BOMBERS TO BRITAIN . . . Page 247

SCIENTIFIC AMERICAN

NOVEMBER • 1941

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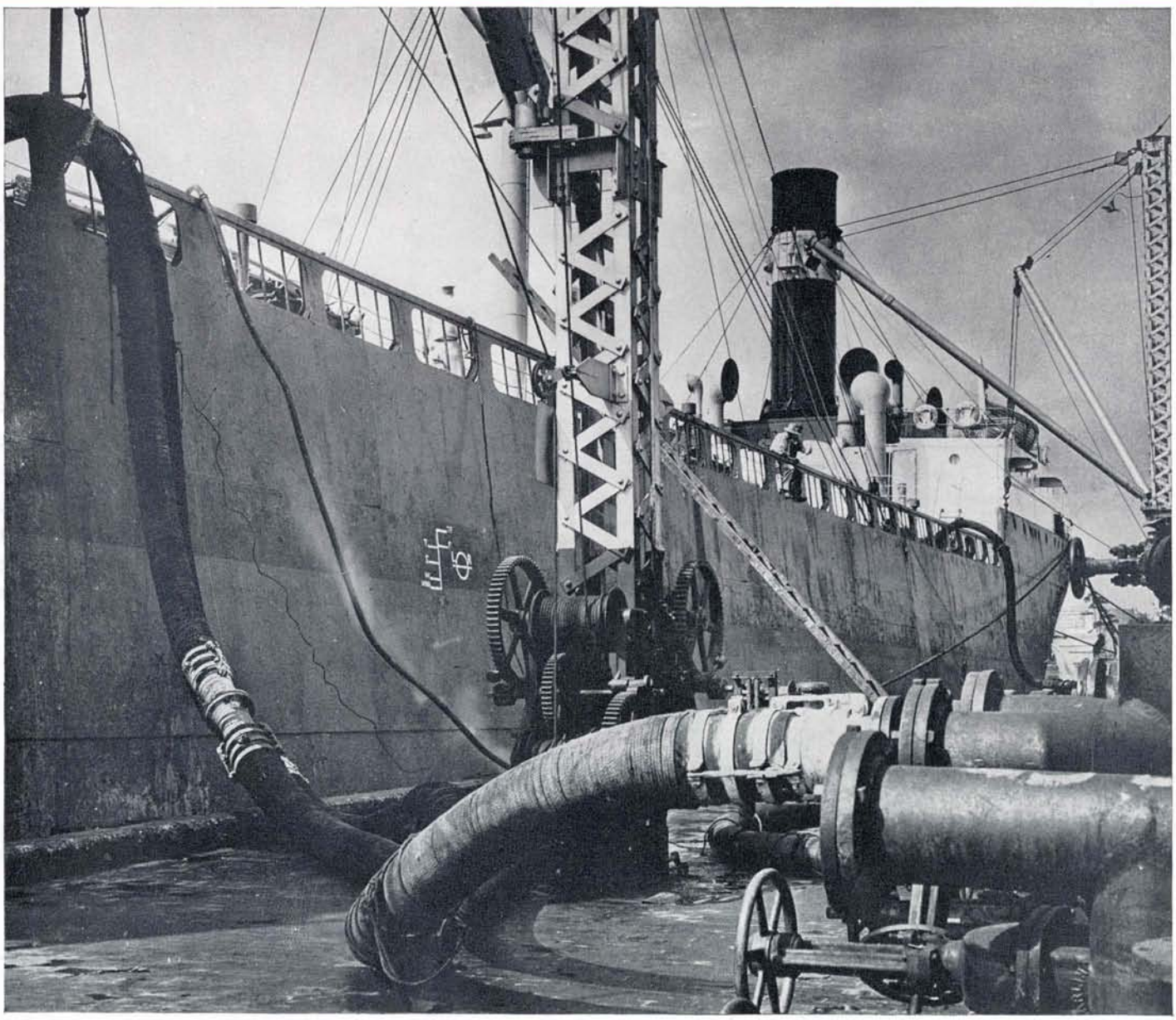

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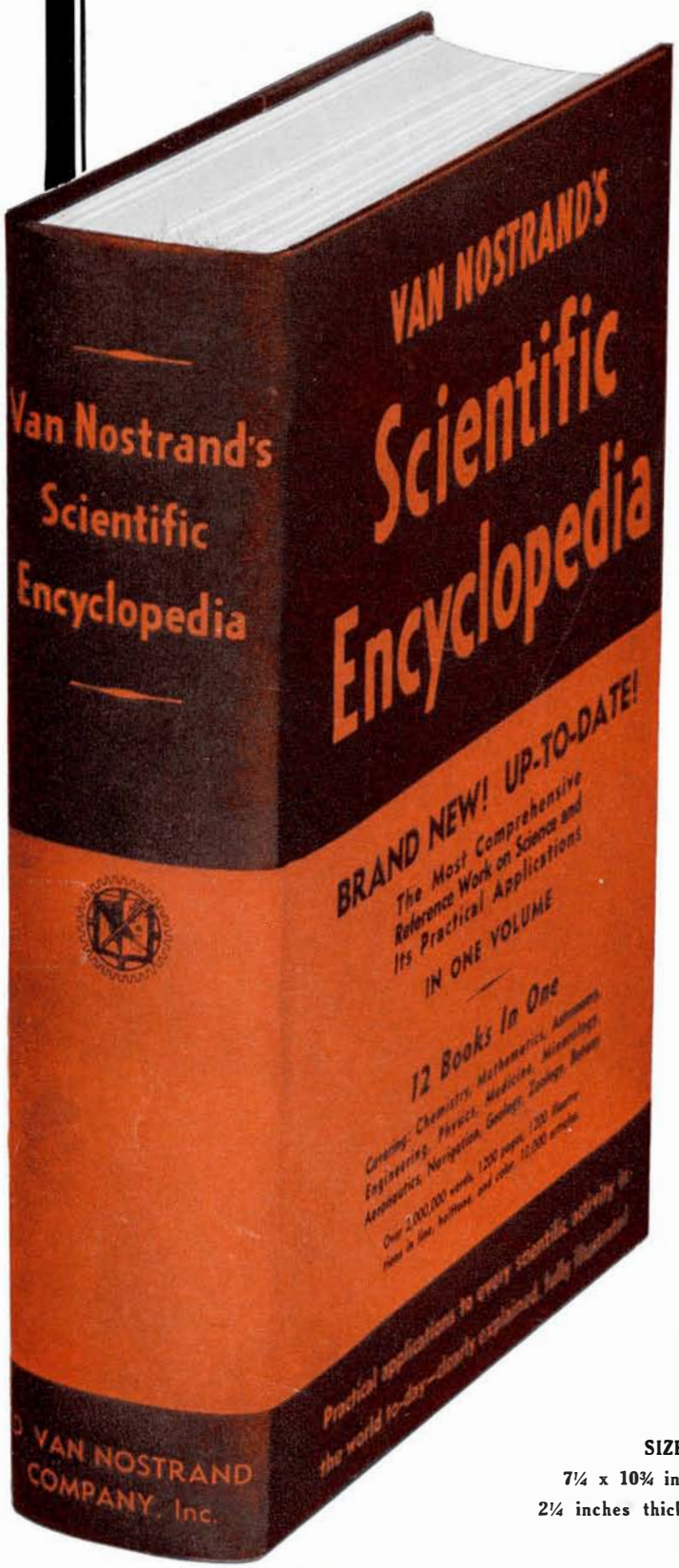

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CLOSELY linked with real or imaginary gasoline shortages in many parts of the country is the fundamental problem of transportation, little known and little understood. Clarification of this factor, essential to an understanding of fuel availability, is presented in the article starting on page 251. Our cover illustration shows an oil tanker taking on its cargo.

