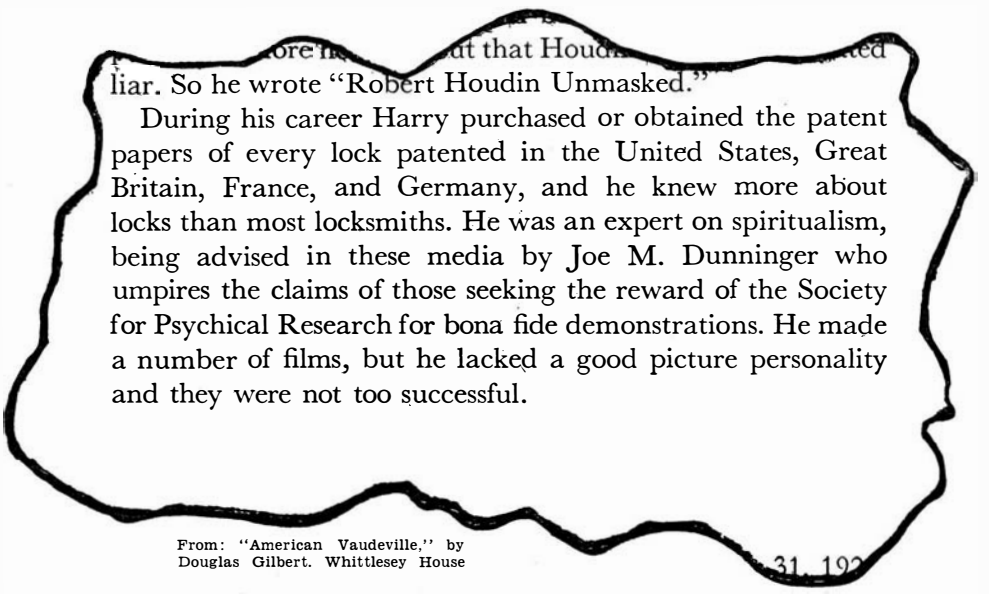
Six Presidents of the United States have called him to the White House to display his amazing talents. Of him the late Arthur Brisbane said: "The most mystifying and by far the greatest mind reading demonstration I have ever witnessed." He is the man who conceived, demonstrated, and turned over to United States Navy officials his device for camouflaging a warship to the point of invisibility. This astounding person is Dunninger, the world's foremost mentalist, who as Chairman of The Universal Council for Psychic Research, long ago offered a $10,000 award to any dealer in the occult whose "supernatural" feats he cannot duplicate or explain through natural or scientific means. This offer still stands.

It was to Dunninger that Sir Arthur Conan Doyle, Thomas Alva Edison, and Houdini each confided a secret message in code before their respective deaths in order to test the theory of spiritual return to this world. It was therefore Dunninger who exposed the many mediumistic claims of spiritistic communication purported to have come from Houdini after his decease, for none corresponded with the pre-arranged message. It was Dunninger who startingly disclosed that Mary Cerrita, the medium who claimed to reveal through psychic powers vital information in the Lindbergh kidnapping case, readily could and unquestionably did obtain her data from purely natural sources.

It *will* be Dunninger, as Chairman of Scientific American's Committee on Psychic Research, who will actively apply all necessary forms of systematized knowledge in this co-operative endeavor to discover whether scientific truth and facts lie behind so-called "supernatural phenomena." Dunninger will be ably assisted by the members of his committee, and by the entire resources of Scientific American. It cannot be over-emphasized that this proposed inquiry into psychic and spiritistic phenomena in *no* sense questions any form of religious belief, but is solely a scientific study to determine the true facts concerning what have been termed "supernatural manifestations."

—The Editors

DUNNINGER



...ore he ... that Houdi... ...ted liar. So he wrote "Robert Houdin Unmasked."

During his career Harry purchased or obtained the patent papers of every lock patented in the United States, Great Britain, France, and Germany, and he knew more about locks than most locksmiths. He was an expert on spiritualism, being advised in these media by Joe M. Dunninger who umpires the claims of those seeking the reward of the Society for Psychical Research for bona fide demonstrations. He made a number of films, but he lacked a good picture personality and they were not too successful.

From: "American Vaudeville," by Douglas Gilbert. Whittlesey House

...31, 192...

Warbird Doctors

Planes Alone Don't Make an Airforce; It Takes Trained Men to Keep Fighting Pilots in the Air

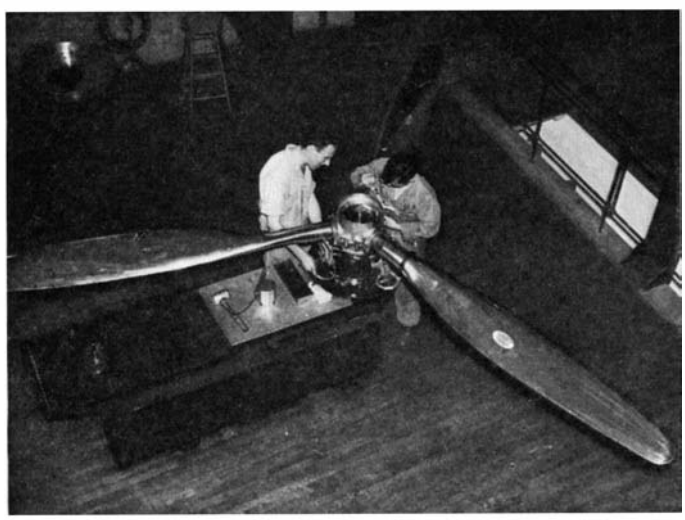
JAMES L. H. PECK

A FLIGHT of glistening fighting planes slides down an invisible sky track toward the big airdrome. The Army's warbirds are coming home to roost. They ease onto the flat turf and, as their landing rolls slow, the nine craft swing their striped tails almost in unison and taxi up to the broad concrete apron in front of the great hangars. The pilot of the silver ship nearest you unbuckles his 'chute harness, takes a form about the size of a sheet of typewriter paper from a metal case in the cockpit, commences writing on it. After the engine runs itself out—one does not quickly switch off these high-powered motors—he climbs from the gadget-filled, glass-enclosed cockpit and hands the piece of paper to the crew chief. The pilot's job is finished; that of the crew chief and his men is just beginning—the job of caring for and feeding these hungry fighters, keeping them "in the pink" that they may fight well.

Khaki-clad men swarm over the oil-streaked ship like worker ants on some fallen bird. Engine cowlings and metal panels are removed, exposing the not-so-beautiful tangle of intertwined cables, conduit, copper tubing, and rods of various sizes. As the crew chief barks orders, you peer over his shoulder at the piece of paper, across the top of which is printed "Airplane Flight Report—Air Corps Form No. 1." Beneath this heading are the pilot's remarks concerning the behavior of his ship's engine, instruments, armament, and radio. Everything has been checked and okayed, so you ask the sergeant—crew chiefs are usually either master sergeants or technical sergeants or those holding some rating—why all the activity if there is nothing wrong with the ship.

"Inspection," he grins, "so that he'll turn in the same kind of report next mission. I'll tell you, that guy who said something about 'a stitch in time—' could have been talking about us."

You nod understandingly. This is a daily inspection, so it seems, which is carried out before or immediately after flight. Oil and gas lines, connections, and clamps are checked for leaks and proper tension, and for wear due to vibration. Fuel strainers are drained and examined for undue clogging. Ignition cables and terminals are gone over for signs of abrasions, broken insulation, and loose attachments. The levers, rods, and bearings of the engine's throttle, spark, and carburetor controls are checked for excess play, improper safetying, or bending. Oil coolers undergo close scrutiny. On planes mounting liquid-cooled engines, such as the 500-mile per hour Lockheed *Lightning*, similar attention is paid to radiators, pumps, and piping. All this is done by engine mechanics under the supervision of a master mechanic. These fellows actually look for trouble before it becomes serious.



Comparable to the Army's checkup system, Pan American Airways maintains extensive repair personnel

In this they are not alone, for elsewhere about the ship airplane mechanics probe for things amiss. Landing and tail wheels are examined for bent rims, damaged hubs, and excess play or signs of wear in brakes; tires are checked for proper pressure, and for cracks, cuts, and wear. Wings, control surfaces, control rods and cables, and the propeller blades and hub mechanism receive their measure of carefully cultivated attention.

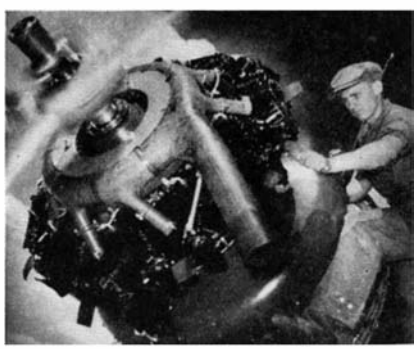
Presently the sergeant says, "Want to come along?" You enter one of the cavernous hangars, and he goes to a large chart on the far wall.

"This," he explains, "is number 24's 'income report,' a complete record of what she's done, or had done to her, within the past three months." It is so high that one must get up on a step ladder to make entries near the top, about eight feet from the floor. You can just make out the heading, "Maintenance Inspection Record, Air Corps W. D. Form No. 41." This huge sheet indicates the routine inspections required of all mechanics and officers, and provides for a record of flying hours, supplies, and remarks concerning delays caused by shortage of these supplies or of personnel.

YOU duck beneath several wings and approach a practically undressed pursuit ship in the center of the hangar. "This one's up for the weekly inspection," says the sergeant. Another gang of trouble hunters in khaki are hard at work. Most of them wear broad-peaked caps on the Apache order, only more so. Army men like these caps; even the pilots wear them upon occasion. From what you can see from behind the caps and wrenches, the goings-on appear to be a revised edition of the daily, or "line" inspection, with more attention to detail. For example, one of the men is busy with the plane's battery. He scrapes the terminals and cable, puts it back in the plane, then smears Vaseline over the metal surfaces. He tests the solution with a hydrometer and adds a little distilled water. Another young chap is cleaning the motor's distributor block with gasoline. On the other side of the ship a radio mechanic

is busy checking the tubes and circuit. Then he cleans the antenna. Discovering that one of the antenna insulators is cracked, he replaces it. An instrument technician is giving the dial-filled cockpit panel the once-over. Looks as though the boys have really found some trouble this time.

You say something to this effect to the sergeant. "You ain't seen nothin' yet," he grins. "Come on over here." The pursuit in the corner is having her nose cleaned. Here are more men and caps and wrenches. Tray racks on wheels are filled with a miscellaneous—but far from disorderly—collection of hardware and engine parts. Spark plugs are removed and replaced by ones which have been tested and cleaned. Valve clearances are checked and adjusted. Breaker points are also being checked for clearance. The ship's whole fuel system of copper arteries and veins is being flushed out:



Adjusting motor of a North American BT-9 training plane

its oil system is being drained and strainers and screens cleaned. One of the wheels is being fitted with a new tire. This goes on the record as the monthly inspection, but it is essentially what is known as a "top overhaul"—the biggest job tackled by the squadron's maintenance men.

"How would you like to fly up to the depot with us after while?" the crew chief asks. As we walk toward another hangar, he explains that the real heavy work—"major overhauls" and rebuilding—is done at the air depots. We stop to watch the armorers and ordnance men at work on the ships' armament—aerial cannon and machine guns. These weapons have to be right at all times: a warplane sans armament, or whose guns are out of alignment or have a tendency to jam, is about as useful as a parachute specialist aboard a submarine. One of the workers is giving a machine gun what is called an "ordinary disassembly" with a most interesting combination tool. This operation involves removal of the gun from its mount on the plane, cleaning, and minor repairs. The only tool required is the three-in-one spanner - wrench - screw - driver-punch. "Stripping" is a more detailed disassembly wherein the gun is completely taken apart and any worn components replaced. Out behind the hangar, two workers are aligning a fighter's guns. Occasionally they fire several bursts into a target mounted in a sand-filled, concrete-lined pit; then they make further adjustments. This precision business is definitely not a job for a cross-eyed armorer.

PRESENTLY you board one of the squadron's transport planes and take off for the air depot. "There are certainly a lot of men at work on your airdrome," you say.

"Yep, there are 133 alone charged with the maintenance of the pursuit squadron—28 planes. There are five master mechs and nine chief mechs, and 53 airplane and engine mechs of different ratings ranging from sixth class to first class. Then—let's see—there's a master air communications mech who has four radio mechs under him. There's seven armorers and two ordnance men, then there are three instrument technicians—still mechs to us—a like number of metal workers, an' seven radio operators. I'm the only first sergeant, and there's just one chief clerk. Under him there are seven or eight administrative clerks an' five technical clerks. But you know something? My specialists are those four cooks and stewards. You know they take regular courses in what they call their 'culinary arts'—which reminds me, are you hungry?"

"Not so much, just now," you probably say, "but tell me, who are those fellows who were washing the planes in the hangar?"

"Oh yes, there are 23 men, fairly recently enlisted, who are learning the ropes. They start out with the dirty work, and after they learn—or rather as they learn—they get jobs with more responsibility and also get higher ratings. I enlisted seven years ago, didn't know a carburetor from an aileron. After the second year they sent me to the Technical School at Rantoul, Illinois. When I came out I returned to the squadron as crew chief. Each chief, you know, is responsible for one or more planes to the engineering officer, who is a flier as well as a fine mech. Some of them are aeronautical engineers—smart boys."

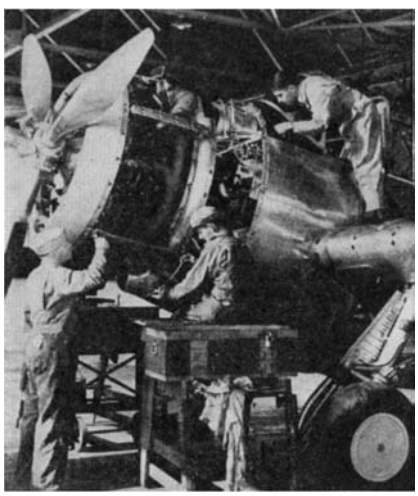
Like the Army, Pan American checks fuselage for loose rivets

Before you realize it the big Douglas C-39 transport is settling to earth. Here at the air depot are bigger and better hangars; better, in that they are equipped with most of the gadgets and machinery found in an aircraft factory, even to the expensive machine tools—huge planers, millers, lathes, and grinders. Inside the hangar there are several craft in various stages of construction or destruction. The sergeant explains there are two classes of jobs done here at the depot: FWT rebuilding jobs, and the reclamation of wrecks. FWT, he says, means "fair, wear and tear," the wear due to normal service.

WHEN a plane has had a certain amount of use in a tactical squadron, the engineering officer asks the depot for permission to send the ship in for repair. When the ship arrives, it is immediately consigned to the supply officer and then stored in a "reception hangar" while a work order is issued to the engineering department. To help them decide whether the plane in question is to be repaired, rebuilt, or junked, the engineers consult a reclamation-loss table and a percentage table based upon the plane's service age (flying hours). If the estimated cost of repair is above a certain percentage of the plane's original cost, the ship is junked and parts are salvaged therefrom. Engines are put on trial in the same manner.

First, the ship is completely dismantled and parts are tagged for identification. The engine is removed and sent to the motor de-

partment. It may or may not be used on that particular ship again. Like the plane, the engine is taken down and all parts are cleaned with gasoline or some prepared solution. Cylinders are rebored, valves ground or reseated, new valve springs provided, the pistons fitted with new rings, cylinders painted, and new spark plugs and ignition wiring supplied. The crankshaft-connecting rod assembly is examined and, if necessary, parts are replaced. The magneto assembly,



Army planes periodically receive extensive examinations

carburetor, supercharger, all gears and their casings receive the same sort of scrutiny. Then the motor is reassembled and put on a test stand for "running in."

THE plane, meanwhile, is undergoing the same sort of piece-by-piece examination. Seats, instrument panel, gun mounts, controls, fuel and oil tanks, and other interior fittings are removed from the fuselage. All piping is replaced, as are control cables and the covering of control surfaces—if they are of fabric. The prop goes to the propeller department, wings and fuselage shell to the sheet metal section, instruments to their particular department for calibration. The landing gear is completely overhauled and oleo struts are given a re-fill. The plane is painted, by part, then reassembled. The engine and prop are fitted last of all. The plane, in certain respects, is actually better than new, the sergeant says. It is truly an amazing job, this rehabilitating of airplanes. After a thorough inspection, the ship is test-flown and then inspected all over again before it is delivered to the squadron from whence it came a month ago. Pursuits, attack planes, reconnaissance and training craft, bombers, and cargo ships are overhauled approximately seven times during their lifetime of peacetime service—fair, wear and tear. Wartime goings-on cut the plane's lives—excepting, possibly, the trainers and cargo craft—to from 30 to 60 days.

WHERE do the Army's "housekeepers" come from?

There are three sources of this valuable personnel: the Air Corps Technical Schools at Chanute Field, Rantoul, Illinois, Scott Field, Belleville, Illinois, and Lowry Field, Denver, Colorado; the 14 Army-supervised civilian schools training enlisted men; and the enlisted men who serve what is equivalent to an apprenticeship with a tactical squadron. The sergeant explains that the personnel he mentioned awhile back included only that for a full-strenth pursuit squadron. Bombardment squadrons, for example, require more trained specialists.

For every plane and pilot aloft, eight of these Air Corps "housekeepers" are required on the ground, when the base or airdrome is of permanent character; 12 are needed when the unit is housed on a temporary airdrome and there is much shifting about. One of America's biggest jobs is the training of these maintenance men.

Last, but far from least, is another variety of maintenance man whose fame is not at all commensurate with the importance of his work. A man who works with fatigued pilots rather than with fatigued metal—the flight surgeon. Airmen, too, undergo "line inspections" and "periodical checks," and they are often in need of "overhauls" of a sort. The Army's source of these none-too-plentiful specialists is the School of Aviation Medicine at Randolph Field, San Antonio, Texas. The flight surgeon's two immediate tasks are determining whether or not the aspirant is physically and psychologically fit for military flying, and keeping the pilot fit throughout his service hitch.

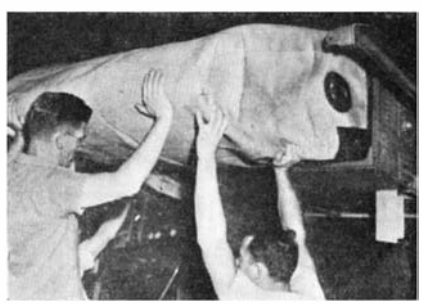
It is quite natural for us to think of the world's armies with wings in terms of thousands of aircraft, but planes don't make an air force; it takes men—and good men—down below to keep the warbirds in their element.

• • •

SEALED

Swelling Rubber Retards Tank Leakage

OUR readers may remember a recent note on self-sealing tanks. The principle is simple; the rubber or other material, when pierced by a bullet, swells and prevents dangerous leakage. This idea was understood and applied nearly 20 years ago, then abandoned in American practice, and now it is revived, with all the pride warranted by a new discovery. While such pride is not altogether justified, it is perfectly true that the modern self-sealing tank is supremely efficient and adds but little to the weight of the tank. Our photograph shows one of these tanks, perfected by the United States Rubber Company, being installed in a Douglas bomber.—*A.K.*



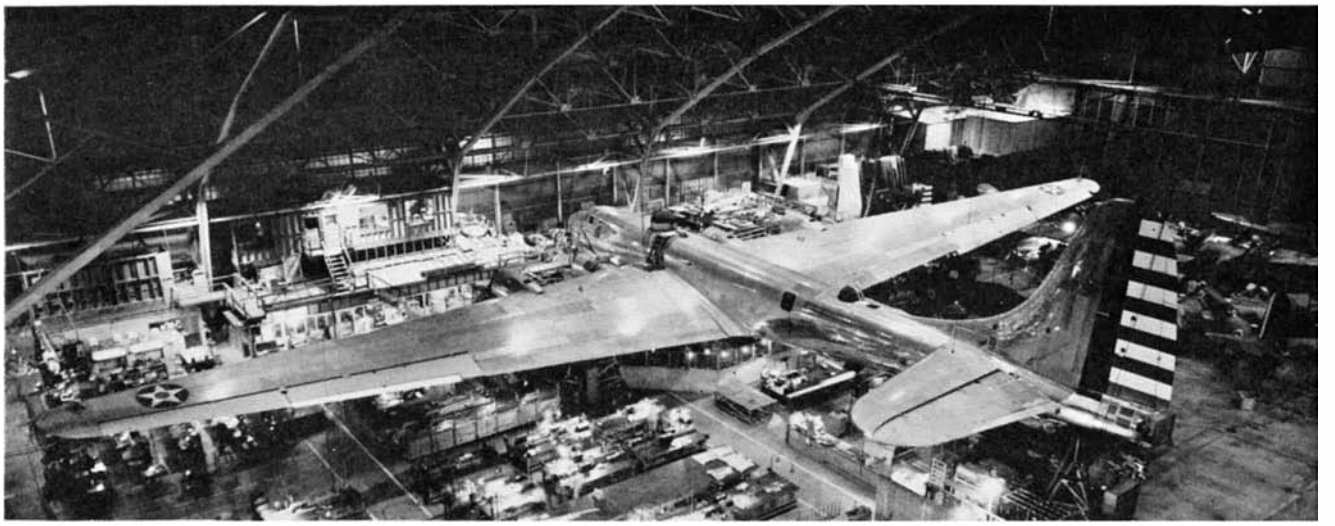
Self-sealing

BROBDINGNAGIAN

Douglas B-19 Bomber Dwarfs All Planes

WHEN Colonel Lindbergh tells us that the Germans cannot invade the United States by air, he apparently forgets his own famous flight across the ocean and the fact that the range of the airplane is ever increasing. Thus the Douglas B-19 bomber, approaching completion as one of our photographs indicates, has a range under some conditions of more than 7500 miles, can carry a crew of ten men and 18 tons of bombs. If equipped as a troop transport, it can ferry 125 fully-armed men.