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

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NOVEMBER • 1941

SCIENTIFIC AMERICAN, November, 1941. Vol. 165, No. 5. 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.

WHAT TO DO ABOUT ASTROLOGY?

ASTRONOMICAL circles—particularly the 70 local groups and clubs of amateur astronomers on this continent—have recently been greatly exercised because a Hollywood motion picture producer is preparing to release a series of 12 films on astrology. They are fighting it.

This, we believe, will be the first large-scale incursion of astrology into the motion picture audience. Astrology's following already is immense, running, we are told, into the millions.

We have added our protests to those already made, simply writing to Mr. Will Hays, motion picture "czar" at Hollywood, that we wish to go on record as stating that scientists stand solidly against the pseudo-science of astrology—which, of course, is a fact.

It would serve little purpose here to try to refute astrology, since we can assume that our readers already oppose it—though each time we have mentioned it in this magazine without much respect, we have, it is true, received letters of protest, but never more than a trifling few. The question is, rather, what can Scientific American readers do to fight astrology in other circles where it is accepted.

For years we have given this matter much thought, but no real answer has appeared. It is easy to refute astrology—for those who already regard it as a pseudo-science; but it is not easy to refute it for those who want to believe in it. In fact we feel that, in the main, no direct attack on astrology is likely at all to have more than limited effect until the general standard of education has been raised—a long, slow process. When that has been done there will automatically be little need to refute astrology.

Two notable attempts in the direction of refutation have been made in recent years, one a rather intellectual paper by Dr. Bart J. Bok and Margaret W. Mayall, astronomers at the Harvard College Observatory, and the other a rather practical if not hard-boiled approach made a year or so ago by our contemporary, *Good Housekeeping,* which probably reaches far more who believe in astrology than does Scientific American. *Good Housekeeping* put the astrologers in a truly awful predicament—and then did nothing to save their faces. It offered to place four astrologers, selected by other astrologers, in separate rooms where they were each to cast the horoscopes of two persons to be selected by its editors. It also agreed in advance to publish the findings, regardless of their outcome. That challenge was not accepted—proving that the astrologers are not fools at all, whatever else they may be!

It is probably not correct, however, and it certainly is not good psychology, if one wishes to shake their beliefs, to label the astrologers fakes and frauds, as some have. Individual frauds there undoubtedly have been, and are, within astrological circles, but in the main the astrologers are honest people who sincerely believe what they believe, and are a bit hurt, in fact, because the scientists treat them somewhat roughly. They are also puzzled because science seems so stupidly blind to the obvious truths they claim to possess. Bigotry and intolerance, this attitude from our side appears to them—and, to tell the truth, some of us really have been bigoted and perhaps intolerant toward astrology. We need to cultivate more patience. Most of these people who accept astrology have had no background in the scientific world, and therefore have no way of seeing the difference between science and pseudo-science; to them, each looks about alike. Moreover, the fact is, and we should admit it, that, even within our world of science, there is not and never has been any way to distinguish positively between truth and error—all such things must be considered as relative.

If one merely wishes to have some fun, and to start a believer in astrology off on an hour's sputtering and raving, just call astrology a fraud and a fake. But if the desire is genuinely to alter his state of mind, that sort of approach is only certain to fix it. Arguing with the typical astrologer is not likely to prove very satisfying. You find that his arguments are not so much rational as emotional. And he is shifty—though we do not necessarily mean dishonest. Once, when a group of amateur astronomers in one of our larger cities was preparing to put on a public debate for and against astrology, we warned its officials that they would not get very far. They wrote afterward thus: "Reasoning with the astrologers proved to be just like punching a feather pillow—you sock it in one place and it bobs up in another. You had them figured out to a tee, and everything you promised for us came true. They haggled about definitions. So we got nowhere."

Haggled about definitions—here is the chief rub, but it's something which few except trained logicians understand as sharply as they should. In any argument, of any kind, unless the two sides accept *at least the premises in common,* there has been no real meeting of minds—no real argument. The astrologers argue from a different set of premises than do the astronomers. Probably there is, therefore, little that can be done about it, until we succeed in reaching the general standard of education mentioned a few paragraphs back.

The fact is that, on the whole, there probably is little that can be done about astrology; probably we on the scientific side haven't yet come fully to realize this fact. We tend to think that, in some way or other, a way can be discovered, if we try hard, to knock the astrology out of those who believe in it. It appears that this, like astrology itself, is mainly a delusion. It probably will take centuries, millenia, to rationalize humanity to the extent necessary to do away with astrology and equally unscientific beliefs.

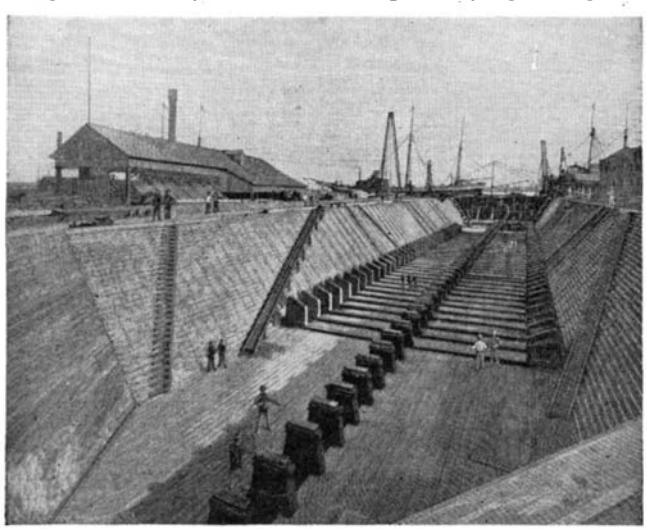
Nevertheless, all protests against the aforementioned films, sent to Mr. Will Hays, Hollywood, California, should carry due weight in the immediate circumstances and perhaps help to prevent further exploitation of the gullible.—*A. G. I.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of November, 1891)

DRY DOCK—"Almost a year has been required in the work of constructing the recently completed dock shown in our illustration, at the foot of Orleans Street, Detroit, Mich. . . The soil where the dock is built is of fine blue clay, so that there was no interruption to the progress of the work from land slides or leakage. Two thousand piles were driven, making the structure very strong, it being designed to safely dock loaded ships carrying a cargo of



3,000 tons, while taking in vessels of the largest size. . . The pumping plant consists of two centrifugal pumps, with 30 inch discharge each, driven by two 150 horse power independent compound Westinghouse engines. . . This dock is large enough to take in any boat now upon the great lakes, and has been designed especially for the wide railway car ferries and passenger boats with their overhanging guards and paddle-wheels. The cost of the dock was upward of $200,000."