The B-19 is armed with machine guns and bombs, and is protected by armor in vital spots. Of course, to compensate for the huge range and pay load, there is some sacrifice in top speed, which is only 210 miles per hour. The fuel capacity is 11,000 gallons and the ceiling



Warbird B-19 overshadows the machines that made it grow

22,000 feet. The weight empty is 83,253 pounds, the gross weight varies between 140,000 and 164,000 pounds. The huge dimensions include a 212-foot wing spread, and a 132-foot fuselage length. The span of the horizontal stabilizer is 61 feet, which would have been considered a large span for the entire plane a few years back.

Power will be provided by four Wright-Duplex Cyclone two-row engines, each developing 2000 horsepower. Engineers and shop men encountered some strange problems in the design and construction of this giant. For example, the huge wing was built in a vertical position with the main fuselage in a great steel jig resembling ways in a shipyard. When the wing was finished, it had to be lifted by cables and turned to a horizontal position for splicing to the fuselage nose and tail sections. This was accomplished in a few hours, so painstaking had been the preliminary preparation.—*A. K.*

THE INSTITUTE MEETS

Brief Report on

Aircraft Progress

THE Institute of Aeronautical Sciences is now firmly established as one of the two leading aeronautical societies in the world, and its three-day technical sessions this year were attended by a large group of engineers. Space considerations, unfortunately, permit us to touch on only a few of the most important points of the meeting.

Washington is worrying the air transport companies a good deal. New transport planes cannot be built, engines intended for transport work have to be passed over for military purposes, pilots are called into military and naval air service. These steps may be necessary, but T. B. Wilson, Chairman of the Board of T.W.A. sounds a warning: "Even if commercial airlines were broken up or forced into temporary retirement at this critical stage when our national existence may depend upon our ability to achieve and maintain supremacy in the air, it is probable that we should have to rebuild an air-tranport system to fulfill the need for a supply service as an auxiliary arm of our combat operations, which would be a wasteful and costly procedure." Another matter discussed in the Transport sessions was that of airplane feeder lines. C. Bedell Monro, of Pennsylvania-Central Airlines, gave excellent reasons for the expectation that there would come a network of feeder lines, operated with small airplanes at low cost, to supplement the main line services; the idea that air transport services can only be justified where great distances are involved is erroneous, in Mr. Monro's opinion.

Harold E. Morehouse, of Lycoming, told us what we might expect in the light plane engine: Muffing, better mounting, use of six cylinders instead of four, higher power, propellor reduction gearing, a cheap controllable-pitch propellor, and a cheap supercharger. A. R. Rogowski, of M.I.T., came to the conclusion that a two-cylinder engine, properly scavenged, with careful port design, would give the light plane the cheap, simple power plant which it requires today.

Thomas D. Perry, of Resinous Products and Chemical Company, set the record straight, on the matter of plastic planes, in his paper on Aircraft Plywood and Adhesives. The so-called plastic plane has been merely a revival of airplane construction in plywood, which, essayed during the World War, passed out because the casein or albumen or other glues employed were not sufficiently proof against weather effects and bacterial growths. Today the new synthetic resin glues are waterproof, temperature proof, and bacteria proof. Also, they permit the plywoods to be handled with great ease and rapidity in a new technique where heat and pressure combined allow plywood to be rapidly formed over a mould into a one- or two-piece fuselage, with elimination of rivets and other fastenings.

Rotary aircraft are forging ahead and two sessions of the meeting were devoted to this type. The art is advancing rapidly, with the new jump-off Autogiro perfected by Pitcairn, the Sikorsky helicopter, a new Kellett 'giro soon to be delivered to the Army, the Platt-LePage helicopter reaching completion. There are rumors that this summer the Army will match in a series of tests the performance of several rotary aircraft types against the performance of specially built, lightly loaded airplanes designed to fly at very low speeds when necessary.

Novelties in aerodynamics, recondite methods of structural analysis, flutter and vibration studies, and a dozen other topics were discussed, leaving the aeronautical engineers, profound technicians as they are, in a daze of mental indigestion.—*A. K.*

Inside the White Dwarf Stars

How an "Absurdity" Became a Discovery, Revealing a New State of Matter

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

MORE than 30 years ago the writer of these lines was visiting the Harvard Observatory and talking with that wisest and kindest of astronomers, Professor Edward C. Pickering. The conversation had started with the fact that stars which were of small absolute brightness were always red —which showed that they were faint because they were cool, and shone feebly per unit of surface, and not primarily because they were small.

Nothing was known about the spectrum or color of one interesting star of this sort because it was close to a much brighter star, Omicron Eridani. When this point was raised, Pickering, very characteristically, said, "We may have this on our plates," and sent a message to Mrs. Fleming—an expert in the observation of spectra—asking to have the object looked up. Within a few hours the answer came: the star had been found on some plates, where it was not drowned out by its far brighter neighbor, and showed a spectrum of class A.

This meant, on the face of it, that we had to do with a body as hot as Sirius, and at least ten times brighter per square mile than the Sun. Its real brightness was known to be about 1/250 of the Sun's and it followed that the area of its surface must be less than 1/2500 of the Sun's, and its diameter less than 1/50 of the Sun's, or only about twice that of the Earth.

This was surprising, but a further deduction was alarming. This faint companion belonged to a binary pair and was known to have a mass at least 100,000 times that of the Earth. With this mass, and the diameter just estimated, the density of the star came out 70,000 times that of water, and more than 3000 times greater than that of any known substance!

Such a conclusion seemed absurd; and the narrator must have looked suddenly crestfallen at so incredible a result of the application of the "newer" physical theories which had previously been so successful. But Pickering, who had learned wisdom through a generation of following the progress of discovery, smiled benignly, and said: "It is just those discordances which lead to real advances in our knowledge."

He was absolutely right. At the moment of that conversation the puzzled youngster and the unruffled veteran were the only two human beings who had made the acquaintance of the white dwarf stars.

IT WAS sometime later when Eddington realized that the atoms inside a star must be stripped clean of all their outer electrons, which, under ordinary conditions, keep them from being crowded close together by high pressure, and hence that this ionized gas could be compressed to an immensely greater density than had previously been supposed to be possible. The "absurd" result of calculation then took its place as an intelligible physical fact. A new state of matter had been discovered by astronomical methods which could never have been produced in terrestrial laboratories. Pickering's prediction had come true.

This strange state was more fully understood after the fundamental laws governing atomic structure had been worked out. Among them was "Pauli's restriction" which stated that no two electrons in an atom could be alike in all the properties of their orbital motion, to use Bohr's older but more intelligible picture. R. H. Fowler showed that the same principles would apply, even if the electrons were torn free from the atoms and flying about freely in space. Within a given limited volume—say, a cubic centimeter—there can be only a certain number of electrons with less than a given speed of motion. More electrons can be put into the volume, but only on condition that they are faster-moving. The more electrons there are, the greater will be their average kinetic energy. This energy is curiously different from that of the ordinary motion of the molecules of a gas. The latter depends on the temperature; at the absolute zero the motions would (theoretically) cease. But the former type of motion cannot be stopped at all, so long as the electrons remain densely crowded. The gas of which they are constituents may be heated. This puts in additional energy of motion, which could be got out again by letting it cool. But no cooling could take out the "zero-point energy" demanded by the quantum laws.

These motions would obviously tend to make the electron-gas expand in all directions. Could it be confined by walls, a heavy pressure would be required to hold it in, and it would still exert this pressure, even if all possible heat could be removed from it. To put in ordinary heat would increase the pressure, but by only a small fraction.

Our assumed mass of gas could not, of course, be composed entirely of electrons, on account of their powerful electrostatic repulsion for one another. But a sufficient number of positively charged nuclei to neutralize these forces could be present without affecting the argument.

All this sounds like the most abstract sort of physics; but it soon becomes astronomy when we apply it to a large mass of matter held together by its own gravitation. When we write down the expressions for the gravitational pressure inside the mass, and for the relation between pressure and density in the "degenerate" state, we have enough to work out the whole structure of the body. Its central density is six times the mean density. Its size depends on its mass—and everything about it can be calculated if we know this and one thing more. This is the average mass per electron, and depends on the composition of the material. For hydrogen, with mass 1, and one electron to be separated, this average is 1. For helium (mass 4, 2 electrons) it is 2, for oxygen (mass 16, 8 electrons) it is still 2. For heavy elements it is slightly greater—for iron it is 56/26, or 2.15, but the

great difference is between hydrogen and everything else.

Given the mass of a body, and the amount of hydrogen in it, we can then work out, on pure theory, the size and density which it would have if, having lost all of its available energy of every sort by radiation into space, it settled down "fixed in an eternal state" of quantum-degeneracy.

For a given mass, the calculated radius comes out greater and the density smaller, the more hydrogen is assumed to be present. The companion of Sirius has 98 percent of the Sun's mass. This quantity of hydrogen in the degenerate state would form a sphere 1/26 the diameter of the Sun. The diameter of an equal mass containing no hydrogen would be 1/125 of the Sun's.

The actual diameter of the star—estimated from its luminosity and spectrum—lies between the two values, and the same is true for θ Eridani B—the only other white dwarf for which we know the mass.

THIS suggests very strongly that the white dwarfs are very nearly in the degenerate state. They cannot actually be so, for they shine, and are still getting rid of heat; but they may be of nearly the same size.

To settle this decisively, we must answer two hard questions. First, what difference in the internal structure of the star will there be if, in addition to the zero-point energy locked up in the quantized motions, there is a moderate percentage of additional energy available as heat? Second, there must be an atmosphere of ordinary gas at the surface, and a gradual change to degeneracy in the interior. How deep is the layer in which this change takes place?

Dr. Marshak, of the University of Rochester, has recently answered both of these questions in a paper which forms a main part of the work for which he and Professor Bethe recently received the A. Cressy Morrison Prize of the New York Academy of Sciences.

Study of the conditions in the outer layers of a white dwarf demands a knowledge of the physical behavior of a gas during the transition from its ordinary state to complete degeneracy. Dr. Marshak has solved this very difficult physical problem, derived the relation between the pressure, temperature, and density of the partly degenerate gas, and determined the rate at which heat will flow through it under a given temperature gradient.

Armed with this equipment, he has calculated, starting with the known values of gravity, temperature, and outward heat-flow at the surface of the companion of Sirius, how the pressure, temperature, and density increase with depth. Twenty-five miles down, the density comes out twice that of water, the temperature 1,900,000 degrees, and the pressure 100,000,000 atmospheres, but the gas is not yet degenerate. At 10 times the depth, the density is 5000 times that of water, the temperature almost 10,000,000 degrees, and degeneracy is practically complete.

Similar calculations show that, for the known white dwarfs, the surface-layer of partly degenerate gas will at most be two or three hundred miles thick. Their diameters are of the order of 10,000 miles or more, and hence the main bodies of these stars must be composed of completely degenerate gas.

The temperature at the bottom of the outer transition layer is of the order of 10,000,000 degrees. Carrying his calculations inward, Marshak finds a central temperature of 15,000,000 degrees for Sirius B, and 30,000,000 for θ Eridani B. These are high values, but a simple calculation shows that the internal energy which is "frozen" and prevented from escaping by the quantum restrictions would correspond to a temperature of several hundred million degrees.

Comparing such an actual star with one which had cooled down and ceased to shine, we find that, for the same mass, the two bodies are of very nearly the same size and density, differing by less than one percent. But the visible stars are as hot inside as ordinary stars, like the Sun.

This raises a new problem. Inside the Sun, the collisions between atomic nuclei cause a gradual transformation of hydrogen into helium, which supplies the energy which they radiate. These atomic encounters should be more numerous inside a white dwarf, in proportion to the density. With the same internal temperature we should expect thousands of times more heat to be produced than in the Sun, and yet the amount actually produced cannot be greater than that which the star radiates—less than 1 percent of the Sun's output.

Here is a discrepancy of 1,000,000 to one, or more. The only way to explain it appears to be to assume that the atoms which, by their reactions, produce heat within the Sun, are enormously less abundant in the white dwarfs. This result could be reached by diminishing the percentage of hydrogen a million-fold, or that of carbon and nitrogen in the same proportion, or of both by a thousand-fold, or in other obvious ways.

But the transmutation process, as Bethe has shown, consumes hydrogen alone—remaking the carbon and nitrogen atoms to be used afresh. It appears, therefore, very probable that there is no hydrogen inside a white dwarf—or, at least, not more than one part in approximately 10,000,000.

IF THERE is no hydrogen in a degenerate mass, its size and density can be computed. When the calculation is made, the results for θ Eridani B agree satisfactorily with those derived from its brightness and spectrum. There is still hydrogen on the outside of this star—its lines are conspicuous. But the process of diffusion inward must be so slow that it could remain there for a very long while, even if it were exhausted in the interior. But for the companion of Sirius, things look bad. The calculated diameter is only 1/125 of the Sun's, while the observed "Einstein shift" of the spectral lines, as well as the brightness, indicate that the diameter is not far from three times this. There seems to be only one escape from the difficulty—to assume that Sirius B is a close double star, and that both of them are white dwarfs. The individual components, being less massive, would be larger, when in the degenerate state, give more light (for the same temperature), and show a smaller Einstein shift. In this way, theory and observation may be brought into agreement. There is something not wholly satisfactory about what Kuiper (who suggested it) calls an *ad hoc* hypothesis. But it is entirely reasonable. There are plenty of double stars. Many components of visual binaries are close spectroscopic pairs. We have no *a priori* reason for supposing that there is such a case in the system of Sirius, but there is good reason *a posteriori*. As Sherlock Holmes once remarked "It is an old maxim of mine that, when you have excluded the impossible, whatever remains, however improbable, must be the truth."—*Princeton University Observatory, February 4, 1941*

Our Next Source of Oil

Petroleum Geologists are Turning from the Structural Trap to the Stratigraphic Trap

RANDALL WRIGHT

IF WE examine the resources of petroleum in the United States we see that we have within our borders more oil than all the rest of the world put together—so much that if no more wells were drilled we could go on supplying ourselves and part of the outside world at the present rate of consumption for 15 years. While we consume more than a billion barrels of oil annually, as each new year rolls around more new reserves have been found than have been used.

Why, then, are so many wells being drilled? Simply because oil is becoming harder to find. Drilling for new oil fields arises from the necessity of protecting immense investments in refineries, pipelines, and marketing facilities. The oil fields are being depleted. For example, some of the wells in the new Illinois areas begin by yielding several thousand barrels per day, but before they are a month old they give only 100 barrels or less daily. In 1939, as many as 2589 exploratory, or "wildcat" wells were drilled. Less than 10 percent of these found oil. While an excess of new oil, over current consumption, was discovered, nevertheless this excess is not as great as in previous years.

If the present trend were to continue it might mean shortage of oil some time in the future. Probably, however, that trend will not continue for very long. Exploration for new oil is today in a transition stage—a transition in its objective from the structural trap type of underground reservoir to the stratigraphic trap.

In the earlier years of his search for oil, the petroleum geologist did not work blindly but had a kind of pattern to follow. In the latter part of the previous century he learned from I. C. White, the noted geologist, that oil would be found in a given locality, provided a certain set of conditions pre-existed. These conditions, a typical example of which is shown in Figure 1, are as follows: There must be a "sand" (a sandstone), porous and permeable, to hold the oil. There must be an impervious stratum—generally a bed of shale or limestone—overlying the sand, to seal in the oil. Previously there must have occurred some special process, not yet clearly defined, which drove the oil out of the mother-of-petroleum beds and into the sand reservoir. And, finally, the pattern required earth movements which had made a structural trap, either the conventional anticlinal fold or a dome in the form of an enormous overturned bowl. The oil, because it was lighter than underground water, gathered in the highest part and could not escape. The geologist mapped the anticline and if all the necessary conditions were present, the drill found a new oil field.

This was the pattern which the oil geologists of two generations followed, with enormous success. By 1930, however, most of these

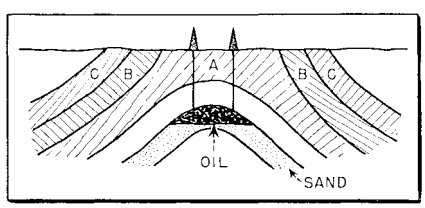


Figure 1: **Showing how oil sometimes gathers under the apex of a structural fold, because it is lighter than the ground water. A, B, and C are impervious strata. Such oil sources—anticlines—have long been exploited**

structures which could easily be mapped on the earth's surface had been drilled, and if the petroleum geologist had stopped there, we would now be facing the prospect of gasoline rationing. But the geologist knew that there were other anticlines so deeply buried as to be hidden at the surface by strata deposited after the anticlines were folded (Figure 2). He therefore diverted to economic ends some instruments previously known only to abstract science and used them as probes to explore what he could not see. The instruments he borrowed from physical science were the seismograph, torsion balance, magnetometer, and others. In the past decade, during which these geophysical aids have been in large-scale use, many new oil fields have been discovered. These geophysical procedures are indirect, not direct, methods of locating oil. That is, they do not point to oil as such, but only help the geologist to find situations where oil is most likely to be found. They make use of the differences in the characters of rocks. For example, the seismograph reveals differences in density in the rocks encountered by artificial earthquake waves created at the surface by dynamite. These waves travel downward and are reflected upward again by hard layers. Time differences required for the round trip of these waves at different points show the direction of slant of the sub-surface beds, and thus lead to prognostications as to the presence or absence of an otherwise hidden anticline. This anticline then may — or may not — be found to contain oil.

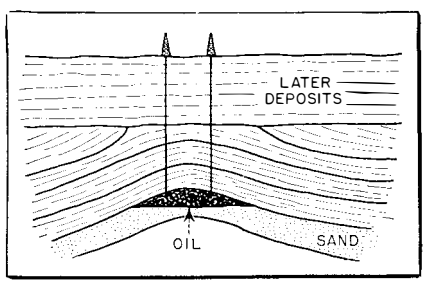


Figure 2: **But anticlines that are hidden like this by later rocks are hard to find by normal methods, may easily be missed**

TODAY, however, these methods are approaching the same impasse which confronted the surface geologist of a decade ago — most of the structures that were easy to locate by geophysical methods have now been found and drilled. Therefore, if structural traps were the only kind of petroleum reservoirs on earth, the future might be melancholy. Happily, there exists another class of oil reservoirs — the stratigraphic traps — and it is these which are at present assuming increasing importance. Moreover, since the events which led to their formation were more common in earth history than the events which made structures of the kind already described, probably the oil available in strati-

graphic traps will be found even more abundantly than it was in the structural traps (anticlines).

Large amounts of oil now are being produced from stratigraphic traps in Oklahoma, Kansas, Texas, and California—perhaps 10 percent of the whole. Long ago, some of these formed as beaches along ancient seacoasts, like the one to be described below. Others formed in other ways. A great many of them have been discovered by accident, a few by study.