SNAKE—"The hoop snake does not roll and does not take its tail in its mouth. It progresses by loop movements, somewhat like the measuring worm. The snake gathers itself up into large loops, and pushes itself forward, all with such amazing rapidity as to appear, to a frightened beholder, as if it actually rolled."

OVER-EXERCISE—"Those who believe in the necessity of physical exercise have need also to remember that even so good a thing as this is in excess an evil. The use of the cycle is a form of bodily recreation in itself doubtless wholesome; none the less it is open to the mischievous effects of undue indulgence. . . Whenever prostration beyond mere transient fatigue follows the exercise, or when digestion suffers and weight is markedly lessened, and a pastime which ought to exhilarate becomes an anxious labor, we may be sure that it is being overdone."

LIGHTNING RODS—"Dr. Hess, who has been collecting statistics and has examined the tips of many lightning rods, finds that fusion of the points never occurs. A fine, smooth point receives the lightning in a concentrated form, while angled or ribbed, as well as blunt points, divide it into threads. Dr. Hess considers that platinum needles and tips are entirely unnecessary, for they have no advantage over copper points; but as there are lightning strokes which are capable of making wire 0.20 in. thick incandescent, unbranched copper conductors should never be of less diameter than this, though in a good lightning rod the main point is to secure perfect communication between it and the earth."

MORTALITY—"It is true that we have immensely lessened infant mortality and extended the mean duration of life to over forty-five years. But the average number of old people is not correspondingly increased, and it is even charged that when great old age is now reached, it is abnormal."

COMPARATIVE COST—"At the recent meeting of the American Street Railway Association, Mr. Pearson, of Boston, said his road has about 350 cars equipped with electric motors. The expense of operation with horses is about 25 cents per car mile. . . The cost of operation with electric motors up to the present has been 20 cents per car mile."

RIFLE—"The new Italian rifle is of 6.5 millimeters caliber. The most important factor in connection with the rifle is the smokeless powder cartridge, which, owing to its light weight and small size, permits the number of cartridges carried by the soldier to be augmented to 160. . . Loading is effected by means of magazines containing five cartridges so arranged that a repeating fire may be maintained until the magazine is exhausted. Experts are convinced that the weapon is the best and most destructive at present existing among European armies."

SPONGES—"The sponge fisheries of the Bahamas cover a large extent of territory, give employment to about six thousand men and boys, and are a source of revenue to the colony larger than any other industry pursued there. . . The quantity shipped from these islands during the year 1890 was 623,317 pounds, the local value of which amounted to $34,500."

EGYPTIAN—"Three colossal statues, ten feet high, of rose granite, have just been found at Aboukir, Egypt, a few feet below the surface. The discovery was made from indications furnished to the government by a local investigator, Daninos Pasha. The first two represent in one group Rameses II and Queen Hentmara seated on the same throne. This is unique among Egyptian statues. The third statue represents Rameses standing upright in military attire, a scepter in his hand and a crown upon his head. Both bear hieroglyphic inscriptions."

NOW X-RAYS CAN—"The bursting of the 68-ton fly wheel of the great engine in the Amoskeag mills, Manchester, N. H., furnishes additional evidence, if such were needed, to prove that with the means now at hand the possibility of flaws in large castings cannot be determined with certainty. . . Till means are found to discover flaws in segments for large fly wheels, it is not safe to use them in the vicinity of workrooms, as at Manchester."

DUST EXPLOSIONS—"Two accidents due to the explosion of coal dust afford further proof of the well-known fact that coal dust is itself a dangerous explosive."

Personalities in Industry

FOWLER McCORMICK

NEW PRESIDENT of International Harvester Company, Fowler McCormick is the fourth of his family to head the business founded by his grandfather, Cyrus Hall McCormick, inventor of the reaper. The McCormick stockholdings and the McCormick tradition of personal participation in the business, taken together, would doubtless have assured Fowler a job and a title. But there is great question whether those things alone could ever have made him president. The "corner office" at Harvester is no spot for a dilettante. The man who occupies that office now, at the relatively early age of 42, is a hard-working, practical executive with no taint of the dabbler about him.

He works hard, associates say, because he is temperamentally unable to take a half-swing at anything. He is practical because of intimate personal contact with the men in the shop and the farmers in the field.

Born in Chicago, McCormick was educated at Groton School and at Princeton University, from which he was graduated with the class of 1921. When he decided that what he wanted to do was to work for the Harvester Company—and the decision was not automatic—he began as a laborer in the Milwaukee Works. Since that time he has been a part of nearly every phase of the business.

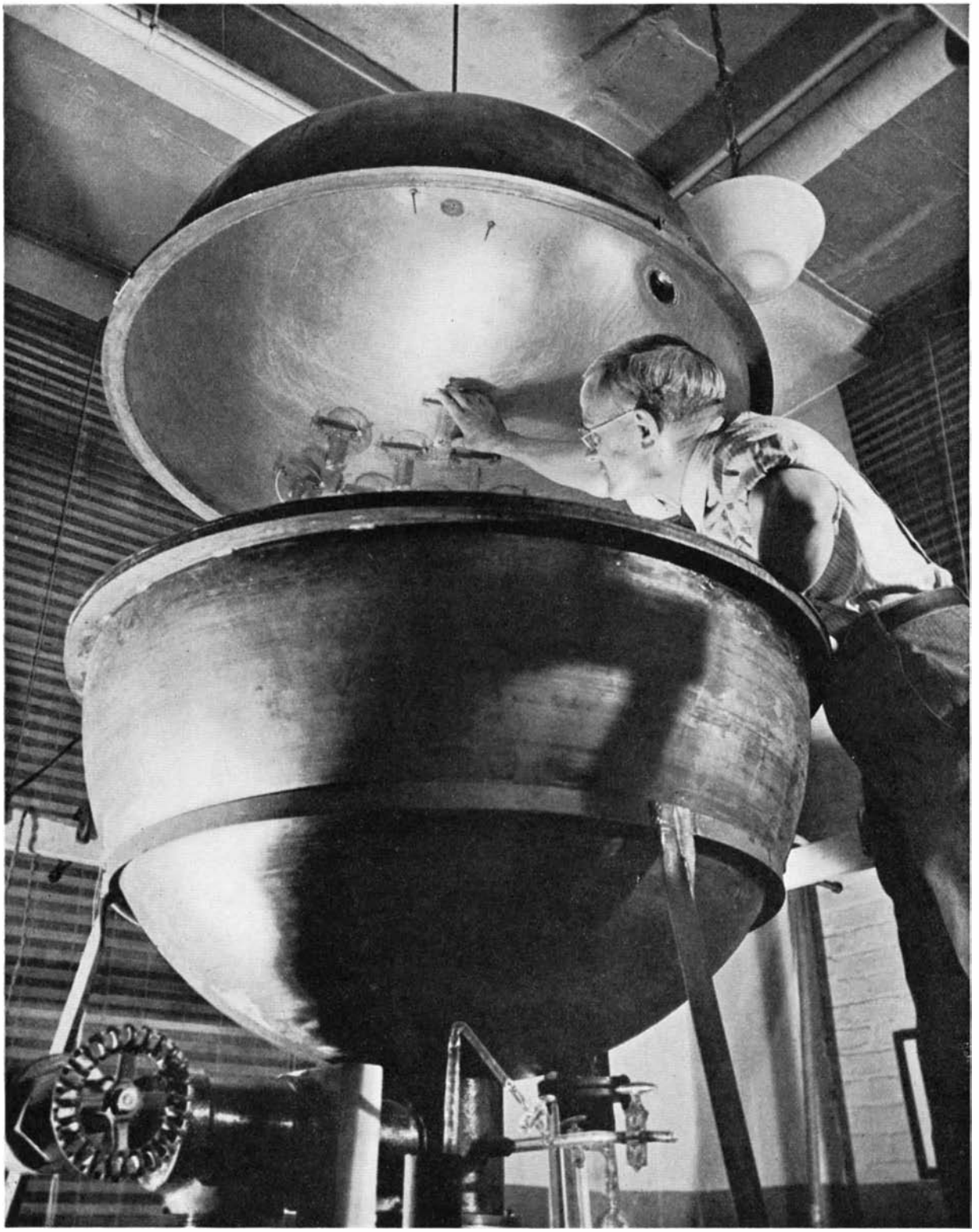
The man who has been shaped by the impacts of these various experiences is serious without being stodgy. He has avoided the pitfalls of personal hauteur and mock modesty. The outstanding impression he creates in the minds of new acquaintances is one of sincerity; he seems always to be thinking of what you are saying or what he is saying—never of what impression he may be making.