A TYPICAL stratigraphic trap — there are several kinds — may be understood by looking first at the sandy beach along the present-day ocean. The sand grains are seen to be evenly sized and cleanly washed by waves and tides, and therefore the mass is porous and permeable. Now imagine this land and seascape buried, as it may be after millions of years, under thousands of feet of mud bed and hardened into shale, coal beds, limestone, and sandstone layers. Imagine also that you are standing on top of this pile of rocks over the ancient beach, and that you are an oil man and you intend to drill for oil. To find fame and fortune, you have only to guess exactly where this elongated former beach strip lies beneath you. Here the seismograph or magnetometer cannot assist you, because there is no differential of density or hardness or magnetism — the basic princi-

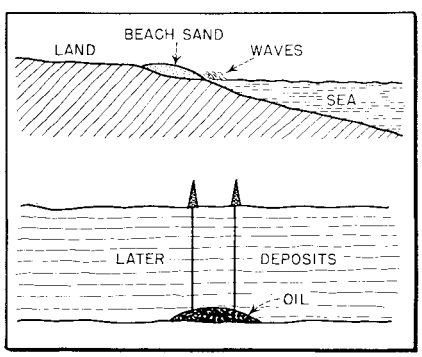


Figure 3: **The buried beach reservoir type of stratigraphic trap, showing (above) how it is formed and (below) how it may later become an oil storage**

ples on which these instruments work — to make the sand reveal itself. What would you do? What, today, is the petroleum geologist doing?

Examples of stratigraphic traps are shown in Figures 3, 4, and 5. In Figure 3, at the top, is shown the cross-section of a beach, a land surface, and the adjacent sea as they actually existed in the Pennsylvanian Period, some 300,000,000 years ago. The action of waves and tides had then formed a beach sand which was porous like a modern strand. The lower drawing shows the same features covered with thousands of feet of later deposits which have obscured the details. Oil, migrating from its sources of formation elsewhere, has become concentrated in the sand, which is now a permeable sandstone reservoir, and has been discovered by the drill — as in the Bartlesville and Burbank "shoestring" trends of Kansas and Oklahoma. To reveal the subsurface details of such an oil sand is beyond the scope of geophysics. Here the geologist has to use his wits and imagination, proceeding from lines of evidence based on observation of a number of things. Some of these appear at first rather obscure and perhaps not helpful. He has to picture in his mind, from close study of the

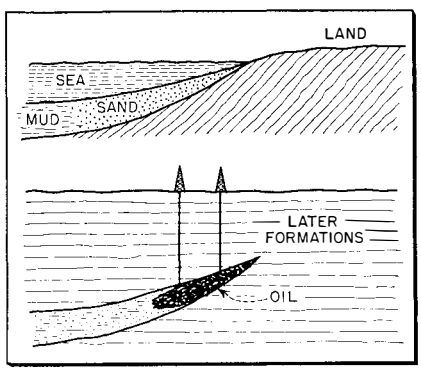


Figure 4: **The lenticular sand body type of stratigraphic trap. Above is the ancient condition and below the modern one in the same place, hiding the oil**

ancient sand grains and tiny fossils, the landscape of a geologically remote time. What he finds repays the tedious work, for he is learning how to locate the stratigraphic traps.

In Figure 4, the upper drawing shows a lens or tapered layer of sand as it was being deposited in geologically ancient times, close to shore on a sea-bottom. The lower sketch shows the trap as it is today, covered with a thick blanket of later formations. The approach to the problem of discovering this type of trap again seems at first to be roundabout; it is made through study of the location of ancient oceans.

A third type of stratigraphic trap (Figure 5) began to form long ago, as sand and mud beds were deposited flat on the floor of an ancient ocean. Later the deposits hardened and were warped, tilted, and uplifted from the sea. Erosion planed the beds off at an angle; then the sea again invaded, younger beds were deposited, and the trap shown was thus completed, to be discovered now by resourceful geological deduction connected with a study of mountain-making

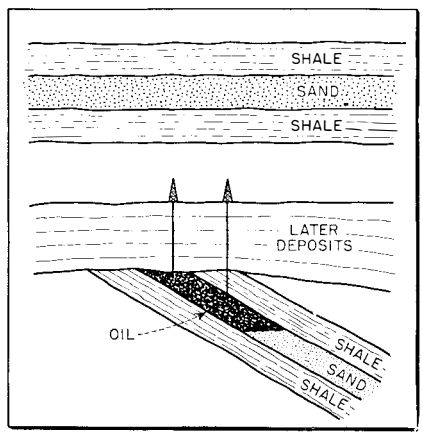


Figure 5: **Overlap type of stratigraphic trap. Original geologic condition is shown above, while the modern and much altered condition is illustrated below**

movements. Some of the largest wells in the world produce from this type of trap reservoir.

The problem of finding stratigraphic traps is essentially a new problem. It involves close study of the events of geologic history. Since the geologist cannot locate them directly, he begins on a broader quest, seeking a clear understanding of conditions in past epochs. This requires new methods of work and the study of new concepts; these still are being evolved. More and more study will be given to this type of oil accumulation before geologists acquire facility in discovering stratigraphic traps.

THE geologist in this newer quest of oil is reading earth history through his microscope as he examines fossils of tiny organisms, such as forimanifera, ostracods, diatoms, and others, because these fossils reveal changes in the ancient conditions from one stratum to another. They also distinguish by their nature whether the beds in which they are found were shallow or deep sea deposits — some organisms prefer one, some the other. Thus these microfossils are used by the oil geologist as keys to the age and sequence of the beds of rock, as found both at the surface and in samples brought

up from deep drilled wells. Thanks to his training, details noted in closely studied samples of shale, sandstone, and limestone permit him to read the events of the ancient lands — the types of erosion, steepness of the hills long since gone, the size and swiftness of former rivers. From the coarseness of grain, its evenness, color, and type of cement, and from other observed evidences, he deduces how far from shore the deposits were formed and, on the basis of this and kindred knowledge of stratigraphy — a part of the stock-in-trade of the schooled geologist—he is constantly learning how to locate hidden stratigraphic traps, our next great source of oil.

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LOST RING

Physicist Squeezes Ring Out of Copper

DISCOVERY that the musical ring can be squeezed out of copper and then pounded back into it suggests a clue to why some materials are hard and others soft.

Dr. Thomas A. Read, Westinghouse Research Fellow, reported the discovery before the American Physical Society. He illustrated the discovery by gently tapping a bar of copper cast from molten metal. It rang as clearly as a tuning fork, but after it had been squeezed in a press, or even just dropped on a table, it answered with a dull "clunk" when tapped with a hammer. Yet when the copper bar was pounded or cold-worked thoroughly, its lost ring returned. [See article "Plastic Metals," Scientific American, November, 1940, pages 262-264. — *Ed.*]

While no one is yet sure why the metal loses its ability to ring and then regains it, Dr. Read said, the most likely explanation is that dislocated copper atoms stifle the ring.

"If given a chance," he said, "the atoms of copper will arrange themselves on perfect rows and layers as they cool slowly from the molten state or during a careful heat treatment of a solid piece of the metal. Then they all 'join hands' in an ideal latticework and when they are struck they vibrate in unison, thus giving off a musical ring. But when this latticework is jarred by dropping or squeezing, some of the atoms are pushed out of place. These disturbed places can move about, absorbing the musical vibrations."

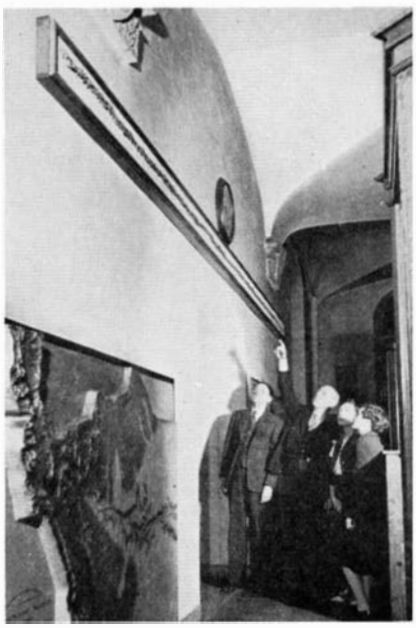
Dr. Read has been studying copper's elusive ring in the hope that his findings may ultimately help improve alloys.

"FOSSIL LIGHTNING"

An Odd Tube of Fused Sand May be a Fulgurite

A 23-FOOT specimen of "fossil lightning," known as a fulgurite, has been placed on display in the Rosenwald Geological Museum of the University of Chicago. It was discovered by Dr. George S. Monk, assistant professor of physics at the University.

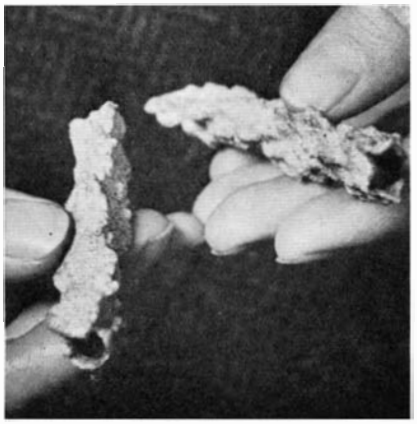
Fulgurite is formed when lightning strikes into siliceous sand, such as is found in sand dunes. The heat from the huge electric spark



Cemented remnants of fulgurite on display in a 23-foot panel

causes the sand particles to melt and fuse into a long, snaky tube composed of a dark gray substance similar to glass. The tube represents the path taken by the lightning as it arcs through the sand, and refutes the popular misconception that lightning has sharp jagged edges.

Dr. Monk discovered the Rosenwald Museum specimen when walking through the sand-dune region of Ludington State Park, in Michigan. He noticed a piece of dark rope-like substance which he



Bits of "fossil lightning"

recognized immediately as fulgurite and mentioned his discovery to a party of University of Chicago geological students who were making a field trip through the region.

Previous finds had been fragmentary. Dr. Monk turned down an offer from the group to probe the spot because the specimen would be of little value if the pieces became scattered among a number of individuals. Accordingly, he arose at five o'clock the following morning, returned to the site of his discovery, and in several hours recovered all the fragments. He removed his shirt, formed it into an improvised bag, and carried away more than 40 pieces of fulgurite, gathered over a radius of 50 feet.

At the University the fragments were cemented together by Dr. Paul Miller, curator of the Museum, and are now on display as a permanent exhibit.

SOAP

Electron Microscope Looks at Twisted Fibers in Cleansers

WITH the aid of an electron microscope, scientists have seen with their eyes into the mystery casually referred to as soap. Soap is revealed as consisting of bundles of fibers, some of them twisted, reports Dr. J. W. McBain, Stanford University professor of chemistry.

The possibility that soap may be photographed in even greater minuteness is foreseen, as the next step toward solving soap secrets. Scientists admit that they still do not know just what happens chemically when you wash your hands with soap. Dr. McBain believes that when the physical structure of soap is understood, it will be easier to understand the problem of soap and dirt.—*Science Service.*

Evolution in the Future

Where is Our Human Species Headed? Will Man Pull Himself Together and Go Ahead?

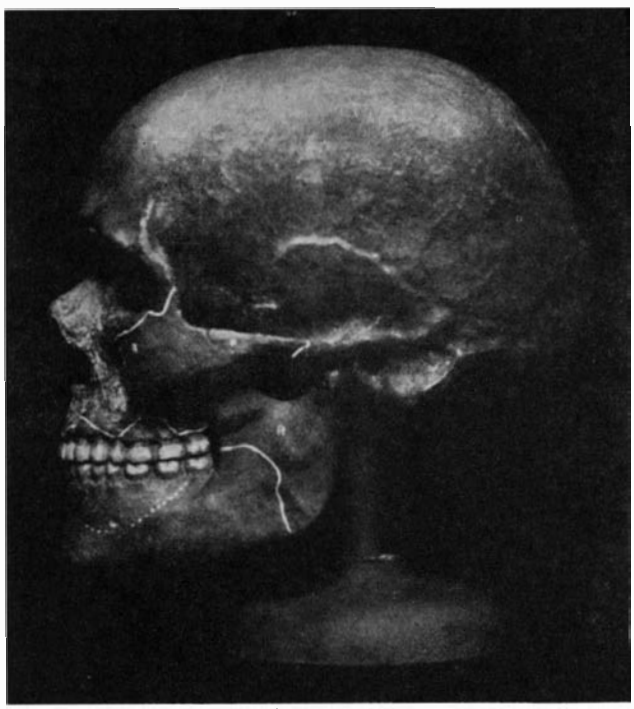
HENRY M. LEWIS, JR.

SINCE the dawn of reason, few questions have so stirred man's imagination and given rise to such varied and diversified speculation as that having reference to the ultimate result of the human evolutionary process. Are the most highly developed specimens of our present civilization the final chapter in the history of human development, or are we merely a step in the ultimate evolution of a race of super-men?

In the light of present trends, it seems probable that our physical and intellectual development is slowing down, while social evolution, on the other hand, is moving at a brisk pace with the rational organization of society—its goal—as yet unattained.

Evolution, in one sense of the word, may be regarded as a response of the living organism to its physical environment. Throughout all history, changes in this physical environment have necessitated and brought about changes of an evolutionary nature in the animal kingdom. Periods of colder climate necessitated the growth of heavier coats of hair to protect animals from death by freezing. Shortage of one kind of food or another brought about necessary changes of teeth and digestive apparatus, rendering them adaptable to new foods under new conditions of life.

In the case of modern man, however, the physical environment has far less evolutionary force than in the rest of the animal kingdom. Through his intellectual development, man has risen above a dependence upon evolutionary factors to preserve him through a changing physical environment. The circumstances of modern civilization have eliminated the necessity for physical alteration and visceral and structural adaptations to meet the needs of environmental change. In cold climates, man need but use heavier clothing as he pleases. Shortage of one kind of food does not compel him to undergo changes of teeth and stomach in order to adapt himself to the use of other foods; he still knows how to continue producing food of the kind he long has eaten, or else can so alter and modify new kinds of food that the old digestive system can take care of them. In this respect, then, to the extent that physical evolution depends upon a changing physical environment, man now is largely removed from the forces of evolution, since he can control his environment.



Courtesy American Museum of Natural History

Cro-magnon man of 20,000 years ago had as fine a brain and skull as we have in 1941, but he lacked written methods of storing up facts to enhance his brain leverage. Earlier man's brain was poorer

Furthermore, natural selection, or the survival of the fittest, considered by many scientific authorities to be the greatest of all the directing forces in physical evolution, has lost much of its meaning in civilized society, and consequently is without much effect. By the most extraordinary means, governmental institutions protect and preserve the feeble-minded, the insane, and the anti-social, as evidenced by our well established state schools, asylums, and prison systems. Public agencies—local, state, and national in character—function to protect the physically weak and deformed from what otherwise would be dominance by more powerful forces. We are just beginning to realize that intelligent human selection must take the place of natural selection, and that the most unfit must be prevented from perpetuating their kind. It is evident, though, that the most that can be expected from such artificial selection is that mankind as a whole shall approach somewhat nearer to the level of the best individuals of the past and present. Unfortunately, the opposition which is brought to bear against this train of thought by religious agencies and teachings makes the task a difficult one. The possibility therefore, of such intelligent artificial selection becoming a reality in the immediate future is exceedingly remote when viewed in the light of a sentimentality which is peculiar to modern man and contrary to Nature.

In these circumstances, the conception of unlimited evolutionary progress among men has become more or less unpromising. In every line of progress, a limit is sooner or later reached beyond which it is not possible to go. Further progress, if it occurs at all, must be in other directions. For at least 100 centuries, there has been no notable progress in the evolution of the human body. This indicates that apparently the limits of physical evolution already have been reached, at least among the most perfect specimens of mankind. However, we are told by those who believe in an endless progress that 10,000 years is entirely too brief a

time in which to look for marked evolutionary advance, and we are cautioned to remember that evolution is slow and that time is long. But, after all, the time available for progressive alteration is not infinite, and 10,000 years, representing 300 or 400 human generations, should be long enough to reveal the direction of any marked tendency in evolution.

When we consider the fact that in every line of evolution, progress is most rapid at first and then slows down until it stops, it becomes difficult to avoid the suspicion that, in those lines in which human evolution has gone farthest and fastest, it has practically come to an end. At least we can say that there is no prospect that the hand, the eye, or the brain of man will ever be much more complex or perfect that it is at present. It is, of course, possible that the brain may undergo further evolution in the future, just as it is possible that the elephant may evolve a longer trunk or the giraffe a longer neck, but the size of the human brain has not increased since the time of Cro-magnon man, approximately 20,000 years ago, and the great prevalence of nervous disorders among the most highly intelligent classes of the present day may be taken to indicate that the nervous system already has developed to a point where it is getting out of balance with the other vital functions. In every line of progressive evolution there comes a time when specialization can go no further without interfering with the harmonious interrelation of parts and thus breaking down co-operation.

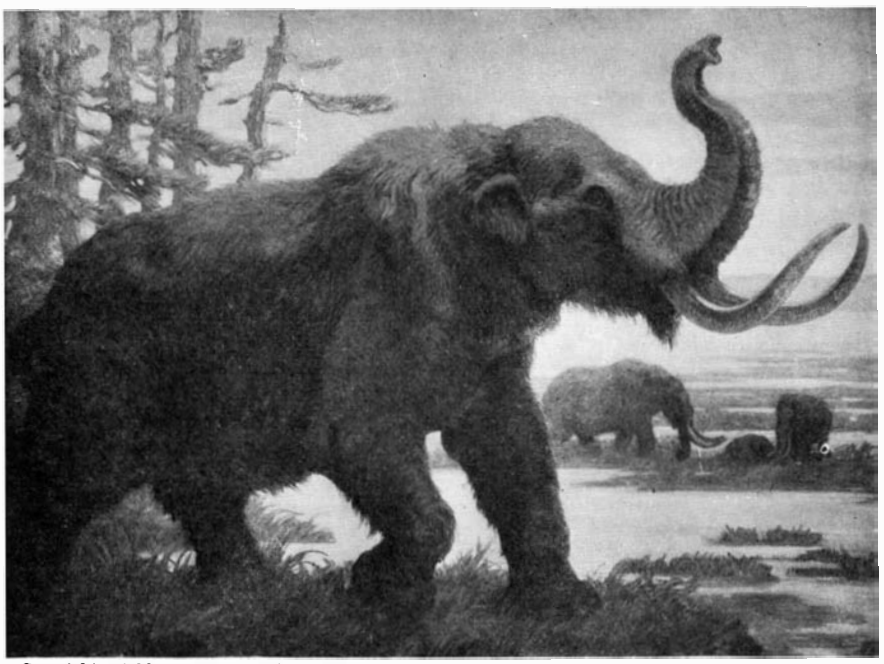
IN MOST respects man is a generalized rather than a highly specialized type of vertebrate. This is shown by his hands, feet, limbs, teeth, digestive system, and sense organs, and, insofar as these animal functions are concerned, present tendencies in human evolution seem in the main to be making for a simpler and still more generalized organism. This is shown in the simplification of many organs and systems, the progressive degeneration of certain parts, and the presence of many rudimentary structures. This combination of a highly specialized brain with other organs of a more generalized type has been of the greatest advantage in human evolution, for it has made possible at the same time unequalled intelligence and remarkable plasticity and adaptability of bodily functions. From the evolutionary point of view, perhaps the most perfect type of man would be one in which the brain had reached the highest possible stage of differentiation and in which the rest of the body remained in a relatively generalized condition.

By eugenics and euthenics—that is, by mate selection and environmental control—the general level of physical development of man may be improved, just as it has been in many domestic animals. Many diseases may be eliminated and immunity to others may be increased, feeble-bodiedness and feeble-mindedness may disappear and the race as a whole may be made more hardy. There are, however, no indications that future man will be much more perfect in body than the most perfect individuals of the present, or than the most perfect specimens of a century or so ago.

No one can doubt that there has been a remarkable development of intellect throughout the long course of past evolution. In the case of man there is abundant evidence that there has been growth of intelligence from the earliest to the latest types, and that this development has gone further in some races than in others. Furthermore, there is considerable evidence that even in the most intelligent races and individuals there is still much room for intellectual growth. When we consider the great mass of irrational and emotional mankind, we cannot but be impressed with the thought that the race as a whole is just emerging from unreason, and that instinct and emotion still are the masters of our lives and beings.

THE fact that there is room for improvement by no means signifies, however, that the improvement will take place. Just as in the case of physical evolution, so here also there are limits beyond which intellectual evolution apparently cannot go, and these limits are far short of ideal perfection. The record of the intellectual development of mankind during the historic period may seem to refute this conclusion, and to prove that, even if men are not growing more perfect physically, they are growing more perfect intellectually, since we certainly know more things than the ancients did.

It is necessary, however, to distinguish between knowledge and intellect—between things known and the capacity for knowing. By means of language, tradition, and writing, the experiences of past generations can be handed on to present and future ones, and thus each generation may receive the knowledge accumulated throughout the past. In this sense we are the heirs of all the ages. Our store



When glacial climes chilled temperate regions, elephants there grew hair. Mastodon, as painted by the scientific artist Charles R. Knight for the Ernest R. Graham Hall, Field Museum of Natural History, Chicago

of knowledge is growing, but is our intellectual capacity increasing? Does anyone think that the past 2000 or 3000 years have yielded an increase in human intellect remotely comparable with the concurrent increase in knowledge? Do the best minds of today excel the minds of Socrates and Plato and Aristotle? On the contrary, it is the opinion of some who have studied the subject that no modern race of men is the superior —possibly none is the equal—intellectually, of the ancient Greeks. Even in the most distant future, there may never appear greater geniuses than Archimedes or Plato, or of Shakespeare, Galileo, Newton, Darwin, or Einstein. Undoubtedly, eugenics and education can do much to raise the intellectual level of the general mass but it probably cannot create a new order of intellect.

The brain has its limits even as a storehouse, and it necessarily follows that, with knowledge continually increasing but intellectual capacity remaining constant, each individual mind can take in only a small portion of the sum of human knowledge. Therefore, in this age, intellectual specialization is necessary. Progress in intellectual evolution, no less than in physical, lies in the direction of increasing specialization and co-operation. This progress is no longer taking place within the individual but rather in the specialization and co-operation of many individuals. It is as if we added one and one and one, and obtained not three, but more. The intellectual evolution of the individual has in all probability virtually come to an end, but the intellectual evolution of groups of individuals is only at its beginning.

IF THE evolution of the human individual has come to an end, certainly the evolution of human society has not. In social evolution a new path of progress has been found, the end of which it is difficult to foresee. Evolution has progressed from one-celled organisms to many-celled, from small and simple organisms to larger and more complex ones. By the union of individuals into families, tribes, and nations, still larger and more complex units have been formed, until now, by intelligent human co-operation, we have political units which include millions of men, and there is the possibility that, profiting by costly lessons we are learning at this minute, we may be on the eve of bringing together into some intelligent form of league or federation all the peoples of the earth. Possibly future historians may record that super-civilization began with the end of wars and the co-operation of all the peoples of the earth. At least, there is every evidence that human culture still is advancing and that the end of this advance is not yet in sight.

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Electricity Catches Trout

Science of Fisheries Research is Aided by Data Obtained With New Electric Shocker

DUCK DORMIN

WHAT happens to all the trout that are planted in our streams? How many survive and finally nestle comfortably in the bottom of the creel as a result of a perfectly cast Quill Gordon? What size fish should be planted for the best results: fry, fingerlings, or legals? What is the subsequent mortality of these various size groups? What time of the year should fish be planted? Do spring plantings bring more tight lines, or do fall plantings make the disciples of Walton happier? Could better fishing be maintained by distributing small numbers of fish throughout the year?

Answers to these and dozens of other questions along similar lines would be of great value to fish culturists. Faced with a constantly increasing demand for more fish in the trout streams of the country, brought about by the rapidly growing number of sportsmen who seek the wily trout, these fish culturists are developing the science of fisheries research. This form of scientific approach to the pressing problem of fresh-water fish conservation is still in its swaddling clothes but unmistakable signs indicate that the infant is growing into a lusty youth. One tonic which has been administered might be termed "electric therapy;" it employs a device know as the "electric shocker" which temporarily stuns a fish so that it can be readily caught, examined, and returned to the water without harm either to the fish, its natural habitant, or the workers who engage in the operation.

The generating apparatus is like the conventional lighting outfit used by farmers and at summer cottages and consists of a 110 or 220 volt, 60-cycle, alternating-current generator. A maximum output of 500 watts is sufficient for work in our eastern trout streams. The generator is driven by a small gasoline engine, the two units being attached to a portable mounting.

One of the terminals of the generator is grounded by connecting it to an iron pipe driven into the

Power from portable generator helps remove undesirable species from trout habitations

stream bed near the shore; the other terminal of the generator is connected by an insulated, flexible wire to a strip of wire screening four to six inches wide and 10 to 15 feet long. A wooden handle is fastened to each end of the screen and large seine-corks are attached so that the screen will float on the surface of the water.

When the electric shocker is in use, the screen is stretched across the stream and two operators move it up and down the test area of the stream which is blocked off with nets. A third man retrieves the stunned fish and the fourth

The electrified screen in use in a section of a trout stream

member of the crew unwinds the wire connected to the screen.

As in all electrical work, there is some shock hazard. Work of this kind should only be done by experienced operators who should wear rubber boots and rubber gloves and who have a clear understanding of the fact that a little water in the right—or wrong—place will permit the current to pass through their bodies instead of through the ground-to-wire-screen circuit. At the best the result may be an unpleasant shock; at worst, it may be fatal to the operator.

THE conventional method of making a fish population census is by seining, but snags and boulders often render this method difficult or impossible. The electric shocker, on the other hand, is approximately 90 percent efficient even in locations where seining is out of the question.

In conjunction with controlled plantings of marked fish, the electric shocker makes it possible to remove the fish from sections of a stream at frequent intervals to determine the biological capacity of the stream, survival ratio, growth rate, the success of stocking at different seasons, the condition of the fish after being placed in a stream, the incidence of parasites, and innumerable other factors which are important in modern management of fisheries.

Previously, experiments with tagged fish depended upon that fickle entity—fishermen's luck. It was necessary to wait until the end of the fishing season to evaluate data. Now, any section of a stream can be selected and most of the fish brought forth for examination in the comparatively short time of a few hours. Best of all, the electric shocker does not affect the insect life of a stream. Food awaits the fish that are returned to a stream.

Another important use of the electric shocker is the control of undesirable species. Carp and perch have ruined many trout waters. Heretofore their removal has been hampered by inefficient methods. The success of preliminary experiments in this sort of fish control with the electric shocker indicates great hope for its extensive use in the future.

Thus the electric shocker takes much of the guesswork out of fish-culture practices. Results can be tested at frequent intervals. Already the shocker has pointed the way to a more scientific approach to fisheries research.

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FROZEN FOOD PACK

For Liquids, Vegetables, Fruits, Solids

A NEW container has been announced by Container Corporation of America, which combines a Cry-O-Vac latex bag (product of Dewey & Almy Chemical Co.) and a solid fiber or paperboard case for bulk packing frozen liquids such as fruit juices; semi-liquids, such as cracked eggs and syrup pack fruits; and also bulk solids such as peas, beans, and berries, in units of from 10 to 50 pounds.

The latex bag is held open for filling by stretching it over a fiberboard collar, rectangular in shape. After filling, an air-tight seal is effected by twisting the collar three or four times. This closure is maintained, and the collar prevented from untwisting by its relation to the side walls of the rectangular outer container. After defrosting, the bag is readily untwisted by the consumer, and the opening through the collar again provides a convenient means of unloading the bag.

The Cry-O-Vac bag, tough and flexible at low temperatures, is said to be sufficiently elastic to prevent any danger of bursting as a result of expansion during freezing, thus eliminating the need of the usual head space to allow for expansion and the consequent undesirable presence of air in contact with the foods.

A somewhat different use of the same principles is the OJ container for orange juice and other liquids. After filling, the latex bag is heat sealed to one end of the carton against a round opening in the inner flap. Upon thawing, the perforated outer flap is removed and the latex bag is punctured through the opening for greater ease in pouring the contents.—*India Rubber World.*

WATTAGE

Economy in Lighting the Home

IT IS more economical to buy one light bulb of high wattage than several bulbs of low wattage, according to lighting experts of the United States Department of Agriculture. Not only is the initial cost less, but one bulb of high wattage actually supplies more light than several small ones that total up to the same wattage.

For instance: one 100-watt bulb costs 15 cents while four 25-watt bulbs cost 40 cents. The cost of operation is the same for both. But it would take six 25-watt bulbs to furnish the same amount of illumination as one 100-watt bulb.

It is important to check voltage as well as wattage when buying light bulbs. Figures for both are clearly marked on the end of each bulb. If a bulb is made for a lower voltage than the house current, it will burn out more quickly. If it is for a higher voltage, it will not give the normal amount of light. Most households have 115-volt

electric systems. It is easy to check the voltage to be specified when buying bulbs by calling the electrical service supply agency.

Since a coating of dust on an electric bulb reduces its efficiency, it should be cleaned occasionally. The safest way to do this is to remove the bulb from the socket and wipe it with a damp cloth. Never let the bulb soak in water or allow the base to become wet.

PLANT FOOD

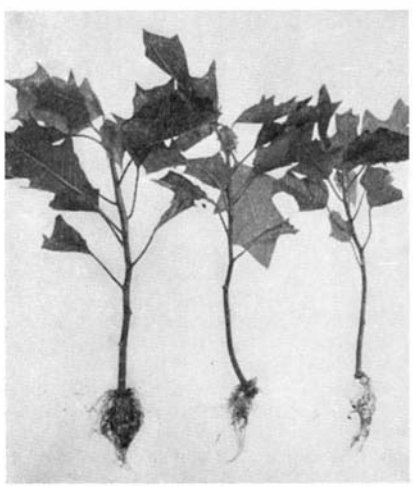
All Requirements in One Concentrate

PLANT chemistry, a comparatively recent science, has made tremendous strides in the last few years. Among the early results predicted by research workers in this field was the development of really efficient plant nutrients and chemical fertilizers, one of which is now announced by William H. Rorer, a Philadelphia pharmaceutical manufacturer, under the trade name of Plant Dinner.

This compound is a chemical concentrate, prepared in powder form, which, it is claimed, contains all the discovered inorganic chemical elements necessary for plant nutriment, as well as the organic substances which the plant itself manufactures but which accelerate growth markedly when administered externally. The plant food includes not only combining forms of nitrogen, phosphorous, and potash, long familiar as fertilizing agents, but also the trace ingredients now recognized as equally important — copper, zinc, iron, boron, sulfur, calcium, magnesium, manganese, and ammonium. It contains, in addition to Vitamin B_1, four other vitamins beneficial to plant health, including the newly discovered Filtrate Factor which has shown striking results when applied in the correct proportions. Also present in Plant Dinner are the two best known and most thoroughly tested growth hormones, napthaleneacetic acid and indolebutyric acid.

Extremely simple to use, Plant Dinner dissolves almost instantly into complete solution. It saves labor by combining plant feeding with regular watering periods, the highly concentrated chemicals providing 128 gallons of regular solution for every pound of the product. Extensive tests by a number of agricultural college technicians, professional growers, and well known amateurs, have established definite and convincing results. Treated grass shows 65 percent average superiority over untreated areas of equal size, yielding more than one and one-half the amount of grass from the same amount of seed and producing seven-inch roots compared to four and one-half inch roots. Flowers are stated to demonstrate an average of 45 percent improvement when treated. Vegetables respond with as high as 50 percent greater yield of normal healthy plants.

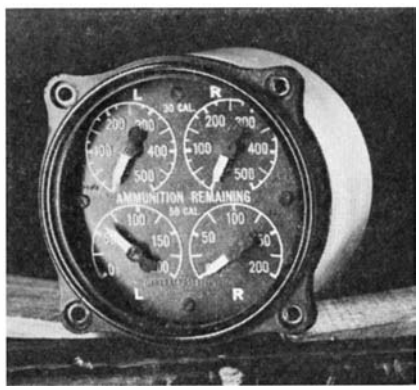
The product is also efficacious and commercially practical for speeding the rooting of cuttings, forcing plants to completion before frost, keeping fruits on trees until ripe and preventing loss from dropping, seed germination in hot beds and seed flats, indoor and outdoor transplanting, and other greenhouse, conservatory, and agricultural problems.



Test results of new plant food described. ***Above:*** **Poinsettias after transplanting. One at right was watered with plain water, center one with nutrient lacking hormones and vitamins, and one at left with Plant Dinner.** ***Right:*** **Lawn grass in which left-hand section was watered with the new plant food and right-hand section depended on rain water**

AMMUNITION COUNTER

A NEW application of direct-current Selsyn control is found in the dials, illustrated on this page, which indicate to military pilots how many



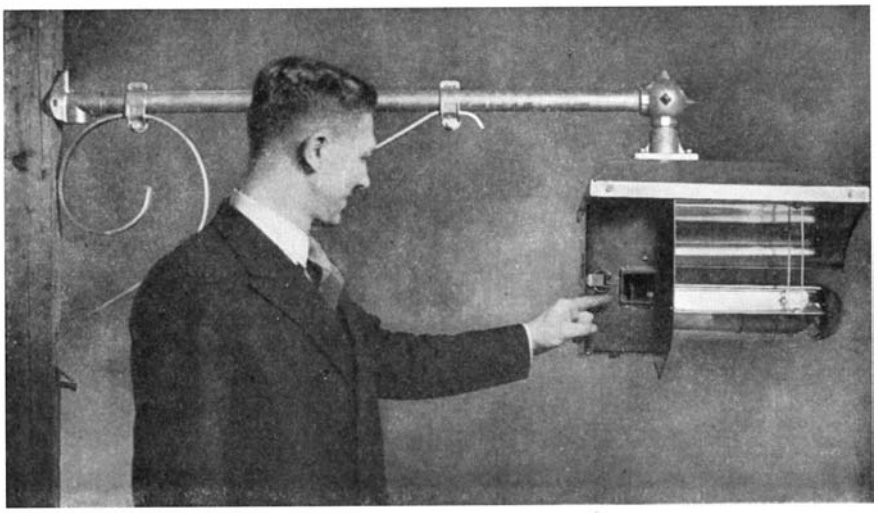
Air-fighter's indicator

rounds of ammunition remain in their machine guns. Designed by General Electric Company engineers, these dials can be placed directly in front of the pilot regardless of the location of the guns on the ship or their distance from the cockpit.

BARBED-WIRE

British Torpedo Destroys Broad Entanglements

A REPORT published in *The Illustrated London News* gives details of the so-called Bangalore torpedo, designed by an inventive member of the Royal Engineers at Bangalore. It is stated that this new torpedo is especially effective in blowing openings in barbed-wire entanglements to provide passage-



Equipment for automatic street lighting

way for troops and mechanized units. The torpedo was used with great effect by the Australians at Bardia.

A series of tubes, apparently some four inches in diameter, constitutes the torpedo. Each tube, packed with explosive, has a pointed nose and hollow cone at the base, into which fits the nose of the next section, and so on to the length desired. The first man dashes forward, carrying the first section of the torpedo, which is pushed through the wire along the ground, and is followed by the next man, whose job is to fit the nose of his section into the base of the first, the jointed tube being then pushed forward. This sapper falls back and takes up a covering position on the flank while the next advances, until the length is decided for the operation. The detonator is attached to the rear and is fired by a fuse or electric wire, the party being retired slightly out of the immediate area of explosion. The torpedo utterly disintegrates the obstruction, blowing a wide opening through which the infantry can then rush the defenses.

AUTOMATIC LIGHT

Street Light That Turns Itself On and Off

LATEST contribution to safer streets and highways is this new sodium street lamp designed by General Electric engineers and equipped with a photo-electric cell which will turn it on and off automatically as needed.

The photo tube is built into the rear of the unit and has a small glass window through which light can pass. This tube is set to respond to a predetermined level of natural lighting which is considered sufficient for safe travel. When the natural light falls below that level, as at dusk, the tube operates a control which turns on the sodium lamp. At dawn, when natural light returns to a safe level, the control turns off the lamp. A time delay feature prevents faulty operation which might be caused by lightning flashes or by headlights of automobiles or trains shining on the photo tube.

The lamp itself is a 10,000-lumen type particularly adapted for isolated installations such as at railroad crossings, highway intersections, and underpasses.

WELDED DWELLING

High-Speed Construction of New Georgia Home

NEW building construction speed, which permits erection of factories, plants, homes, and other structures in half the time of conventional methods, and which has definite implications in speeding present defense building requirements, is recorded in completion of a new seven-room residence in Georgia in less than two months.

This home, built for Mr. and Mrs. R. G. LeTourneau, utilizes a new type of prefabricated arc welded steel "building block," or panel, which completely eliminates the usual framework. Applicable to any structure, this "building block" is framework and wall member in one unit, reduces building construction time up to 50 percent.

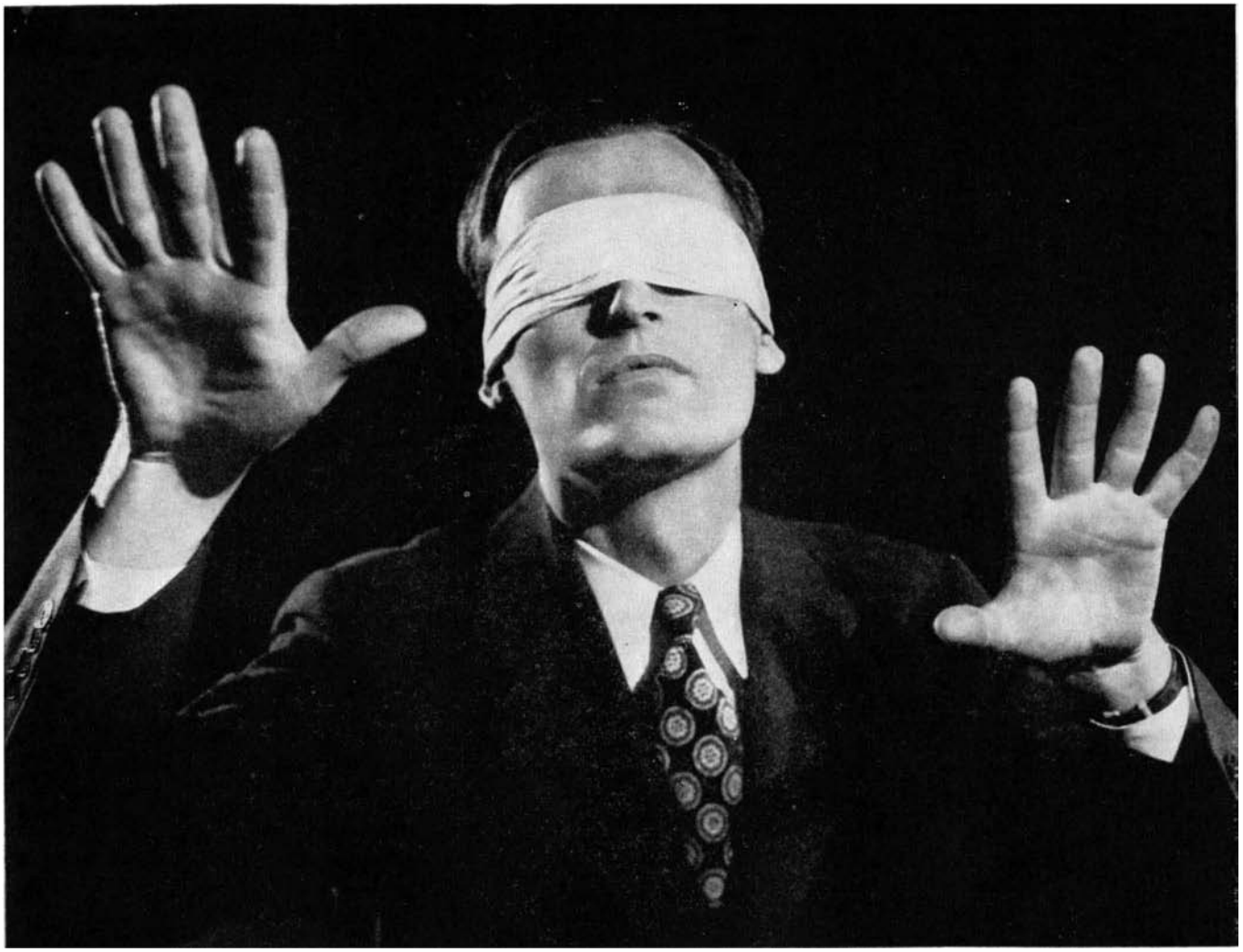
These steel "building blocks" are 7 feet 8 inches long by 3 feet 10 inches wide by 6 inches thick for walls and 18 inches for roof. Panels are formed by pressure stamping of 12-gage steel sheets, which are welded together with interior spacers set at intervals of not more than 24 inches to form a stout, box-like double panel member. In home construction, these panels completely eliminate conventional stud and joist framework; in larger structures, they do away with columns and roof beams. Because they are field welded together by continuous welds, both inside and out, they form unusually rigid and fireproof construction. They can be welded together to suit any design or arrangement. Modern shielded arc welding equipment, manufactured by The Lincoln Electric Company of Cleveland, Ohio, is used.