Mr. McCormick has evolved a personal business philosophy. He regards his company as primarily a social institution which must justify its continued existence by social usefulness. He conceives that it has an immediate responsibility to three major groups: its customers, its employees, and its stockholders. The job of management, in the McCormick scheme of things, is to provide for each of those groups the greatest benefits commensurate with the rights of the other two.

This responsibility has led Mr. McCormick, among other places, into a deep and continuing interest in the company's industrial relations problems. He is neither sentimental nor hard-boiled about this. He evidently wants employees to feel that they would rather work for Harvester than anywhere else, but he has no desire to pose as a generous lord of the manor. Furthermore, having assured himself that the company's wage and other policies are right, he will not be pushed around, a fact discovered early this year by a number of union leaders. He genuinely believes in collective bargaining but he has no notion that collective bargaining means saying "Yes" to every demand, reasonable or unreasonable.

His approach to most problems is that of the student. He gathers and assimilates quantities of facts and opinions before acting. His patience during this process is monumental. No one can remember that he ever snapped at a bore or a ditherer.

Outside the office, Mr. McCormick lives quietly. He seldom talks about himself or his activities. He has a farm near Barrington, Illinois. He is known to be a musician and a student of psychology. There is a current rumor that he is learning to fly. His golf, at best, is mediocre.



TREATING GLASS TO ELIMINATE GLARE

IN A NEW method for treating glass surfaces to eliminate glare and increase the efficiency of many optical instruments, the units to be treated are placed in a large metal globe which is then sealed and evacuated. When a bit of magnesium fluoride is electrically evaporated in the vacuum, the vapor coats each glass surface with a film 1/300,000 of an inch thick. Photograph shows the equipment developed for this work in the research laboratories of the General Electric Company. The glass units, in metal frames, are held to the interior of the sphere by alnico magnets.

BOMBERS TO BRITAIN

Gigantic Newfoundland Airport is Jumping-Off Place

EDWIN MULLER

THERE'S a spot in the windy wastes of Newfoundland the name of which is known to very few, but it's one of the most important and exciting places in the world. Yesterday an uninhabited waste of spruce forest and muskeg swamp, it is today the world's biggest airport—and growing bigger as fast as thousands of men working day and night can make it. It swarms with aerial traffic. The scores of bombers that arrive and take off for Britain every week are only one of its activities. It's the great junction and forwarding point for transatlantic passengers and air-borne freight. It's the center of military flying the nature of which cannot be fully told. It is, perhaps, the most vital point in the outer defenses of this hemisphere.

For an hour before I arrived there, in a Lockheed-Hudson bomber, I had been sweating steadily on the palms of my hands and the soles of my feet. After sighting Newfoundland, coming in high and fast over the blue, empty waters of the Gulf of St. Lawrence, we had run into a solid bank of fog—like ramming your head into a wall. For 200 miles we had just two fleeting glimpses of land.

By now we should be over the airport. The pilot couldn't be sure because, for various reasons, there is no radio beam at the airport. We made one or two tentative dips down through the gray soup. No land. Then we turned tail and ran north toward the ocean to get our bearings, coming out suddenly into the clear. Back we went toward the airport, keeping just under the ceiling. At a scant 400 feet it seemed as if we'd scrape our bottom on the tops of the pine trees.

I was glad to land.

Coming onto the field by air you are bewildered by its immensity. Seemingly, you could set down La Guardia or Tempelhof in one corner and then have to hunt for it. Runways are so big that an ordinary plane could land or take

NATIONAL DEFENSE

off across their width. The expanse is like a smooth lake, so wide that when you strain your eyes across it, you see a mirage against the far horizon.

I tried once to count the hangars and shops, but it's half a day's brisk walk to skirt the edge of the runways and by the time I'd gotten around I'd lost count. And here and there in the distance the skeletons of other hangars are rising, and sprawling villages of houses, and sheds, and barracks, and tents.

Switch engines shift long strings of box cars from which are unloaded mounting piles of lumber and steel, crates and drums. Bulldozers scrape off the forest growth, acres at a time, and steam shovels scoop out great pits in the raw earth. Riveting machines are going on every side. Fleets of trucks and tractors are busy. Every now and then a blast goes off and you see a geyser of smoke and chunks of rock thrown high in the air. The noise goes on by night as well as by day.

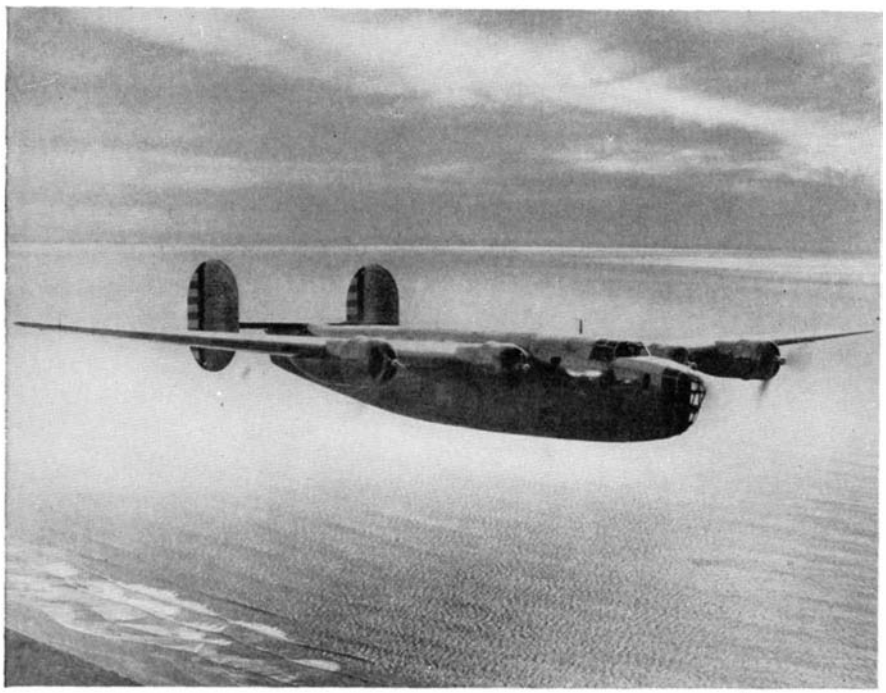
Above all is the constant overtone of airplane motors tuning up. Most thrilling is the breath-catching crescendo of a big bomber as it starts down the runway on the long, lonely road to Britain.