CHEMICALS FOR TREES

Can Retard or Force Blossom Formation

AN EXTRACT of last year's dead leaves will delay the opening of next year's buds on cut fruit-tree twigs set in it, Prof. C. G. Vinson, of the University of Missouri, reported recently. A contrary effect on peach twigs, forcing the flower-

A building block of welded steel



WHITE COLLAR MEN ARE STILL A DIME A DOZEN!

LOOK around your office. A few men have "arrived". They are the executives, earning big money. The others are what the top men in the company call "white-collar workers"—able, conscientious, hard-working—perhaps with specialized training, but they are nevertheless figuratively worth a dime a dozen.

WHAT'S THE DIFFERENCE between the executive and these "white-collar workers"? That's the question being asked by men who have hopes . . . men who want to climb out of the rut and into the top-flight class themselves. The answer is—*there's very little difference!*

Has the man who makes $5,000 twice as much brains as the man who makes only $2,500? Has the man who makes $10,000 twice as much brains as the man who makes $5,000? Of course not! And it would be amazingly easy for *many men* to transform an average salary into a large salary!

HOW IT'S DONE! The difference between success and merely "getting along" lies in executive training. In the old days, successful executives had to gain their ability through long years of experience. But as business became more complicated, educators became business-minded. Many big universities added schools of business; the Alexander Hamilton Institute was founded—and since then has pointed the way to success to more than 400,000 men!

HOW YOU CAN DO IT. The Institute has organized and formulated the knowledge of the country's most successful business men. Co-operating with it are dozens of leaders like Edward R. Stettinius, Alfred P. Sloan and Thomas J. Watson. As a result, the Alexander Hamilton Institute offers you modern, up-to-the-minute training and information you would almost have to give your right arm to gain by any other method!

CUSTOM-MADE TO SUIT YOUR NEEDS. Please get this fact clear in your mind. *The Alexander Hamilton Institute offers a PERSONAL service, geared not only to YOUR particular needs, but to your particular needs TODAY—whether you are a young man just earning his first business laurels, or a busy corporation official who wants to keep up with rapidly changing economic conditions.*

PUT IT UP TO US. Why not prove to yourself that you have the first quality of an executive—the ability to make a decision? Write us for a free copy of that important little book, "Forging Ahead in Business". For many men this simple act has been a major turning-point in life!

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ing at an earlier date, was obtained with several organic acids commonly found in plant tissues—succinic, maleic, fumaric, and malic. Tannic acid had an effect similar to that of the dead-leaf extract, hindering flower opening.

The experiments reported by Prof. Vinson are preliminary steps in a search for a compound that can be sprayed on dormant fruit trees in early spring, to prevent them from blossoming too early and then getting caught by frost, at present a source of great losses in northern orchard regions.—*Science Service.*

PRESS

For Transfer Work, Offset, and Color Printing

A NEWLY patented portable press for use in a wide variety of printing processes has recently been announced. Called the Laszlo Universal Press, its features include a resilient hard-rubber cylinder which lends itself to offset printing, eliminating the necessity of rubber blankets. It is also provided with two interchangeable printing beds, one a flatbed for printing from unmounted metal, celluloid film, paper plates, and so on, the other a chase for type-high material, mounted cuts, rubber and linoleum plates and the like.

This new press is of wide interest to schools, photographers, artists, and small printing plants. Because of its versatility it can be used as an etching or lithography press, for making reproductions from photographs, for squeegee operations, or for printing lithographs and making color reproductions.

In operation, the press is clamped to the corner of a table. The motion is imparted by a three-spoke star wheel, while a pair of strong metal frames holds the upper hard-rubber roller and the lower steel roller. The drawing bed, or printing board, has a bevel edge which moves back and forth between the two rolls. Roller bearings are provided for easy operation.

TENDER "FRANKS"

Pineapple Juice "Predigests" the Skins

IT HAS been discovered that the fresh juice of pineapples, when properly applied to natural frankfurt casings, makes them more tender. By means of the new process, these casings become as tender as the ground, cured smoked, and cooked meats which they contain.

This process was developed in

A bath in pineapple juice renders "frank" skins more tender

food laboratories of Swift and Company. According to Dr. R. C. Newton, who supervised the experiments, many months of exacting research were required to perfect the new process, patents for which are pending.

"It has long been known that pineapples are particularly rich in protelytic enzymes, which have an effect on proteins," Dr. Newton explains. "It remained, however, for exhaustive tests made in the laboratory to apply these enzymes to natural casings. Further experimentation was necessary to develop the process on a manufacturing scale and this was achieved by the laboratory and operating departments."

The enzymes referred to are a peculiar kind of protein found in some vegetable, fruit, or animal cells, which have the ability to act on other organic materials, "peptizing" the proteins and thereby softening the cell tissues.

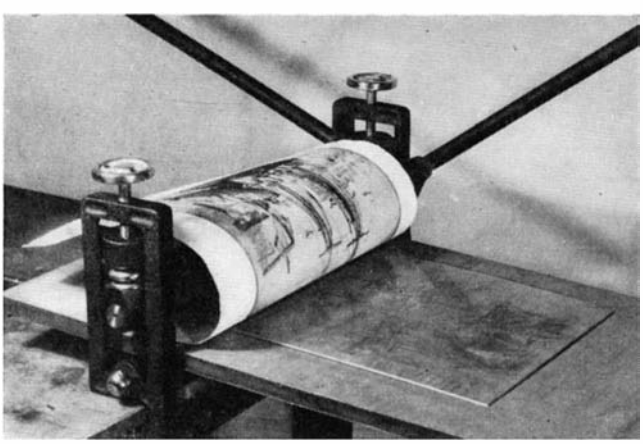
In production, the frankfurts are given a bath in a pineapple juice solution immediately after the natural casings are filled with the meat, or the links of sausage may be sprayed with a fine mist of the same solution. After the frankfurts are allowed to hang for a sufficient time to permit the enzymes to do their work, the regular processing of smoking in special ovens over hardwood fires is continued. This smoking and the following steps of cooking, cooling, and washing with sprays of water remove all traces of the juice and its enzymes. The traditional flavor of the sausage remains without even the slightest taste of the pineapple juice.

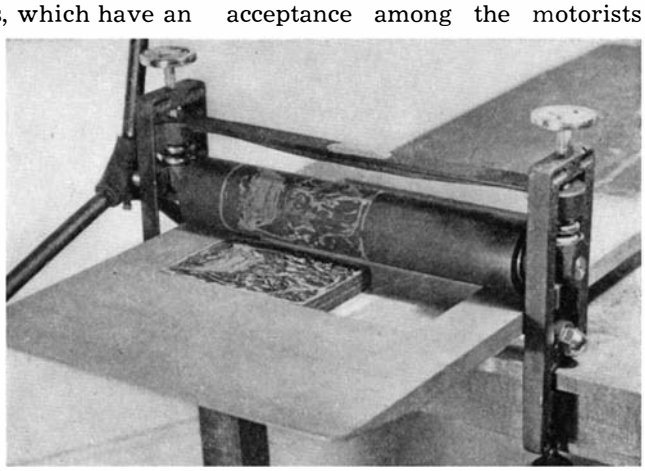
RUBBER FENDERS

Reduce Motor Vehicle Upkeep Costs

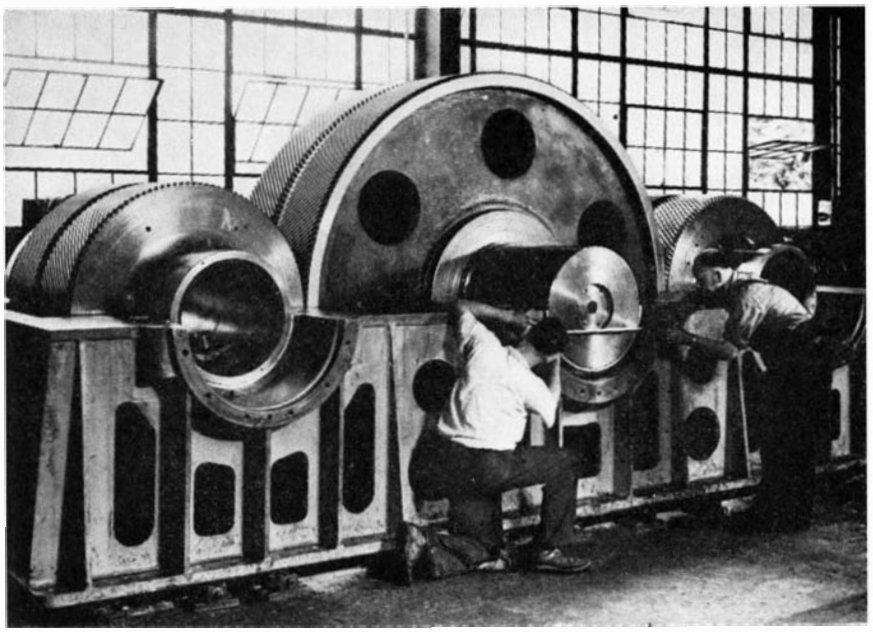
THE fenders of automobiles being among the most vulnerable parts of a vehicle, the Dunlop Company of England some time ago decided to investigate the possibility of replacing metal with rubber in the manufacture of fenders for commercial vehicles.

The original Dunlop rubber fenders met with overwhelming acceptance among the motorists





This versatile press will handle a wide variety of printing surfaces



Checking the main bearing seat of a huge Diesel propulsion gear

of England and today, reports *Highway Research Abstracts,* thousands of passenger and commercial vehicles in England are fitted with these rubber fenders.

The fenders are molded in one piece and by the careful compounding of the rubber are made sufficiently rigid without impairing flexibility.

Many collisions which would damage metal fenders have no effect on the rubber type and they immediately recover their shape after impact. Furthermore, the rubber is waterproof and rustless.

Economy of rubber fenders is evident from the fact that they greatly reduce the cost of replacing or repairing damaged fenders, plus the saving of the time consumed for such repair work.

DIESEL GEARS

Largest Twin Engine Propulsion Gear

TWIN Diesel engines, each rated at 4250 horsepower, will drive the propeller shafts of four of the type C-3 Maritime Commission vessels. The reduction gearing through which these engines will operate is shown in one of our photographs; the engineers in the picture are checking the main bearing seat of the unit.

Since the Diesels used in these particular installations operate at a normal speed of 180 revolutions per minute, it is necessary to introduce a reduction gear in order to drive the propeller at the predetermined rate of 85 revolutions per minute.

By means of electric couplings in the propulsion gear drives, it is possible to operate the ship with either engine while the other is shut down. This will, in emergencies, permit adjustments to be made on the engines at sea, while the vessel is proceeding under the power of the other. Maneuvering is also simplified since one engine can be run in the forward direction, while the other can be run in reverse. The engineer can thus move his ship forward or astern by the operation of a single lever controlling the electric couplings.

The propulsion gear drive illustrated is being built by Westinghouse Electric and Manufacturing Company. Among other Diesel gear drives being produced by this organization are ones for type C-1 vessels for the Maritime Commission. These units, smaller than that shown, are rated at 4000 continuous shaft horsepower, and will also incorporate the electric coupling system.

HEINKEL BOMBER

More Details of the Plane Shown on Page 198

FROM S. W. Clatworthy, artist, of London, England, comes the drawing reproduced as the frontispiece of this issue, together with the following data regarding this plane that can carry a load of eight 550-pound bombs.

"In raids on Britain," writes Mr. Clatworthy in a letter to the editor of this magazine, "this type, Germany's standard long-range bomber, so predominated, especially at night, that raiders were being termed 'Heinkels,' just as they were called 'Gothas' in the last war after the fighter-bomber makeshift so widely used by Germany.

"Less ugly than most German bombers," continues Mr. Clatworthy, "the Heinkel still has the typical hog-backed, sagged-tail look. Crew is normally four, span 74 feet, all-metal construction, top speed 274 miles an hour, ceiling 26,000 feet, can manage about 2000 miles with two tons of bombs. Defense armament, as usual with German bombers, is woefully weak. The three machine guns are on crude mounts that allow only restricted cones of fire.

"Detail design of these Heinkels is involved, especially in the petrol injection system that replaces carbureters to handle the inferior 87-octane fuel. The undercart action, clearly shown in the drawing, is another typical instance. There is evidence of quick mass-production standardization in the wings, where the same bracing piece is merely multiplied for additional local strength, a negation of true design which must carry the penalty of reduced performance."

LARGEST CAR FERRY

Is Also Safest, One Of Fastest in World

RADICALLY different in appearance and construction from previous ships of her type, the all-steel *City of Midland* is the largest, most modern, and one of the fastest car ferries in the world. It was launched last fall from the yards of the Manitowoc Shipbuilding Company, and will go into service in the Lake Michigan fleet of the Pere Marquette Railway Company. The *City of Midland* has an over-

Over she goes!

all length of 406 feet, a displacement of 8200 tons, and a service speed of 18 miles per hour, reports the *Du Pont Magazine*. Special construction features which make her one of the safest ships afloat include: division of the reinforced double-waterbottom hull by steel bulkheads into 11 water-tight compartments; all-steel, fireproof construction; all-metal furniture; automatic sprinkler protection and fire-alarm system; signalling, communication, and lifeboat facilities; gyroscope and radio compasses; direction finder. When completed, she will cost $2,000,000.

DENOUNCED

Astrology Lacks All Scientific Foundation

ASTROLOGY, the tenets of which hold that the stars and planets exert an influence on human events by which predictions may be made in advance, is denounced as lacking every conceivable scientific foundation as well as being psychologically harmful, in a report issued by the Boston and Cambridge Branch of the American Association of Scientific Workers, according to *Science Service*.

The report was prepared by a committee of which Dr. Bart J. Bok, associate professor of astronomy, Harvard University, is chairman, and Mrs. Margaret W. Mayall, research associate of the Harvard Observatory, is secretary. Methods and claims of the astrologers are briefly summarized, and reasons given why they are not accepted by scientists.

"Astrologers have not provided us with as much as a sound hypothesis that might serve as a basis for their speculations," states the report. "Astrologers attempt to offset this lack of a sound working hypothesis by the introduction of terms and concepts that are unknown to physicists and astronomers.

"Scientists would feel justified in considering astrology as a legitimate field of scientific inquiry," continues the report, "if astrologers could claim that its basic rules had been established through a rigorous study of correlations. This is not the case. The rules by which astrologers interpret their horoscopes have not been derived from any known experiments or observations."

Though no careful, extended, statistical study of the success or

failure of astrological predictions, which might prove a decisive test, is known ever to have been made, statistical tests of the supposed broad influences of the planets and zodiacal signs have failed to verify these claims, the report declares.

GARDEN HOSE

50-Foot Length Weighs Only Eight Pounds

A DISTINCTLY new type of garden hose is featured by its extreme light weight. A child can handle a 50-foot length with ease, since the

50 feet—eight pounds

total weight, including coupling, is only eight pounds.

Although the "Junior Garden Club," announced by The B. F. Goodrich Company, is designed for many specialized services, where the regular size may be cumbersome, such as watering flowers, supplying sprinklers, washing the car, cleaning basement floors and other uses, it carries from 65 to 75 percent as much water as the conventional size, at average pressure, when attached to spray nozzle or sprinkler.

Inside diameter of the hose is 3/8 inches, while the standard inside diameter is 5/8 inches. The hose, however, is equipped with full size couplings, to fit all standard bibs.

WOOD PLASTIC

Treatment Opens New Fields for Wood Products

IN OUR January 1940 issue we published a report on a new method of plasticizing wood. More details of this method have been announced by the Forest Products Laboratory, Madison, Wisconsin. Comparatively simple in operation and reasonably inexpensive, this plasticizing proc-

ess has apparent application in the bending of wood and in the production of cheap plastics for molded products. The treatment is a by-product of the laboratory's research on the chemical seasoning of refractory woods.

During the course of seasoning experiments it was found that oak which had been soaked in a concentrated solution of urea and then dried became plastic and capable of being bent, twisted, and compressed when a temperature of approximately 212 degrees, Fahrenheit, was reached and while the wood was still in the dry condition. The wood retained its plasticity while at or above the critical temperature and resumed its normal hardness and rigidity when cooled, retaining its altered shape unless reheated. In addition, it was found that urea-impregnated wood chips or sawdust when subjected to elevated temperatures and pressures can be compressed to a density approaching that of basic wood fiber, and that in becoming self-bonding with the urea-lignin produced by the treatment, they form a material of true thermoplastic properties.

Although the new process apparently has wide possible application in wood bending and in the production of cheap plastics, the Forest Products Laboratory has so far been obliged to ignore specific applications and concentrate its available research effort on exploring fundamentals of the treatment. The work was initiated with blackjack, overcup, southern red and white oaks, but trials with such woods as Sitka spruce and juniper have indicated that the treatment should be applicable to softwoods as well as hardwoods.

Thermoplasticity, as produced in wood by the urea treatment, should be useful in the molding of a variety of wooden articles, including those produced by molding large plywood sheets.

HIGHBROWS?

The Highbrow Hasn't a High Brow

MYTHS of "Nordic superiority" fare ill at the hands of Dr. Ales Hrdlicka, eminent physical anthropologist of the Smithsonian Institution, who has just completed a study of the heads of 150 of America's leading scientists. Far from being long-headed blonds, Dr. Hrdlicka's group of outstanding American

scientists tend to be wide-headed, and their hair is decidedly dark.

The group included in the study were chosen from the membership of the National Academy of Sciences. This body, sometimes referred to as the Senate of American science, elects to its membership only persons of proved accomplishment and reputation in the various fields of science.

Another myth that suffers from this study is that of the "highbrow." Eminent scientists don't average more prominent foreheads than do other men, the measurements show. Neither do scientific leaders have massive heads on stoop-shouldered, spindling bodies; the general physique of Dr. Hrdlicka's 150 is full-grown and sturdy. This, it is pointed out, is largely a matter of nutrition. Men with their brains and training get good jobs and keep them.

Seven percent of the group have decidedly back-sloping foreheads —another traditional "sure sign" of inferior intellect. This, Dr. Hrdlicka explains, has nothing to do with the brain content of the skull. A sloping forehead is usually due to larger-than-ordinary sinuses over the eyebrows, giving a wider base rather than a narrower top. Even when the slope is due to other causes, however, it does not necessarily mean any inferiority of the brain.—*Science Service.*

CABINET KITCHEN

Combines Sink, Stove, And Refrigerator

A NEW cabinet kitchen, produced by Dwyer Products Corporation, may well be installed in the living room of a home where, in its closed position, it would appear to be a

Cabinet kitchen, open

private bar or a large radio cabinet. In reality, it is a combination refrigerator, electric stove, and kitchen sink. It is intended, of course, for use in small apartments or other places where space is at a premium.

As shown in our pictures, the upper lid opens to expose the small

Cabinet kitchen, closed

kitchen sink with a work top to the left and two electric hot plates to the right. Below, a door to the left opens into an electric refrigerator. The right-hand door opens to show an oven sufficiently large for roasting average-size birds.

BOAT FITTINGS

Of Monel, They Are Light Weight

SOMETHING new in fittings for the masts of small sailing craft, especially racing classes, was dis-

Light but strong boat fittings

played at this year's Motor Boat Show in New York City. The fittings were developed in connection with the trend toward fittings lighter than those which can be provided in conventional cast forms.

The fittings are made of 20 gage, cold-rolled, Monel strip with a breaking strength of 120,000 pounds a square inch. Their weight is approximately one-third that of cast fittings. They were designed by Whitney Stueck, naval architect.

RECORD PLAYER

For Recording and High Quality Reproduction

FAST-GROWING interest in high-quality recording and reproduction of records for transcription in the home has created a demand for a turntable that will meet these requirements. Such a unit has just been announced by the Presto Recording Corporation. It consists of

Professional tone for amateurs

a dual-speed, 12-inch turntable of a type formerly available only in commercial recorders.

This new turntable is made up of an aluminum casting that has been precision machined to dynamic balance. It revolves on a single ball bearing at the base of a bronze shaft well. A metal pulley on the motor shaft drives against a rubber tire fitted directly on the rim of the table, thus eliminating idler wheels and other wearing parts. A slip-over pulley is provided so that the turntable can be operated at speeds of 78 and 33 1/3 revolutions per minute.

The manufacturers claim that each part of this turntable unit is hand-fitted and finished. Speed accuracy is placed at 0.4 percent and speed regulation at 0.2 percent.

The entire motor and turntable unit, shown in one of our illustrations, is mounted on a steel base ready for installation in portable or console phonographs.

(Continued from page 208)

synthetic material created from polyvinyl chloride, which is derived by a series of chemical reactions from coke, limestone, and salt.

The new paint is liquid at room temperatures and requires no heating before application. At ordinary temperatures it can be either brushed or sprayed, and can be thinned with either brush or spray thinners when necessary. It is made only in semi-glossy black and must be used in conjunction with a Koroseal primer with similar characteristics.

The new paint, when thoroughly dry, is extremely resistant to the action of fumes and vapors from acids, alkalies, and salts at room temperatures or slightly above. It resists all acids except concentrated formic and acetic, and is not affected by brass, chrome, nickel, cadmium, zinc, copper, silver, or tin plating solutions. Such solutions are not contaminated or fouled by the thoroughly dried paint, although it is not recommended for constant immersion in liquids.

REFRIGERATED METAL

Process Prevents Premature Age-Hardening

IN DIE pressing duralumin sheets for aircraft body paneling, bottle-necking has hindered production. Sheets must be pressed within one to two hours after solution treatment because those allowed to age-harden longer give excessive splitting and consequent loss in scrap. High cost limits the number of presses in a shop, and an efficient management must plan production from the various dies to keep the presses operating as much of the time as possible.

To increase press efficiency by eliminating delays from waiting for freshly heat-treated blanks, J. C. Arrowsmith and K. J. B. Wolfe, Pressed Steel Co., Ltd., have reported to the Institute of Metals experiments on the storage of heat-treated blanks at subnormal temperatures, as has been done for some time with duralumin rivets, to inhibit premature age-hardening.

Temperatures of −6 degrees to −10 degrees, Centigrade, were found the most useful and economical for storage of heat-treated blanks. The time for material to harden to about 90, the Vickers penetration number at which pressing begins to be difficult, is then around 100 hours. It can safely be assumed that no appreciable age-hardening occurs in the initial 50 hours of storage.

Because of its low cost, paraffin was selected for the liquid in the quenching bath following the normalizing operation. Film remaining on the blanks helps to spread the lubricant used in the subsequent pressing. Where presence of paraffin is undesirable, industrial methylated spirit or white spirit may be substituted.

A refrigerator has been installed immediately outside the salt bath shop in the aircraft department of the Pressed Steel Co. Rapid transfer to the refrigerator and the quench into refrigerated paraffin are important factors in obtaining maximum delay in age-hardening.

Experience with the refrigerator in actual practice shows increased press efficiency, reduced scrap, and necessity for fewer heat-treatment furnaces. Output of the heat-treatment department has been raised by the more regular flow of work and the fact that heat treatment of blanks can proceed regardless of fluctuating demand from the press shop.—*News Edition*, American Chemical Society.

SPINNING BALL

Spins 110,000 Times a Second

THE propeller of a pursuit airplane, spinning at 2500 revolutions per minute, is practically standing still compared with a tiny steel ball used in experiments described by L. E. MacHattie, of the University of Virginia, reports *Science Service.*

By magnetically suspending a steel ball 3/32 of an inch in diameter in a vacuum, so that friction was nearly eliminated, he was able to spin it 110,000 times per second, about 2600 times more rapidly than the propeller.

In some researches, a rapidly rotating mirror is needed. To test the feasibility of such a use of the device, two flat faces were ground on the ball. Then it was spun to more than 100,000 revolutions per second without bursting. In another test a drill rod 3/16 of an inch in diameter and 7/8 of an inch long, was spun at 36,000 revolutions per second, before it was bent double.

An important use of rapid rota-

tion is in the possible separation from ordinary uranium of the power-producing U-235. The different forms of the elements, or isotopes, can be separated with a spinning device called an ultra-centrifuge, which works fundamentally like the cream separators used on farms. Though relatively slow rotary speeds such as 66,000 revolutions per minute have been estimated as necessary for the uranium separation, the cylinder must be several inches in diameter, which makes much more of a problem than the tiny ball.

The leader in this research is Dr. J. W. Beams, also of the University of Virginia.

SLOTTING HEAD

Precision Unit for Milling Machines

A UNIVERSAL slotting head that can be used on all types of milling machines for precision work has a ram stroke adjustable from 0 to 4 inches; the adjustment may be quickly and accurately accomplished. The head is equipped with a ¼ horsepower motor with four

Sharp corners, special shapes . .

speed changes — the speeds range from 50 to 250 or from 100 to 580 strokes per minute. The tool holder —of the clapper-box type — can be turned in any position desired.

The housing of this universal slotter, announced by The Experimental Tool and Die Company, is polished cast aluminum, and all working parts are made of graphitic steel, heat treated and ground. Preloaded Timken bearings are used throughout and the gears are hardened and ground.

It can be used for cutting keyways, templets, splines, internal gears and for slotting out precision blanking dies or wherever sharp corners and special shapes must be machined.

GLASS INSULATION

Plus Varnish for Electrical Equipment

GLASS cloth, impregnated and coated with heat resisting varnishes developed especially for this purpose, is now available for use as insulation by manufacturers of electric motors, generators, and similar equipment. This new insulation material, known as Irvington Varnished Fiberglas, is furnished in full-width rolls and tape of various widths and thicknesses.

The material consists of a woven glass cloth base (Owens-Corning Fiberglas) impregnated and coated with a special varnish which greatly increases its resistance to abrasion and impact, and increases its overall mechanical strength. The resulting material has much higher insulation resistance and much greater ability to withstand heat than other flexible insulations, thus making possible manufacture of lighter, smaller motors for any given horsepower rating and safer operation of these motors under continued overloads.

NEW RAYON

Exhibits Characteristics of Wool

A NEW rayon fiber, with a high degree of permanent crimp, has been developed by the Rayon Department of the Du Pont company. Lacking as yet a more formal title, it is known by its laboratory designation of "Fiber D." Tests indicate that fabrics containing Fiber D possesses certain characteristics now available only in wool. The crimp, which gives bulk and loft to the yarns and the wool-like appearance and feel to the fabrics, is an inherent characteristic; if it is partially removed during processing, it may be recovered by simple treatments. An outstanding characteristic is a smooth cross-section, as contrasted to the crenulated or ridged pattern of standard rayons. It is claimed that fabrics made of

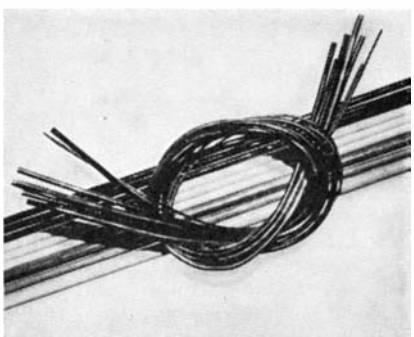
it are able to shed dirt more effectively. As with other rayons, Fiber D may be dyed to brilliant clear colors even in the lightest shades.

VARNISHED TUBING

High in Strength, Extremely Flexible

A NEW electrical insulating tubing, designed for use by manufacturers of electrical, radio, and instrument equipment, is varnished on the inside as well as the outside surface.

Known as Ire-O-Volt Varnished Inside-and-Out Tubing, the new



Varnished—inside and out

product meets all A.S.T.M. specifications for an oleoresinous varnished product. An oleoresinous varnish is an oil-base varnish as distinguished from spirit soluble varnish or lacquer.

Principal advantages to the user include greater ease of slipping over wires due to the smooth varnished inside surface, and high tensile strength with extreme flexibility. It possesses maximum heat endurance when subjected to A.S.T.M. test at 425 to 450 degrees, Fahrenheit, for 15 minutes and is slow burning. Moisture resistance and ageing properties are said to be superior to those obtainable with tubing varnished on outside only.

FIRE RESISTANT

Paint for Wood Retards Spread of Fire

FOR SEVERAL years the United States Forest Service has been conducting experiments with fire-resistant paints. Of these, the Service now reports that the most satisfactory are those made with linseed oil and finely ground borax. Pigments may be added to provide desirable brushing qualities and to furnish hiding power.

In the manufacture of this paint the borax is ground in a pebble mill and screened through a 200-mesh sieve. Then two parts of the powdered borax by weight are mixed with one part of raw linseed oil and thoroughly ground. This paste is then mixed with color, turpentine, and drier just before using.

Experimental work thus far is proving satisfactory although it will take some time to develop fully the advantages and limitations.

GLASS FABRIC

THE airplane has a way of pressing into its service every branch of applied science and every new material. Also, the needs of the flying machine have a way of bringing new methods or materials into being. Thus, while linen or cotton fabric for the wings and fuselage is an excellent covering material, it has certain drawbacks, and we learn that wings covered with glass cloth have been flown on the light Taylorcraft plane. The glass cloth, developed by the Owens-Corning Fiberglas Corporation, is held to be ideal for aviation use. It does not shrink or stretch in the presence of moisture, does not rot, and is not affected by temperature changes. The glass cloth is non-absorbent, smooth, and continuous, and does not soak up moisture in rain or fog, which is an important matter from the point of view of weight.—*A. K.*

ALUMINUM FOIL

Protects Bacon, Keeps it Fresh

A NEW packaging method keeps bacon fresh in color and taste for periods up to six months or more, thereby making it possible to ship bacon over long distances and store it until sold. The package consists of a flat aluminum foil envelop with a Pliofilm lining, developed by the Reynolds Metals Company. It is designed to hold 12 half-pound packages of sliced bacon. After the meat has been placed within the container, carbon dioxide is directed into the envelop for approximately 12 seconds, after which the package is tightly sealed.

The aluminum foil exterior of the envelop protects the meat from exposure to the light, thereby preventing rancidity. The inner lining insures an air-tight seal and helps to prevent escape of the gas, which is employed because of its retardent effect on the development of mold.

CAMERA ANGLES

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

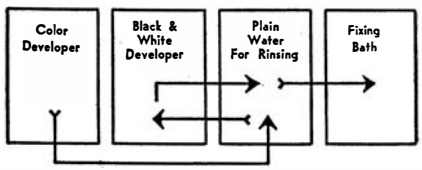
One-Solution Toning and Developing

By combining in one tray a special developer solution with a toning solution of a desired color, it is now possible to make a print in any one of a large variety of colors by direct development in the ordinary way. The means is provided by Develochrome toners, based on a discovery by Anton Bruehl, internationally famous photographer. All you need is three trays, as usual; one for the color developer, the second for a plain water rinse, and the third for the usual fixing bath. The one exception to the regular routine is that no acid or hardener is to be used either in the rinse or the fixing bath. The latter is plain hypo without acid hardener.

The method is really as simple as that, but the effects achieved may truthfully be said to be without limit. And the variety of results may be greatly extended by using a secondary bath known as the "black-and-white" developer in a fourth tray. These four trays provide, by varying the colors, the time of development in each bath, and the paper used, a truly royal road to the world of monochrome color photography.

Say you want to make a print with a snow-blue tone. You set up your three trays, pour plain water in the center tray and plain hypo solution into the third tray. Into the first tray you pour equal parts of the "A" and "B" components of the Develochrome developer, say 125cc of each. To this you simply add 10cc of the Snow-Blue Toner, and you are ready to go to work. The temperature of the solution should be kept within the limits 65 to 70 degrees Fahrenheit.

Six toners are available: red, yellow, blue, snow-blue, sea-green, and sepia. The latter three are used when these specific colors are desired; to mix up colors to produce any desired tone, it is necessary to have on hand a bottle each of the three primary Develochrome colors—red, yellow, and blue—which are mixed in various proportions, the exact quantities being determined by individual experiment.



Two-bath toning tray set-up

The complete process involves the following steps:

Exposure of the print for double the time normally required by the paper for ordinary black-and-white prints.

Develop in the toning-developing bath from two to three minutes, depending on the contrast desired.

Rinse in plain water.

Fix in plain hypo for five minutes.

Wash for 15 minutes in running water or in ten changes of fresh water in a tray.

Remove excess water with sponge or squeegee, and dry face up on clean photo blotters.

For "off-black" tones, a black-and-white developer is made up with one part of Quinolin developer and 10 parts of water, in a separate tray, and the print developed for part of the time in the color developer and the balance of the time in the second developer. Variations in the time of immersion in the one bath and the other will produce varying results. The print must be rinsed in plain water after each immersion. Prints that

Sea-green works nicely

Snow-blue fills the bill

have already been developed in the usual black-and-white way may be toned by bleaching and re-developing in Develochrome.

Recommended papers for use with Develochrome are the following: Defender Velour Black (all grades and surfaces); Eastman Illustrators Special, News Bromide, Kodalure, Vitava Opal and matte and semi-matte Kodabrom surfaces; Agfa Brovira. Velour Black seems to give the best results with Develochrome, and some workers use this paper exclusively for this work. Personally, we have obtained very agreeable tones with Kodalure, particularly when using Sea-Green.

Sepia is fine for some portraits

By the two-bath method—color-developer and black-and-white bath—a beautiful green tone particularly suitable for forest scenes is obtainable, a result that seems appropriate even for a portrait.

In general, more subtle color values are obtained by using the two baths rather than the color-developer straight. The beauty of the process is that you can command colors to suit your taste and that, through personal experimentation, you may select a shade of any given color varying anywhere from slightly off-black to very vivid.

Since we cannot reproduce here the colors of prints processed by the Develochrome method, we present black-and-white reproductions of several types of subjects that lend themselves particularly to this type of work.

Shooting Lectures

CAMERA clubs sometimes gain much practical information from lecturers, who supplement their talks with demonstrations involving the actual setting up and lighting of the subject. Although some of the members are able to retain all or most of the lecturer's demonstration, too many forget the details, with the result that this information must be picked up again somewhere else when it is actually needed by the individual worker, or inaccurately used due to lack of exact data.

The camera club may eat its cake and have it too, simply by arranging to make a snapshot memorandum of the demonstration. One or two members of the club should be assigned to photograph the various steps in a particular demonstration during the

Main light, spot, and reflector

progress of the lecture, each worker shooting what he feels to be useful. It is obviously better to have two photographers cover the event rather than one; afterward, both sets of pictures can be compared and the most useful, without duplication, retained for the final, complete story.

The method was successfully employed in a recent club lecture-demonstration by Morris Germain, A. R. P. S., who demonstrated fundamental lighting technique in portraiture. The only lighting used was that employed by Mr. Germain in making the demonstration; exposure on fast pan film varied from 1/10 to 1/50 at apertures *f*/2.9 to *f*/5.6. Since the pictures were to show how the lights were placed with relation to the model, the lights themselves were included in the pictures, the resulting prints showing the set-up. In most of the shots, even the lecturer himself was included, perhaps arranging a light or, again, holding a card reflect-

Single light and reflector

or. Two of the pictures are reproduced here to show the type of picture memoranda which club members can take, and how useful such records can later prove to be for all the members of the club.

In this particular instance, all the suitable pictures were enlarged to 11 by 14 inches and mounted on regular 16 by 20-inch boards, which were displayed on a wall in the club.

Tabletop Background

A LARGE print, 14 by 17 inches, behind a sheet of glass to keep it upright and flat, provided the background for the table top, "Homeward Bound." A better way of doing the job would have been to mount the print on a stiffer cardboard and attach it to a wall or other flat support without the necessity of using glass.

Background for tabletop

The glass arrangement happened to be most convenient at the moment, however, and, in order to avoid too bad reflections from the glass, the light was pointed to the ceiling to supply indirect illumination. A small light, partly masked by the print, was used to light the figure from the side. To get both in sharp focus, a small stop, *f*/22, was used.

Got a Spare?

WHEN the enlarger bulb suddenly burns out, you have to stop work right in the middle of things. But if you have a spare bulb handy, all you have to do is substitute the new one for the old, and go right on working. It's just a case of applying the old rule of an ounce of prevention. . .

Gray Equivalents of Colors

WHEN photographing colors on regular "black-and-white" film, they reproduce in various shades of gray when printed on paper. But what specific shade of gray and how much darker or lighter will a particular color reproduce than another? Certainly, the photographer will not

be able to tell unless he has photographed those colors before and remembers just what they were and what their particular intensities or brightnesses were. Likewise, if he changes one type of panchromatic film for another, there will be a difference again because of varying red sensitivity, resulting in a darker gray with one film and lighter gray with another.

One amateur, C. H. Rowles, of the London Terrace Camera Club (New York City), realizing this when he bought himself a set of water colors for use in tabletop set-ups, made himself a chart of gray equivalents in the following manner: On a white card he drew a line in each of the colors, one color below the other, labeling the name of the color alongside. He then photographed the card and thereafter had an accurate guide as to what gray he could expect from any one of the colors, using the same panchromatic film all the time. Obviously, different pan films could be "charted" by photographing the color card with each type of film.

Three-Way Bulb

THERE'S a three-way bulb available for a quarter that seems ideal for use in contact printing. Instead of varying the distance of the printing frame, simply adjust the bulb and you have weaker or stronger light at will. Providing about the same result as would a rheostat, the bulb burns 40, 60, or 100 watts as desired. You just turn a collar at the base of the bulb and any of the three light intensities is yours.

More on Latensification

REFERRING again to the subject of latensification recently treated in this department, we are now able to give a procedure recommended by Du Pont for increasing the sensitivity of their Superior films, 1, 2, and 3. Said to increase the speed of the films about three times normal, exposure meter ratings that may safely be used with latensification, are as follows:

	Weston		*G. E.*		*American Scheiner*	
	Day.	Maz.	Day.	Maz.	Day.	Maz.
Superior 1	100	80	125	100	29	28
Superior 2	200	160	250	200	32	31
Superior 3	240	200	300	250	33	32

Use a dark red or dark green safelight employing a 10-watt or weaker bulb. To determine the effect of a particular safelight on film at a given distance from the light, try the following experiment: Take several identical pictures of any subject, underexposing about two lens stops. In the darkroom, cut the film into short lengths, each long enough to include one whole negative, and arrange the strips at varying distances from the safelight, emulsion side facing the light. Pin down flat and use black paper supports for the film. With film strips mounted one behind the other, making sure that they do not cast shadows upon one another, expose the set of test strips for 30 minutes. Identify each film as to distance; then develop, increasing the developing time 50 percent above normal since latensification decreases the contrast. Inspect the results and pick for future guidance the distance that produces the greatest amount of shadow detail. The slight overall fog will not affect the printing of the negative, according to the makers.

Indoor Rink Shooting

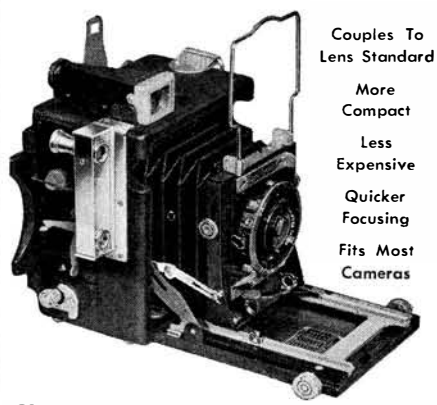
CONFRONTED with a rather monotonous daylight illumination coming through the skylight and the curtained windows of the indoor ice skating rink we visited in town one morning, there seemed nothing to do to pep up the lighting but to utilize

"Beginner"

in some way the direct beams of sunlight that managed to cut through between the curtains and strike the rink. This we did by withholding our fire until the subject moved into the beam or could in some way maneuver her movements so that the beam could be made part of the composition. In this way we were able to obtain the next best thing to artificial spotlighting and get interest into the picture.

Candid Shots in Photo Stores

EVER notice your brother fans browsing around the counters and display stalls in camera stores? Probably you've been so busy browsing yourself that you have paid no attention



to the others. Next time, try being objective, but make sure you have your candid camera along. In one of the large New York stores—Willoughby's, in fact—a trio of young fellows was inspecting a strip of miniature negatives. One of the lads was holding the strip stretched out, while the other two, in rather humorous attitudes, assumed unconsciously, of course, were taking a look, too. All three had concentrated expressions, one of them screwing up his face in a manner indicating a desire to scrutinize the negatives very carefully. It made a perfect picture, but no one was ready to shoot it. Besides, it needed a flash gun. Little incidents of the sort happen all the time, one of the salesmen told us. Make it a point to look for them; never can tell what you may catch.

Flash Gun for Low Priced Cameras

A LONG list of low-priced Kodak, Agfa, and other camera makes having pre-set automatic (self-setting) shutters can be fitted with Kalart's new Compak Speed Flash gun, the manufacturers announce. The Battery-Flector unit, designed expressly to accommodate the midget bayonet-base flash bulbs, comprises Kalart's Concentrating Reflector with its bulb ejector and a built-in battery holder containing two standard size batteries.