That night I met some of the men who fly the big ships across. For several days bad weather had been reported from "Q. M.," the secret and well-guarded airport in the United Kingdom where the bombers land, and more than a score of fliers were waiting at the Newfoundland field, sitting around the rough board tables of East-Bound Inn.

These are not the dare-devil youngsters who fly the ships in combat over Europe. There are plenty of gray hairs, and every pilot has had thousands of flying hours. Some flew in the last war. They have come from trans-continental lines in the United States, from Imperial Airways, in Britain, from Trans-Canada Air Lines. You hear tales of the early days of the Southampton to Singapore run, of being forced down in the desert and hiding in the dunes from tribesmen until rescued; of landing mountaineering parties on inaccessible glaciers of Alaska, keeping them supplied by parachute; of ferrying freight into the jungles of the Amazon.

ON THIS transatlantic job the pilots have settled down to routine. It takes nine to ten hours to cross and, when the weather is good, they maintain a schedule as regular as that of ferry boats crossing the Hudson. Each pilot is given a flight-plan, telling him his course, what height to reach at each point, what weather to expect and how to dodge it.

The weather man is really the pilots' hero at this airport. They say there has never been anything like his work. "He tells you: 'In



Official photograph, U. S. Army Air Corps

A Consolidated B-24; in England these ships are called "Liberators"

Zone 5 at 6 o'clock there will be ceiling at 2000 feet, top of cloud at 6000, moderate icing at 5000, tail wind of 40 miles per hour, veering shortly to north.' You get there and that's exactly what it is."

Sometimes the pilots fly the course at 15,000 feet, or higher, the whole way over. It's 50 degrees below zero up there but the heated planes are comfortable. Insidious, though, is the effect of altitude: at first you don't recognize the dreamy, don't-care feeling as the higher centers of the brain gradually cease functioning and you may wait too long before attaching the oxygen tube.

ONE pilot, flying in winter at 20,000 feet to avoid icing, had to detach his tube and go back to help a passenger. When he returned to his seat he had to readjust his tube, a simple operation. But he couldn't do it. The tube in his hand approached the socket—wavered away. That went on for five minutes while they slipped down toward the dangerous icing level. Then the navigator realized what was wrong and came to the rescue.

They don't see much of the ocean. Most of the flight is above a vast sea of unbroken cloud from horizon to horizon, an Arctic landscape of white hills and valleys. On its surface, far below, the tiny black shadow of the plane drives along.

Sometimes that glacial surface is torn apart. Then they may see a big convoy crawling along, destroyers circling its flanks. One pilot saw the last plunge of a torpedoed merchantman, the stern rearing high. Men were struggling in the water—no life boats. There was nothing the pilot could do.

In the last hours they begin to slide down toward the landfall, a faint, dark smudge on the horizon. There the pilot and his crew search the skies for intercepting Germans. Not so anxiously now, however, as at first. In all the hundreds of crossings only one or two pilots have sighted a German—and nothing came of it. Once a Hudson sighted a Fokker-Wolf. Both turned tail and ran.

The landing at Q. M. is made on a field so ingeniously camouflaged that even the keenest-eyed German observer could hardly recognize it as an airdrome. It doesn't look like a spot where you could make even an emergency landing. There's no fuss about the arrival. Three years ago the surrounding countryside would have been black with the crowds waiting to greet a transatlantic flier. Now, when the pilot and his crew crawl out of the fuselage, they are greeted casually, pick up their suitcases and trudge away to quarters. They may get a few days leave—London if they're lucky. Or, within 12 hours, they may be on their way back by ferry plane.

The pay is high—a minimum of $1000 a month, with a bonus for each trip above two trips a month. A pilot may earn better than $25,000 in a year. Navigators and radio operators earn about two-thirds of a pilot's pay.

Nothing irritates these fliers so much as the suggestion that they are engaged in a glamorous, adventurous job. They deny it, with profanity and short, Anglo-Saxon words. It's a routine flying operation, they assert, and rather dull at that. One of them is saving his pay to open a haberdashery store in Seattle. He looks forward to that. They read detective stories, one after the other to keep from being bored. They say that the R.A.F. puts a combat pilot on the transatlantic run to rest him.

They really mean it—but it isn't so. Two thousand miles of empty ocean isn't a routine flying job—not yet. No plane, so far, has come down on the water but that record can't be maintained indefinitely. The worst hazard is on the take-off, when the plane has to get off the ground with its staggering load of extra gasoline.

One night at East-Bound Inn a pilot came in with the news that a returning ferry plane had cracked up on the take-off at Q. M. The 22 men in it had been killed. Every man present had good friends on that plane; some of those killed had sat at this same table two nights before. The talk stopped a few seconds, then resumed. The conversation was of other things.

ACCIDENTS never interrupt the eastern flow of traffic. I was in the control tower watching a line of Hudson bombers take off for Britain, one every five minutes. It was the turn of the fifth in line. It started for the take-off—got halfway up the runway. Suddenly it swerved slightly, then a violent swing, and it came around in a three-quarter circle of a ground loop. The under-carriage collapsed and one wing sagged to the ground. It couldn't have been two seconds before it blazed up, a great bloom of orange flame. Three little figures dived out through the door in the tail.

With the scream of the siren the fire trucks were out on the field. But, while the flames were still burning brightly, two tractors raced out, yanked the big plane off the runway, drew it to one side. Ten minutes from the time of the accident the next bomber in line had taken off and was on its way.

Across the broad runways from East-Bound Inn are the quarters of the Royal Canadian Air Force. It

is forbidden to go into detail on the activities of the R.C.A.F.—the technique which it has evolved for protecting convoys, the broad net which it has flung over the western ocean. It's no secret, however, that there are planes today which are capable of flying to Germany from Newfoundland, delivering a load of bombs, and returning.

Here as nowhere else you can see how fast space and time are shrinking. You see the big transport planes come in, the Consolidated B-24's, as large as the ships in which Columbus came over the sea. They converge from points on the American continent, stop to check and refuel, wing on across the ocean. An official in Washington must make a quick trip to London. Via this Newfoundland airport he can be there within 24 hours. At your breakfast table here you can choose between *The New York Times* and the London *Times* of the day before. It's all as casual as travel between New York and Chicago.

This air center is a shipping point for freight as well as passengers. All kinds of non-bulky goods are carried—urgently needed airplane parts, vitamin concentrates, precision instruments, laboratory materials. One plane carried to Britain a shipment of 200 bullfrogs consigned to a laboratory engaged in the study of the effects of poison gas. They disturbed the pilot by croaking loudly all the way over.

Official photograph, 2d Air Base Squadron Photo Section

Sister ships of this Flying Fortress are seeing service abroad

It's a bleak, inhospitable spot, this Newfoundland airport—long, icy winters, snow that falls through June and starts again in September, piling up in 20-foot drifts on the lee side of the runways. Always the wind blows, in gales and gusty squalls. Fog lies heavy.

No trees are left standing in the settlement, there's no blade of grass. The houses and shacks are hammered together from rough timber. The unpaved streets are deep in sticky mud. Everywhere there is mud. The clear brooks have turned to sluggish streams of liquid mud. There are scores of gun emplacements, camouflaged pits where the anti-aircraft guns thrust muzzles toward the sky. You can't walk far without being challenged by sentries.

The bulk of the construction gangs are "Newfie" laborers from St. Johns or the coastal fishing villages. There are the superintendents and foremen, the mechanics and engineers, the troops who garrison the post, the Newfoundland Rangers who police it. Beer, when it's to be had, is drunk out of the bottle.

Feminine influence is lacking. There are a few wives of the construction superintendents and half a dozen nurses in the hospital, but they are not much on view. There is also the daughter of the base manager, Sally Elizabeth Ross, who is almost seven and easily the best known and most popular resident.

But in general it's a he-man place, lacking the amenities.

And yet there are few spots on earth where more big names are registered. A Walter Winchell would have a busy life here. In the short time I was there Lord Beaverbrook and Lord Halifax, a Roosevelt and a Royal Duke were seen about the East-Bound Inn. Lady Halifax and Harry Hopkins had been through a few days before.

When the war is over, some airmen say, this will be the center—the chief junction and forwarding point—for transatlantic traffic. There are some who doubt it. These latter say that the fogs of Newfoundland will always limit its use to aviation, also that the long-range planes of the future won't need a half-way point. But, no matter how long a range planes may have, they will carry a bigger pay load across the Atlantic if they stop to refuel a third of the way over. Bermuda and the Azores will be used too, but this northern route is the shortest path between the important centers of North America and those of Europe.

It will be a different place then. There'll be warehouses for freight, big hotels for passengers. East-Bound Inn will be an affair of 1000 rooms, 1000 baths, and will probably preserve as a show place the present room where the pilots gather. The mud will disappear, the raw earth will be landscaped and beautified. There'll be schoolteachers from Nashville and bank clerks from Cleveland on their way to Europe for a two-week vacation, business men from Chicago and from Prague, students from Tokyo and Harvard and Vienna. This will be the most cosmopolitan spot on earth, where all nationalities will meet and pass.

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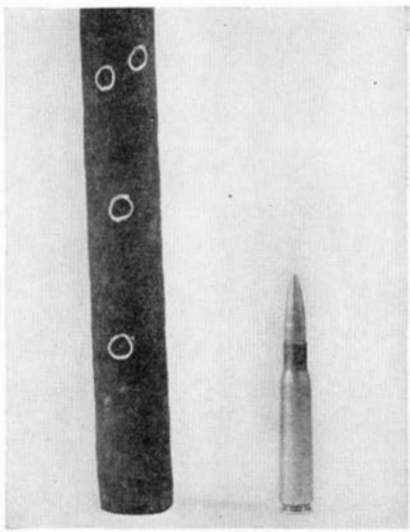
BULLET-SEALING

Hose Protects Fuel System of Combat Planes

SELF-SEALING fuel tanks for military airplanes can now be supplemented by self-sealing hoses, thus providing a completely protected fuel system. This new bullet-

sealing hose was recently announced by The B. F. Goodrich Company.

The secret of the hose construction is a sealing member that prevents fuel leaks even under ten to fifteen pounds pressure and despite numerous punctures from large-caliber machine gun bullets. The inner surface of the hose is a layer of Ameripol, the synthetic



rubber which is highly resistant to oil and gasoline.

The principal use of the hose in aircraft is to connect fuel tank cells and engine supercharger systems. With this hose, it is stated, there will be a substantial saving in weight in the average bomber; the rubber hose eliminates the weight of auxiliary metal fuel systems which are ordinarily required to guard against the hazard of punctures in main fuel lines.

Above: **Testing bullet-sealing hose with .50-caliber machine gun.** *Left:* **Despite holes, hose held fuel at 10-15 pounds pressure**

BLACKOUTS?

Value Questioned by Lighting Expert

STREET lights are silent policemen on the night force of every police department, Dudley M. Diggs, a General Electric engineer, recently told the International Association of Chiefs of Police.

Any reduction in these lights during the present emergency would result in increased crime and traffic accidents, he said, citing a number of cases to prove that the criminal element takes advantage of the darkness, which also imposes an additional handicap on the automobile driver. Diggs urged the use of modern lighting systems to meet modern traffic needs, and said that blinding lights directed skyward to confuse and mislead enemy airplane pilots may be found to afford better protection for cities than the blackout in case of war.

Diggs doubted that blackouts would ever be needed for American cities, and pointed out that the blackout in countries abroad has been of questionable value as a military measure while creating many new problems for officials to solve. Nazi fliers, he said, can find English cities via radio beams, and are aided by the breaking surf on the coastline, plus the reflections from roof tops and from rivers. In modern war, parachute flares and incendiary bombs can easily pierce the blackout, Diggs explained. The work of the police, air-raid precaution workers and firemen is hindered during blackouts, he said, while traffic accidents occur much more frequently and the morale of the people is attacked through reduction in social life. Transportation is slowed, as well as loading and unloading of important war and other materials in the darkness, it was explained.

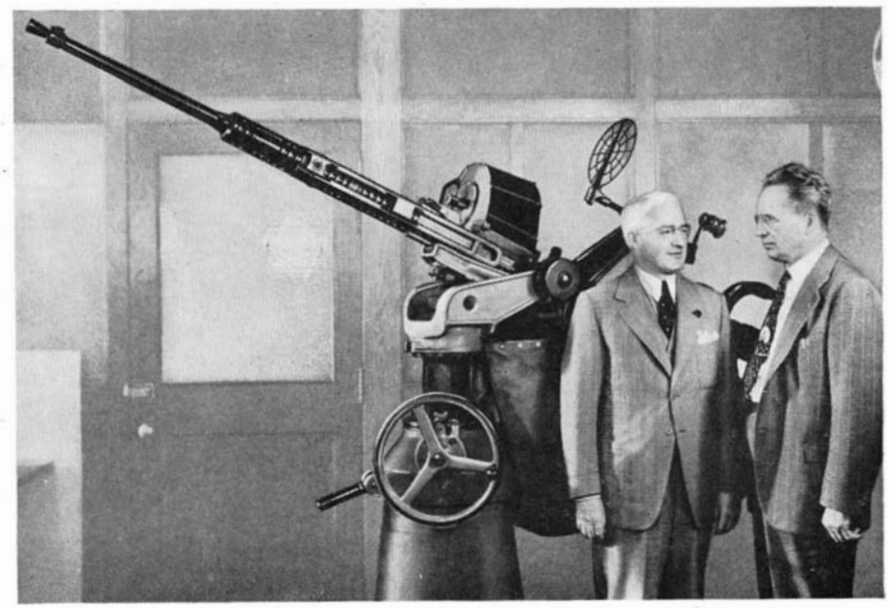
The use of small though powerful searchlights and wide angle floodlights directed skyward to confuse and hinder the enemy would also aid protecting aircraft in shooting down the enemy, and would allow civilians to live and work under more normal conditions, Diggs said. In preliminary tests of the plan, the U. S. Army has been reported to have found that even with a long viewing tube airplane pilots could not penetrate the glare to find important targets, thus indicating the effectiveness of the "reverse blackout," the engineer added.