Baby Bottle Stoppers

ONE worker solved the problem of keeping solutions of concentrated developer by employing the familiar eight-ounce baby bottles, rubber stoppers and all. By distributing his developer in eight-ounce bottles, his solutions always fill the bottle and he thus avoids oxidation caused by partly filled bottles. The rubber cap makes an ideal cover, keeping the contents air-tight.

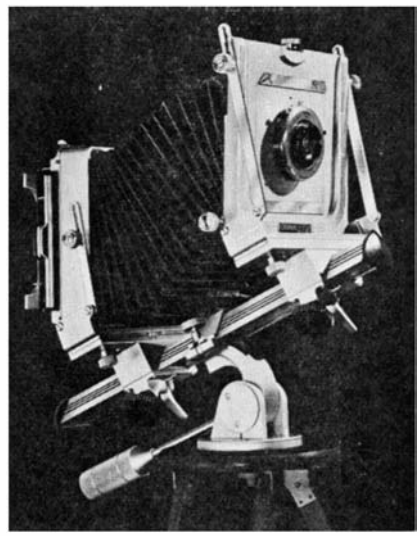
• • •

WHAT'S NEW

In Photographic Equipment

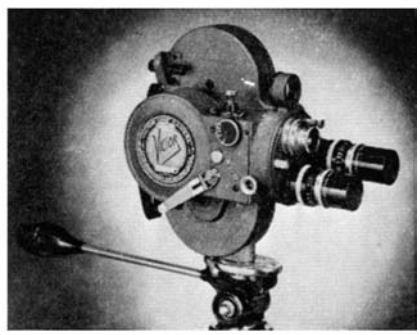
BEE BEE PLATE HOLDERS for Bee Bee, Maximar, Recomar, Voigtlander and similar cameras are now available in the 6½ by 9cm size, through photographic dealers. The design of these American-made plate holders is a distinct improvement over the imported product. They are of rigid, all-metal construction and are easy to load. A fine quality of felt is securely cemented to the frame in a manner which eliminates loosening or tearing. These holders list at $1 each. Cut-film sheaths for both 6½ by 9cm and 9 by 12cm sizes also are available, priced at 12¢ and 15¢ respectively.

GRAPHIC VIEW CAMERA: 4 by 5 view camera made entirely of metal. Various adjustments permit wide latitude in control of linear perspective, sharp field, and form of subject photographed. Front rises three inches, tilts forward or backward, swings and shifts either to right or left. Back also swings, tilts, shifts. Removable lensboard; camera also accepts regular 4 by 5 and 5 by 7 Speed Graphic lensboard. Bellows extension 12½ inches. Graphic or Graflex ground glass back. Inverted



V-section bed of aluminum alloy forms support upon which both lens and film may be focused. Rack and pinion may be locked in any position. Combined camera base and revolving-tilting tripod head built integrally with camera. Built-in spirit level on top of camera. Reversible back may be removed and re-positioned for vertical or horizontal pictures.

AIRCRAFT MODEL VICTOR: Improved model of 16mm Victor movie camera, with speeds 8, 16, 24, 32 and 64 frames per second, all set by dial. "The new unit," write the makers, "turns in results of remarkable accuracy at all speeds over a range of temperature down to zero and even

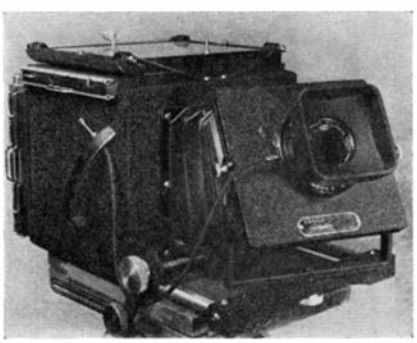


lower. In fact, the speed tests were made in a cold storage warehouse at -10 degrees and the camera was left overnight to simulate the toughest conditions likely to be encountered in practice. The speeds were tested with a neon type stroboscope and the settings of the instrument were not touched during the run at any speed. Even at the end of the winding the

speed was still so close as to cause only a very slow 'creep' under the stroboscope. This is so accurate that time intervals for most scientific purposes can be obtained merely by counting frames, without the necessity of supplementary timing devices. The value of this for both scientific and industrial research is apparent; the new camera will be found very useful for sport pictures such as analyzing one's golf stroke."

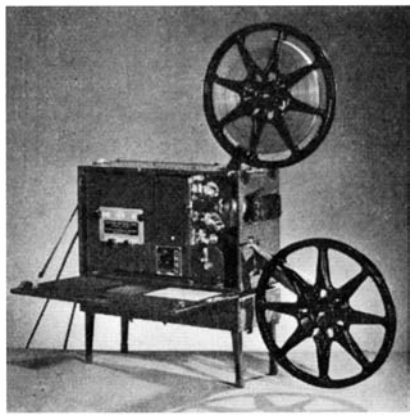
LUXOR MERCURY FOOT SWITCH ($4.95): Double mercury contacts, eliminating possibility of sparking, burning, or eventual wearing out of metal contacts. May be used safely on any electrical equipment using from 60 to 250 volts A.C. or D.C. Provides three outlets, one for steady pilot or safelight; two for enlarger or printer, operating simultaneously. Equipped with rubber feet.

KRIEGR-O-TONE 4 BY 5 COLOR CAMERA ($147.50): Complete with Velostigmat *f*/6.3, 7¼-inch lens, in Betax shutter, speeds to 1/100 second, cable release, two double registered holders with pressure plates. Movements include rise and fall, swing and front tilt, bellows extension. Features include natural position of hand holds on each side of camera; anchored trigger release worked by thumb of right hand while holding camera steady; weight, 6 pounds with holders and lens shade; handy sight mounted on top center. Balanced for use with



Photoflood without filter. Weston speed about 6; daylight, Weston 4. KB-6 filter used for daylight shots; KF-1 for flash. Accessory filters and combination lens shade and filter holders complete $3.75 each. Defender type B Tri-Color combination film used.

SOUND KODASCOPES ($295 to $520): Power output 10 watts to 40 watts. Choice of six lenses, in focal lengths one to four inches, available for each projector. All models accommodate 1600-foot reels for uninterrupted 44-minute show at 24-frame sound speed. All portable. Special provision for smooth film movement at point where it is "scanned" for sound. Either variable area or variable density sound films can be used with all models. Model FS-10 ($295), complete with two-inch *f*/1.6 lens, 750-watt lamp, all tubes, speaker and speaker cable, extra exciter lamp, oiling and splicing outfits. Any other lens may be substituted, with price adjustment. Rated output 10 watts; operates only on A.C., 50-60-cycle, 100 to 125-volt. Projector and speaker built into one compact case which divides into two sections, one for 10-inch permanent magnet speaker, other



serving as platform for projector. Also space for 1600-foot reel and accessory equipment. Model F (with two-inch *f*/1.6 lens, $370) operates on D.C. or A.C., 25-60 cycle, 100 to 125-volt; 10-inch electro-dynamic speaker; built-in motor generator; jack for microphone or phonograph pick-up; in two cases—speaker case has brackets to hold projection screen. Model FB (with two-inch *f*/1.6 lens, $400), mounted for projection in soundproofed blimp case, top of which conceals four-inch supporting legs and lifts projector to proper level for clearance of 1600-foot reels. Model FB-25 (with two-inch *f*/1.6 lens; with single speaker, $425; with double speaker, $450), available either with single 12-inch permanent magnet speaker or with two of these speaker units, allowing use of full rated capacity of 25 watts. Sound-proofed blimp; jack for "mike" or phonograph pick-up, permitting sound from either one to be mixed with sound from film track. Double speaker units can be used side by side, or separated. Model FB-40 (with 100 feet of speaker cable; with two-inch *f*/1.6 lens, $520): rated capacity of 40 watts, operates only on A.C.; 12-inch permanent magnet speaker. Separate jacks for microphone and phonograph pick-up, each with own control. Lenses available: one-inch *f*/2.5; 1½-inch *f*/2.5; two-inch *f*/2.5; two-inch *f*/1.6; three-inch *f*/2.; four-inch *f*/2.5.

FILMO "SPORTSTER" 8mm CAMERA ($69.50): Equipped with Taylor-Hobson 12½mm *f*/2.5 lens. Camera speeds, 16, 32, 48, 64 frames per second. Lens interchanges with choice of seven speed and telephoto lenses. Has automatic footage dial, automatically reset each time camera is loaded. Single frame exposure. "Drop in" loading—no sprockets to thread. Fully enclosed spyglass viewfinder equipped with masks for telephoto lenses. Built-in exposure guide.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle in a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

Let's Open The Trout Season

A LONG, long time ago we camped on the banks of Michigan's Little Manistee river the night before we opened our first trout season. We were so green at this trout-fishing business that we spent most of the evening poring over the pages of our first Weber catalog in an effort to identify newly acquired lures by comparing them with the catalog's excellent color plates. That's why we took the catalog along, and it continued to be a part of our duffle for many moons.

We believe American fishing tackle catalogs are an invaluable source of attractive and informative material

A Manistee river rainbow

and we wouldn't be without them. Each one is an angling encyclopedia, filled with constructive suggestions on the art of fishing, on tackle selection, how and where to use it, and many other helpful hints. Each tells of tackle and lures for bass, pike, pickerel, muskie, bluegill; for salt water men as well as fresh water devotees, but this being the dawn of a new trout season, we'll specialize in the stream fishing equipment now and review other types of angling later. As Izaak Walton said:

"I care not, I, to fish in seas.
Fresh rivers best my mind do please."

If you're like us, there's much to do before opening day. Take your rods, for example. Need new windings? Are ferrules, guides, or tips loose or cracked? How about a new, protective coat of varnish? But when it comes to repairs, remember, unless you're capable of performing a highly specialized job, don't try it—you may ruin the balance of a delicate piece of bamboo mechanism. "Balance" in American fishing tackle is the art of coördinating action of rod with size of

Weber's 2-piece 4-ounce fly rod

line so that energy of the rod is transmitted to the line with maximum efficiency and minimum effort, thereby producing the best possible conditions under which to lay a fly properly on water. Improper windings, too much or poorly applied varnish, an inexpertly repaired tip may completely upset this vital factor of balance. It doesn't pay to take chances. If a rod needs repairing, send it to the people who made it.

As in the construction of a fine rod, time and expert hand labor are important factors in production of a fly fishing line. Long-fibered Japanese silk must be treated with waterproofing compound before it is braided. Then, with lapses of several days between each, the line receives a series of applications of a special oil solution, impregnating the line to the core. After each treatment, every foot of line is hand-rubbed and honed, and the completed product is aged for months before you buy it.

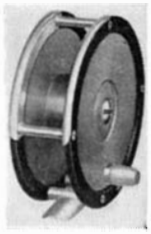
Dry fly

In determining correct size of line for a particular fly rod, we must keep in mind the definition of "balance" and endeavor to coördinate the "action" of the rod—not its length and weight—with the line to bring about the ideal mechanical conditions for the laying of a fly. The rest is up to the fisherman, who must develop his own skill through practice.

Although perfect complement of rod and line may seem confusing, it is not difficult to achieve. Again we refer to the encyclopedic 1941

South Bend Automatic

American tackle catalogs, many of which contain helpful charts and illustrations on this subject of balance. In addition to this fund of clearly stated, easily understood information on the proper line for your rod, The Weber Lifelike Fly Company offers a "Rod-and-Line Matching Service." Simply pack your rod carefully and ship it—*fully insured*—to the "Matching Service Department" at the Weber factory and you will receive, without charge, the scientific knowledge and competent judgment of their experts. Your rod will be promptly returned with a tag attached giving you detailed "Line Recommendations."



Weber's "Silent Knight"

In reels, the trout fisherman does not face the problem of the surf caster, the troller, or the bait caster: the trout reel is primarily a storage place, spare line for playing the hooked fish being customarily looped in loose coils in the left hand. Many stream anglers prefer the automatic type of reel, a development that has reached a new high in mechanical efficiency. Equipped with larger, stronger springs, the automatics will reel in from 75 to 90 feet of line, and some of the newer models are self-winding. One cardinal principle that should be embodied in all reels is the solid side spool disk. Perforated disks permit the line to bulge at the openings, a condition that will quickly cut and chafe the line.

Normally, the tapered leader is for dry flies, the level for wet fly fishing. Length, degree of taper, color, tensile

The new Erskine Minnow

strength, and the use of droppers all come within the realms of stream and weather conditions, personal preference, and casting skill. If you can learn to handle a long, finely tapered leader in dry fly work, your chances of piscatorial success will immeasurably improve.

In the matter of terminal tackle, we come to that perennial controversial question of "which fly?" Since Izaak Walton wrote about his "jury of flies (12), likely to betray and condemn all the Trouts in the river," the number of patterns has increased to more than 10,000. No man can satisfactorily tell you which half-dozen or so flies will prove to be the best for you—it is again largely a matter of personal preference plus a touch of Lady Luck's magic wand.

However, two years ago it was our pleasure to conduct a nation-wide trout fly survey through the columns of *National Sportsman*. The poll drew replies from 23 states, named 319 different patterns, and, after final compilations were made, the Weber people printed a folder showing both national and regional results of the survey, and they attractively packaged the winning lures into what is known as "The All-American Trout Fly Selection." We make no claim that possession of a set of these "All-American" dry flies, wet flies, and streamers will solve all trout lure problems, but it will present a cross-sectional view of the nation's trout fly preferences and form a logical base from which to start. We'll gladly send you one of these folders—free, of course.

Since that first night on the Little Manistee there have been countless camps, on waters near and far, but none has succeeded in topping the thrill of our initiation into the mysteries of trout fishing. Through the years we've annually pored over the new catalogs and learned much. In them you'll find all we've said and more. They're profusely illustrated and are briefly reviewed in the following paragraphs. Tell us which ones you wish and we'll send them to you. But despite the best of suggestions and advice, improvements in tackle, and inventions of new lures, trout fishing is still exactly what Izaak Walton so aptly termed it when he said, "O, sir, doubt not that angling is an art. Is it not an art to deceive a trout with an artificial fly?"

Library of Catalogs

ASHAWAY LINE & TWINE MANUFACTURING COMPANY'S series of world's record catches on Ashaway lines is an imposing one. Kip Farrington and the late Zane Grey are but two of many noted deep sea fishermen who have used Ashaway products. Also casting, trolling, and trout lines.

CREEK CHUB BAIT COMPANY needs no introduction to anglers. Five of the winning fish in *Field & Stream's* 1939 contest and eight in the *National Sportsman* event were taken with Creek Chub lures. A total of 35 enticingly colored pages of plugs, baits, fly rod lures, reels, casting rods, and miscellany.

FRED ARBOGAST'S Hawaiian Wigglers, with their vari-colored rubber "skirts" can out-hula the quivering grass dresses of Waikiki Beach anytime, so far as fish are concerned. It's a tried and proved lure, conclusively witnessed by photographic evidence in the catalog.

JAMES HEDDON'S SONS ably carry on the business founded by their father, Jim Heddon, with such well known lures as "River-Runt-Spooks," "Crazy Crawlers," "Chugger-Spooks," and a host of others. The Heddon line is extensive, includes rods, reels, all kinds of lures, including bass bugs for

trout rods, and every accessory. It has earned testimonials from Cal Johnson, Mack Sennett, Gene Tunney, Lynn Bogue Hunt, Irvin S. Cobb, and other noted anglers.

MONTAGUE ROD AND REEL COMPANY attractively displays both fresh and salt water rods in natural color. These include fly, salmon, bait casting, and trolling rods in one,- two,- and three-piece types; tarpon, tuna, and swordfish rods; surf casting, weakfish, and squidder rods, together with accessories.

OCEAN CITY MANUFACTURING COMPANY, in addition to their own widely known brand of reels, are now also producing the famous Edward vom Hofe reels and accessories. The 50 pages of this catalog will delight the salt water fisherman especially, but it likewise includes trout and fresh water reels, as well as spears, dart shanks, gaffs, and other sea-angling necessities.

PFLUEGER FISHING TACKLE, made by Enterprise Manufacturing Company, has won the respect of anglers from coast to coast. Picturing 51 varieties of fresh and salt water game fish, the catalog recommends tackle specifications for each, refers readers to pages on which equipment is described and illustrated.

SHAKESPEARE COMPANY'S "fishing ambassador extraordinary" is Tony Acetta, Professional Casting Champion. In motion pictures, as well as diagramatically in the catalog, Tony shows you how it's done. This 86-page publication has everything in the tackle line with which to emulate Tony, and with Shakespeare's famous "Wondereel," it can easily be done.

SOUTH BEND BAIT COMPANY'S newest guide to fishing tackle depicts every angling need (January 1941). Its 130 pages, many in full color—including pictures and descriptions of 34 species of fish—comprise a veritable text book on angling methods and equipment.

WEBER LIFELIKE FLY COMPANY for 22 years has produced the "Fishing Bible" of America's trout fishermen. The 112 pages of the 1941 edition are, as usual, packed with indispensable trout fishing lore and information. Its color plates of wet and dry flies, streamers and other lures provide invaluable assistance in selecting this year's supply of tackle. There is nothing in trout fishing equipment that is not covered in this publication. (As it is Weber's custom to charge for the catalog and to offer, in addition, a new fly or a 10-yard coil of Vec leader material, please send 25 cents with your request and specify whether you wish the fly or the Vec. —*Ed.*)

Boots

ONE absolute necessity for the early season stream fisherman is a pair of good boots. They may be hip boots, as shown, or knee-height rubber shoes, or the full length waders, depending on the kind of stream to be fished. Whether your opening-day river be large or small, shallow or deep, swift or placid, be certain you are properly booted for comfort and protection. There's nothing that so ardently dampens one's fishing ambitions, literally and figuratively, as the steady, irritating seepage of cold spring water into either leg of a pair of boots. The newest catalog of L. L. Bean, Inc., makers of canvas, leather, and rubber specialties, pictures waders of the stocking type for use with wading shoe, and the heavy-soled variety. There is also an extra light pair of stocking waders, patterned on the English mode, weighing 42 ounces, as well as many other styles of outing and fisherman's footwear. Want a catalog?

A necessity, good boots

Shotgun Preferences

INDICATIVE of preferences in gage, barrel length, and choke of shotguns are the following figures, taken from an Ithaca Gun Company report.

How Ithaca Model 37 Featherlight Repeating Shotguns Were Ordered During 1940

Gage & Length	Percent of each Gage & Length	Percent of boring ordered in each gage and length: Full Choke	Modif. Choke	Imp. Cyl. & Skeet
12/32	1%	95%	5%	
12/30	21%	90%	10%	
12/28	21%	23%	74%	3%
12/26	3%	5%	28%	67%
16/30	1%	90%	10%	
16/28	31%	41%	57%	2%
16/26	6%	7%	48%	45%
20/28	10%	60%	35%	5%
20/26	6%	15%	53%	32%

Model 37 has a five-shot capacity, with plug to conform to the three-shot Federal Migratory Bird Law. It has a chamber length of 2¾ inches, stock of 14 inches, with drop 1⅝ inches at comb and 2¾ inches at heel. All barrels are thoroughly proof-tested and the attractively etched receiver has solid top and sides for safety. Stock and forend are of genuine black walnut and are nicely checkered.