ANTI-BOMBER

New Gun for Defense Against Dive Bombers

A WICKEDLY efficient 20 millimeter machine gun of tremendous fire power, now being produced in quantities, is said by experts to be the answer to the dive bomber menace for ships at sea.

While no details have been released regarding this particular weapon, one of our accompanying illustrations shows a completed production model as built by the Hudson Motor Car Company. Similar weapons are being produced by the Pontiac Motor Division of General Motors.



Reportedly a potential Nemesis for Stukas

Oil Is Where You Ship It

Transportation Facilities Available to the Petroleum Industry Govern Fuel Supplies

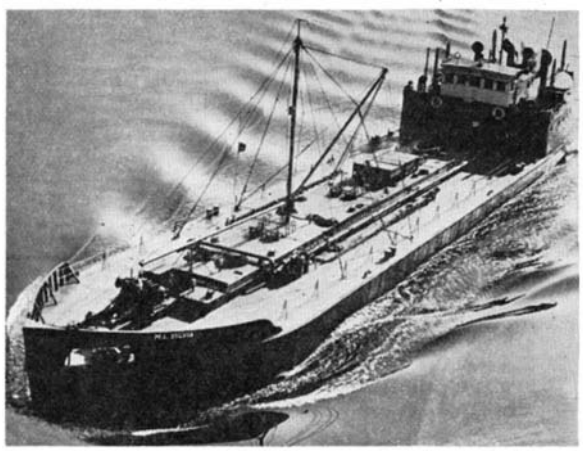
A. P. PECK

REGARDLESS of what may be the precise gasoline and fuel-oil situation in any particular part of the United States by the time this article reaches the reader, there are certain facts that consumers of petroleum products are entitled to know; lacking these facts it is almost impossible to evaluate the rapidly changing picture as presented in the daily press.

The beginnings of the gasoline and fuel-oil shortage on the eastern coast of the United States are now history. Developments at the time of writing are coming so thick and fast that it is still anyone's guess as to the ultimate outcome. Thus it seems appropriate to forget for the moment the day-by-day reports from the gasoline and fuel-oil battle-front and to dig into the service of supply in an endeavor to bring into clear focus those problems of the oil industry which must be solved and constantly re-solved in order that fuel supplies of all types may be assured to the entire nation.

It has been frequently stated elsewhere, but will bear constant reiteration, that there is no national shortage of petroleum and the products derived from it. There are plenty of gasoline and fuel oil of all types. Proved reserves of crude oil still underground are ample. Production is sufficiently ahead of demand to insure against any shortage. The shortage, real or imaginary, is purely and simply one of transportation. Unfortunately, from the standpoint of distribution, the areas in which crude oil is produced are relatively remote from the large centers of consumption. And gasoline and fuel oil are bulky, unwieldy, liquid commodities, usually purchased by the consumer in relatively large quantities, that require special handling.

Getting the crude oil from the wells to the refineries, and the finished products to the dealer from whom the consumer purchases them is, then, the crux of the entire matter. And here, perhaps more than with any other commodity, old man economics plays the leading role. Because there are five major means of transporting the liquids under consideration over long distances, the situation becomes somewhat involved, leading to many of the misunderstandings that have been so prevalent in recent months. These five methods are by tank ship and tank barges (which are usually lumped together in any general consideration of the subject), pipe lines, railroad tank cars, and highway tank trucks, listed here in ascending order of relative transportation costs.



A small tanker such as used on rivers and canals; large ones carry up to 155,000 barrels

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Bird's-Eye View of Petroleum Industry, 1940

Number of producing oil wells 390,000
Production of crude oil 1,350,000,000 barrels
Proved U. S. Reserves 19,024,515,000 barrels
Number of Refineries 557
Production of Motor Fuel 26,000,000,000 gallons

Transportation

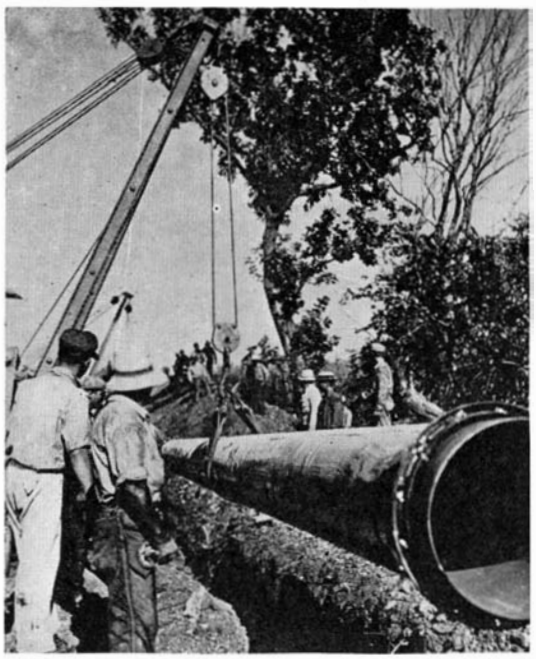
Mileage of Oil Pipe Lines 126,000 miles
Number of Tank Ships 467
Number of Tank Cars 148,000
Number of Tank Trucks 75,000

Strangely enough, when data were being collected for this article, exhaustive inquiries, directed to unbiased sources of information, failed to bring to light any quotable figures covering exact costs of transportation by all of these five methods. This was due largely to the complications that arise when seeking comparative costs in a field where there are a tremendous number of variables, any one of which can be applied to make the final figures prove just about anything desired by the one who juggles the figures. It was definitely determined, however, that the above listing represents the *relative* economics of oil and gasoline transportation, tankers being the lowest cost method and highway tank trucks the highest. The only definite figure that could be obtained, and upon which any reliance could be placed, other than one set mentioned later in this article, was that the relative cost of oil transportation between tanker, pipe line, and tank car is something on the order of one to three to six, when dealing with the run from Gulf ports to main points on the eastern seaboard centering around New York.

THUS it can be stated here that any cost figures advanced regarding any two or more of the methods of transportation, in an endeavor to prove a given statement, must be open to question unless they are based definitely on terminal points and existing transportation facilities between these points.

Before going into quantity figures regarding methods of getting oil from one point to another by means available and projected, let's step off to a distance and view this whole industry that revolves around the work of gleaning nature's crude product and getting the refined results into the gasoline tank of your automobile or the fuel-oil tank of your home-heating oil burner.

Crude oil, as it emerges from the well, is piped into field storage tanks from which it flows into gathering lines, which, in turn,



Laying a pipe line to insure a constant supply of petroleum products to consumers

feed into trunk-line pumping stations, to railroad loading racks, or to marine terminals. How it moves depends upon geography, economics, and other factors, but it will move certainly by the fastest, cheapest, and most convenient available route.