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 AVIATION MECHANIC

By Carl Norcross and James Quinn

THOROUGHLY up-to-date and comprehensive in treatment, the text of this book deals with the construction and maintenance of modern airplanes of every type—civil and military, large and small. The introductory chapter deals with the importance of the mechanic's work—his necessary function in all branches of aviation. The point is stressed that the mechanic holds the most important position in the field but one for which he must train himself thoroughly in order to contribute his part. After introductory material about the airplane and how it flies, the text goes on with the construction of planes and their maintenance, describing materials and methods. Throughout the book the reader is lead by simple step-by-step methods which present facts in easily assimilated form. (564 pages, 6½ by 9 inches, a large number of photographs and drawings.)—$3.60 postpaid.—*A. P. P.*

SCIENCE IN INDUSTRY

By Professor A. M. Low

LABORATORY work squarely underlies most of modern industrial development, and this book shows how this has come about. The fields chosen are in food, canning, plastics, coal, synthetics, oil, shipbuilding, aviation, printing, photography, and others. The book is entirely non-technical and easy reading. (160 pages, 5¼ by 8½ inches, 15 illustrations.)—$1.85 postpaid.—*A. G. I.*

WILDLIFE CONSERVATION

By Ira N. Gabrielson

DURING the past ten years no project of so vast a scope has created such wide-spread interest or received such universal support as efforts toward conservation of our natural resources, both inorganic and organic. Concerning himself only with the latter as resources that can be and are affected by man, the author, writing with authority gained from practical, constructive experience as Director of The Fish and Wildlife Service, U. S. Department of the Interior, clearly, simply, and factually explains the intricate inter-dependence of humans and wildlife, of soil and water, of forestry and land utilization. Conservation of our organic resources is a problem that requires close application of almost every known science; it is a momentous question that should seriously interest every person in this country. In a volume that qualifies both as text-book and as exceedingly readable literature, the author has expounded the problem and delineated the scientific approach to the solution. (250 pages, 6 by 9 inches, 56 illustrations.)—$3.60 postpaid.—*A. D. R., IV.*

DIESEL MONITOR

By Julius Rosbloom

PRESENTED in question and answer form, the text of this present book has been prepared with a view to simplifying the solution of problems encountered in Diesel service work. This is no highly technical textbook, but rather has been prepared for the average man whose knowledge of the field of Diesel engineering is confined to fundamental principles. It carries the official endorsement of the Diesel Engineers' Association and the United License Officers U. S. A. (528 pages, 5½ by 7¾ inches, numerous drawings and photographs.)—$5.10 postpaid.—*A. P. P.*

BIOLOGY

By Howard M. Parshley, Professor of Zoology, Smith College

SURVEYING only the main facts and principles of modern biology, this relatively brief book avoids entering on the technical details which so many scientist-authors, naturally in love with their work, think every reader surely must be made to learn. It is an elementary college textbook and is lucid. (232 pages, 5¼ by 8½ inches.)—$2.35 postpaid.—*A. G. I.*

HANDBOOK OF HEARING

By A. F. Niemoeller

PRACTICAL chapters on types of hearing aids, how to choose, buy, use, care for, and test them, together with other pertinent information, make up this excellent little book. Though its publisher sets an exhorbitant price

The Editors Recommend

Best Sellers in Science

COMPLETE GUIDE FOR THE DEAFENED—*By A. F. Niemoller.* The ear, impaired hearing and causes, diseases, drugs, ear discharges, hearing tests, everything worth knowing about the ears and hearing. **$3.10**

REFINING PRECIOUS METAL WASTES—*By C. M. Hoke.* Practical. Gold, platinum, silver, alloys, iridium, rhodium, low-grade wastes, equipment, identification, repurification, dealer list, etc. **$5.10**

SCIENCE EXPERIENCES WITH HOME EQUIPMENT—*By C. J. Lynde.* A book of 200 simple home tricks based on physical laws, each experiment being illustrated and its principle explained. **$1.45**

THE ENGINEER'S SKETCH-BOOK OF MECHANICAL MOVEMENTS—*By Thomas Walter Barber.* Working drawings of practically every conceivable movement, device, appliance, and contrivance employed in the design and construction of machinery for every purpose. Nearly 3000 illustrations. **$4.35**

SUPERSONICS—*By Prof. R. W. Wood.* A great deal of data on science of inaudible sounds, their every aspect, physical and biological, by a noted physicist-inventor. Has bibliography of articles on subject in many journals. **$2.10**

OH DOCTOR! MY FEET!—*By Dudley J. Morton, M.D.* Help for foot sufferers. Scientific treatment which makes possible discarding of arch supports and special shoes and stopping of exercises. **$1.60**

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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

WHILE a large majority of amateur telescope makers today are of the genus American, subgenus North, and species Yankee, the hobby also has taken root the world over. From time to time we have published here the descriptions of telescopes made by amateurs in India, and Figure 1 shows one more of these. Kamalesh Roy, of Lhasa Villa, 80 Park St., Calcutta, India, is the maker and this reflector has a 7″ mirror of focal ratio 9. Roy made two such mirrors, one for himself and one for the University of Dacca, Bengal. He says that, fortunately, Prof. M. N. Saha, F.R.S., at Calcutta University, took interest in his work and encouraged him to build the mounting at the University's workshop. Prof. Saha (pronounced "shah") is an astrophysicist of world-wide note. The telescope is mounted on the roof of the University Science College Building.

A series on telescope making, by Roy, appeared in the November and subsequent numbers of the Calcutta magazine *Science and Culture*, where his connection with the Palit Laboratory of Physics at the Calcutta University College of Science is mentioned.

When his telescope was completed, Roy took one of the discarded tools, of thin ½″ glass, ground it to *f*/4.3 and

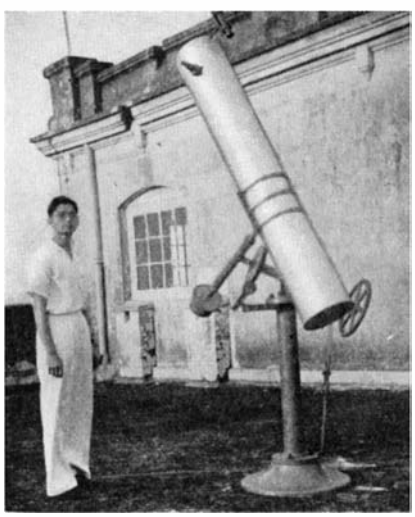

Figure 1: **Roy and telescope**

made of this the primary for a Cassegrainian telescope. Performance was not very good, and Roy therefore asks just how far one can safely go with the thickness-to-diameter ratio of glass mirror disks. Answer is difficult and not sharply definitive for individual cases, or even for general cases. That is, while a ratio of 1 to 8 is usually recommended (sometimes even 1 to 6), this includes a rather liberal factor of safety. But if the worker is willing to gamble, he may run his ratio along to 1 to 10 or 1 to 12 with fair chances of good results. It *has* even turned out satisfactory at ratios like 1 to 20, but this is much like skating on thinner and thinner ice. If only every disk of glass were identical with every other disk of glass, and if every telescope maker were identical with every other telescope maker, we probably could refine the matter to a definite limiting place.

Thus, nobody can give a set answer to this question. If you're a born gambler try a 1:50! Such a disk probably would be useless, yet who would dare dogmatize, even here, without hedging? One piece of glass out of a dozen, at 1:50, might miraculously stand up. Some born gambler with sporting instincts and lots of time on his hands may want to see just how far he can pursue fate by making thinner and thinner mirrors till he thus receives as much punishment as he can endure.

CLUBS of amateur telescope makers and astronomers in various centers have from time to time started 20″ reflecting telescopes as group projects but none of these projects ever has been reported as completed. Evidently an individual can start a 20″ after a club does, yet finish before it—William Buchele of Toledo, for example, whose 20″ was described here in October 1939, and who went straight through the work without taking time out to differ with himself. Now the Northwest Amateur Astronomical Society of Detroit has tackled a 20″ and we predict that Detroit will finish it. A. J. Walrath, 14024 Archdale Ave., Detroit, Mich, sends the photo in Figure 2 and says it is the 20″ Pyrex disk after being trued up and with a groove ground in the edge for a locking ring. "A spiral spring, adjustable in tension, will be attached to this ring," he explains, "and by this arrangement the pressure of the mirror on the tool can be adjusted as grinding and polishing conditions require. In the illustration a sub-diameter tool, rotating at 40 R.P.M., is shown. This is used for rough grinding. The mirror, when completed, will be an f/7.

IF YOU want to get out of grinding and polishing your mirror by hand, yet if you also want to get out of building an elaborate machine to do the same job of work, you can without very much trouble throw together a sort of demi-machine. That is what James L. Russell, an attorney at law, Chester-twelfth Building, Cleveland, Ohio, did, as Figures 3 and 4 show. He calls it his "Man Friday" and says it takes the "swets" out of the grinding wets.

Lower half is a board swiveled over a shelf on a vertical bolt (the lower end is discernible in Figure 3). The tool is held between wooden end pieces attached to this board.

Upper half is a pear-shaped piece of wood (to afford access to the mirror disk to rotate it occasionally) with a central hole to drop over the handle of the mirror. This part is actuated by a horizontal pitman driven from a lathe or what-have-you.

In Figure 3 the upper, or horizontally reciprocating, half is shown lifted off the mirror and tipped up

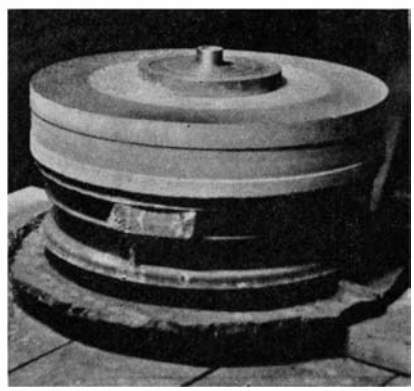

Figure 2: **Detroit twenty-inch**

on edge above the mirror button. The fork-shaped object to right is a guide standing on its own loose base. Through this guide the pitman runs, and when in use it is clamped to the shelf with a C-clamp and shifted sidewise if side strokes are temporarily desired.

The pitman is hinged on a bolt and crosspiece over the mirror (Figure 4), but it will be better if these are kept considerably lower than those shown, since a high point of application of effort tends to tip the mirror and cause turned edge.

The tool should be rotated now and then by hand—not very important in earlier stages of grinding—and the mirror may be turned when desired, simply by giving it a turn by hand while you sit and watch the slave do your drudgery, as you feed the Carbo to it and struggle to keep awake. Possibly the latter also would take care of itself automatically if you were to attach sandpaper to the pitman, then do your nodding with your nose over it. [For this latter brilliant contribution your scribe does not, however, take credit since a friend's dog really furnished the germ of the idea. Like many another mutt, old "Tote" enjoyed the winter warmth of a kitchen stove and, if the oven door were left open, would stand and insert his entire head well into the oven and soak up heat. Soon he would drowse, and then his head would gradually sink. Finally his wet nose would touch

the oven floor and there would be a hiss of steam and Tote's head would jerk suddenly upward, whacking the top. But he would not withdraw—the place was just too good. So the cycle

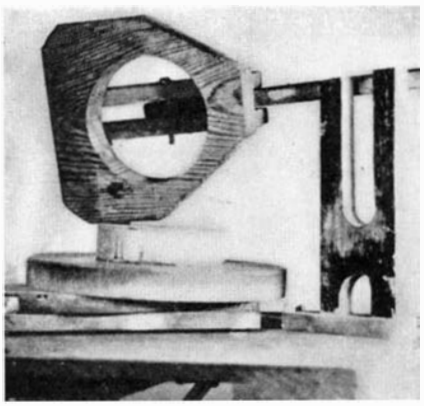

Figure 3: **The Man Friday rig**

would begin again: sink, hiss, jump, sink, hiss, jump, at about one stroke per minute. Two lads—your scribe and his chum—slandered the dog by calling him a poor old fool, but this scientific canine was only trying his best to give them the inspiration for an interval timer.]

ALL of the above was light, easy reading, so put on your workin' pants for the following, which isn't.

TREND away from prisms and toward flats for diagonals in reflecting telescopes is growing. In "ATMA," page 282, Hindle urges flats for best results. In the October, 1940, number, Wates discusses the subject favorably to flats, and now H. H. Selby, author of the chapter on flat making, in "ATMA," quantitatively investigates errors caused by prisms, giving us something definite that we can lay hold of and showing how damaging prisms can be in some cases. "Every now and then," he writes, "someone

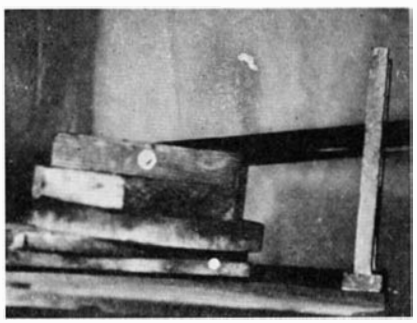

Figure 4: **Friday at work**

asks me why I use diagonals instead of prisms; or remarks, 'That RFT worked fine till I put in my diagonal eyepiece'; or says, 'This plate from my Newtonian is fuzzy, yet you checked my mirror and said it was OK.'" Here is Selby's analysis, and let not those grimacing goblins, the complicated formulas in it, scare you a bit, since they turn out, on closer examination, to require nothing worse than substituting some known values

for symbols and then doing some common arithmetic. Selby writes:

If even a perfect prism is used to deflect the rays from a perfect paraboloid to the side of the telescope tube, the correction of the mirror will be adversely affected and the telescope will perform as if the mirror were over-corrected for axial spherical and axial chromatic aberrations. Also, some chromatic variation of axial spherical correction will be introduced. These effects are slight, however, in the average case. Because the effects of prisms on the performance of telescopes have been the subject of many discussions with TNs, formulas for computing these effects are given here for reference.

Spherical aberration: In Figure 5, a marginal ray is shown reflected from the mirror to the original focus, F_o. When glass is interposed, the ray is refracted and reaches the axis, Fm. The error introduced by this refraction will be a function of the following variables:

R = radius of curvature of center of mirror
R_r = radius of curvature of edge zone of mirror
r = radius of mirror
T = thickness of glass equivalent to the prism used, which equals side of cathetus face
n = Refractive index of prism. No subscript indicates that n is for a wavelength of 5893 A.U.

By substituting the proper values of any specific example in the following equation, the distance $\overline{F_o F_m}$ which computers call $\triangle$ sph for spherical aberration, can be found for any color of light.

$$\triangle Sph = \frac{T}{n} - \frac{T\,(R_r^2 - 2r^2)}{\sqrt{n^2R_r^4 - 4R_r^2r^2 + 4r^4}}$$

This equation may mean more if examples are given; hence two examples at the extremes of normal use are chosen, so that practically all cases will lie between.

I, a 6", $f/8$ mirror with a 1½" prism.
Constants: $Rr = 96.047$, $r = 3$, $T = 1.50$, $n = 1.550$

II, a 12", $f/2.5$ mirror with a 4" prism.
Constants: $Rr = 60.300$, $r = 6$, $T = 4.00$, $n = 1.550$

In Case I, sph = 0.0012". Since the r^2/R correction is 0.047", $\triangle$ sph is insignificant.

In Case II, $\triangle$ sph = 0.0302". This is 10 percent of the r^2/R correction of 0.3000" and is more than sufficient to ruin the image.

Chromatic aberration: This aberration is computed quite simply within 0.0005", thus:

$$\triangle chr = \frac{T}{n_c} - \frac{T}{n_g}$$

where n_c = refractive index for red at 6563 A.U.

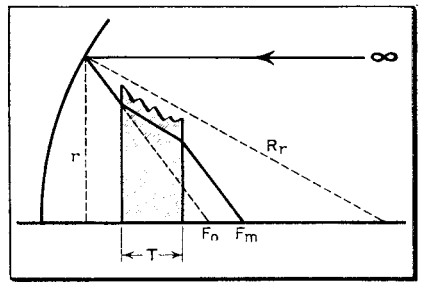

Figure 5: **Sph. Ab. error**

n_g = refractive index for blue at 4359 A.U.

The size of the blurred patch due to chromatism is given by

$$\odot \text{ chr} = \frac{2rR\left(\frac{T}{n_c} - \frac{T}{n_g}\right)}{R^2 - r^2}$$

For comparison, the diameter of the central diffraction disk of a perfect mirror, without prism, is found by

$$D = \frac{2.44\,R\,\lambda}{4r}$$

where λ = wavelength of light, or 0.00002". A glass frequently used for high-grade telescope prisms is a borate crown in which n_c = 1.514 and n_g = 1.526.

In Case I, $\triangle$ chr = .0077"
$\odot$ chr = .00048"
D = .00039"
and the image is only very slightly affected.

In Case II, $\triangle$ chr = .0200"
$\odot$ chr = .0040"
D = .00013"

Here, the image is enlarged to 30 times normal and results are very seriously impaired.

Chromatic difference of spherical aberration: This error is the least of three axial aberrations introduced by a prism. (The lateral, or Seidel, errors which are functions of the position of the prism and the angle of incidence are not considered because nothing can be done in figuring a mirror to eliminate them while maintaining a sharp central image.) However, if a mirror is to be used for different colors, for different purposes, such as a mirror tested visually and used later for infra-red or ultra-violet photography, this aberration might well be considered with very large jobs. The equation is

$$\triangle Diff. = \frac{T}{n_s} - \frac{T}{n_l} - \frac{T\,(R_r^2 - 2r^2)}{\sqrt{n_s^2R_r^4 - 4R_r^2r^2 + 4r^4}} + \frac{T\,(R - 2r^2)}{\sqrt{n_l^2R_r^4 - 4R_r^2r^2 + 4r^4}}$$

where n = index of prism for shorter wavelength and n the index for longer wavelength.

Compensating for prism: The preceding equations will allow the builder to find the errors which any given prism of good quality will introduce when used with his telescope. The spherical aberration can be eliminated in the figuring but the chromatic error cannot, while the chromatic difference of spherical

aberration can be considered in special cases. If the introduction of a suitable prism would blur the image chromatically more than an allowed tolerance, the prism should be discarded in favor of a flat. If not, the mirror should be figured to a definite amount of under-correction less than $r^2/2R$ in order to have a sharp image. To do this, it is necessary to know the spherical aberration of an uncorrected mirror of the same constants as the mirror to be used. This is given by

$$\triangle F = \frac{R\sqrt{R^2 - r^2} - R^2}{2\sqrt{R^2 - r^2}.}$$

The proper radius of the equivalent sphere is that of the paraboloid at the edge, or $R = R_0 + \frac{r^2}{2R}$. Then the proper correction to give the mirror, instead of the usual $r^2/2R$, will be $-2(\triangle F + \triangle sph)$. In Case I,

$R = 96.047$
$r = 3$
$\triangle sph = +.00120$
$\triangle F = -0.02341''$
$r^2/2R = .04688$
Proper correction $= .0444''$.

In Case II, $R = 60.300$
$r = 6$
$\triangle sph = +.03021$
$\triangle F = -0.15000$
$r^2/2R = 0.30000$
Proper correction $= .2396''$

End of Selby's contribution, which ought to have the effect of raising the standards of telescope making. Readers wishing the mathematics behind his formulas may obtain it by asking.

To avoid unnecessarily worrying the very beginner, the lesser effects due to prism error probably will not be likely often to exceed those due to inexperience in mirror making; they

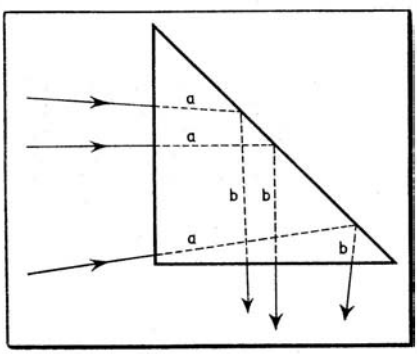

Figure 6: **It equates**

may even help compensate the latter in some instances. For second and subsequent telescopes the worker may to good advantage work out the extent of the prism factor and allow for it if it is found appreciable.

In case Selby's statement that the glass thickness, *T*, (Figure 1) in a prism equals the width of its cathetus (shorter) face seems puzzling, note Figure 6. The light path, $a + b$, within the prism, is of equal length no matter where the ray strikes it and, the reflection at the back not entering into this particular consideration, the prism therefore equates with a simple, plane-parallel slab of glass, as shown.

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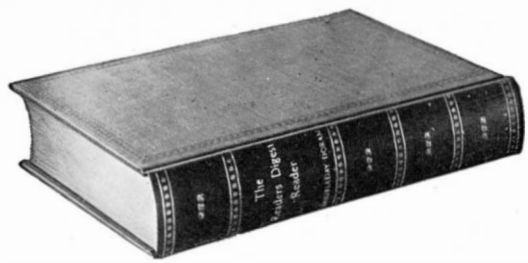

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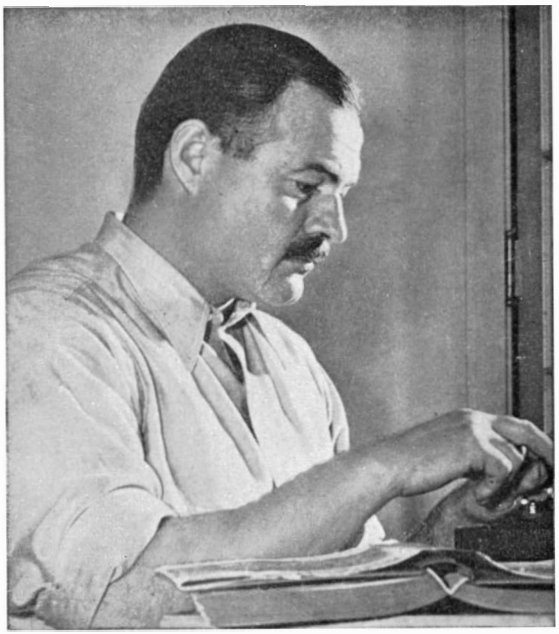

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