The oil which goes to the trunk-line pumping station thereafter will move through a trunk-line system of pipes ranging in size from eight inches to 16 inches in diameter. An eight-inch line normally can move 20,000 barrels (42 gallons to the barrel) about 120 miles a day. The speed of travel depends upon many conditions, including the nature of the terrain, the number of pumping stations, the pressure maintained, and the type of crude oil itself. A large number of pumping stations, a flat terrain, and a crude oil of average gravity mean faster travel; heavy oils must travel more slowly, and lifts over mountains contribute to delay, so that a day's journey may be only 50 to 60 miles.

Pushed on its way by powerful pumping stations, normally located some 40 miles apart in level country, and closer together where the line crosses mountainous regions, the oil next reaches semi-permanent storage in tank farms. These are merely collections of huge tanks holding from 55,000 to 100,000 barrels each, located at strategic points for the further distribution of the crude oil. Sometimes the tank farms are combined with marine and railroad terminals, and also with refineries.

Refineries may, as noted, receive their crude raw material direct from self-owned tank farms or again the oil may start on a journey, this time by one of several means. It may be withdrawn from storage and loaded into tank ships or tank cars or it may again enter a pipe line for further pumping to a distant point. In some cases, where only highway transportation is available, it may be shipped by tank truck. In any event, the oil next reaches refinery storage from which it is withdrawn as needed to feed the complex processing equipment from which it emerges in the form of gasoline, fuel oil, lubricating oil, and a host of other petroleum products.

BUT the end of the line has not yet been reached. These finished products must be transported from the refinery to distributing points and from these to local dealers from whom you purchase your gasoline and oil. Here, again, tankers, pipe lines, tank cars, and tank trucks take up the job and move the liquids on their way. Ordinarily the next stop, in the case of public consumption products, is the jobber's bulk plant, located in every large community, where local storage is provided and from which the materials may be distributed to local dealers, largely by tank truck. This transportation phase is best handled by tank truck because of the flexibility of the method and the fact that the product is now nearing its final destination and is being moved in relatively small quantities to a diversified group of outlets. Large industrial plants may receive their petroleum products either from the refinery direct or from bulk plants, depending on local conditions; bunkering stations, where ships are fueled, are supplied direct from refineries.

The variety of methods of distribution grows out of a variety of methods and volumes of consumption. In the case of gasoline, it is necessary for the petroleum industry to handle roughly 180,000,000 gallons every 24 hours—refining 60,000,000, moving 60,000,000 to bulk plants and retail stations, and pumping the third 60,000,000 into the fuel tanks of consumers. Since gasoline weighs about eight pounds to the gallon, this transportation job is equivalent to moving 720,000 tons of freight—all of it in liquid form.

From all that has been published on the subject of delivering gasoline and oil supplies to the ultimate consumer, the casual reader might not be blamed if he formed the opinion that a few miles of pipe lines and a handful of tankers, tank cars, and tank trucks were being used by the oil industry to transport these vitally necessary products to a point where he may purchase them. A few figures will quickly disabuse any such idea and will serve to indicate that the petroleum industry is making use of a vast and rapidly extending transportation system in an effort to avoid fuel shortages anywhere in the United States and to provide for the greatly increased demand for petroleum products in the name of national defense.

At the end of 1940 there were in use in this nation some 126,000 miles of pipe lines for the transportation of oil, 467 tankers (of which 50 have already gone to England under the Lend-Lease program), 148,000 tank cars, and 75,000 tank trucks. According to the American Petroleum Institute, there will be more than 10,000 miles of additional pipe lines built during 1941. Under construction and on order are 145 new tank ships, plus 11 which have already been completed during 1941.

DURING 1940, on the authority of the Bureau of Mines, the following quantities of crude oil were delivered to refineries in the United States by the methods noted: Pipe lines, 939,732,000 barrels (remember that there are 42 gallons to the barrel); boat, 277,589,000 barrels; and by tank car and truck, 38,990,000 barrels.

Largest of the new pipe lines, on which preliminary work has been started, will be one to transport oil from East Texas via Salem, Illinois, to Bayonne, New Jersey, and Philadelphia. Part of this 1500-mile line will be 24 inches in diameter, larger than any ever before constructed. Cost of this line will be some $75,000,000, but, according to Ralph K. Davies, Deputy Oil Co-Ordinator, such a pipe line could transport 200,000 barrels of oil daily to the New York terminal at a cost of $67,000 a day, com-

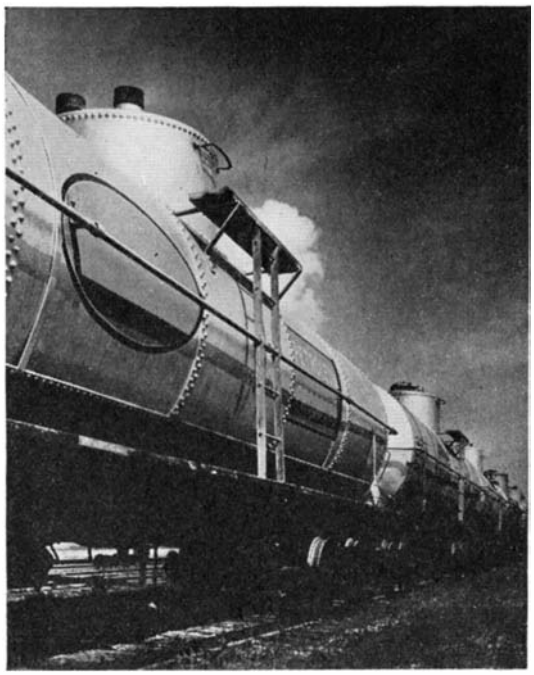
pared with a cost of $207,000 for the same amount of oil over the same distance by railroad tank cars. The capacity of this line, to compare it with another method of getting oil from here to there, would be sufficient to release from service on the same point-to-point run some 65 tank ships.

Other pipe lines that will help the general situation are the 1260-mile line from Louisiana to North Carolina and Virginia which should release 10 tankers; the 450-mile line from Florida to Tennessee which will not only relieve at least two tankers from this service but will also expedite deliveries along its route; and the international pipe line that stretches 236 miles from Portland, Maine, to Montreal, Quebec, which will eliminate a 10-day tanker trip and release four tankers for other routes.

Pipe lines, it must be remembered, constitute a 24-hour-a-day method of transportation, little affected by weather and other conditions that place limitations on mobile units on the rails, on the highways, and on the water. Maintenance is required, of course, but in general the service may be placed high in the reliability brackets. And pipe lines do make possible handling a huge quantity of oil during a given time, as has been shown. For purposes of comparison, however, the following figures are needed: Tankers can carry as high as 155,000 barrels (6,500,000 gallons) in one trip; tank cars hold from 8000 to 10,000 gallons; tank trucks have capacities up to 5000 gallons.

THE pipe line is a little known method of transportation, but it has many economic superiorities. Out of sight and mind, largely buried in the ground, it is safe from sabotage and bombing. When it is not moving oil, it is storing oil, so that its cargo always can be unloaded merely by turning a valve. It never makes a return trip empty, but is working, either moving oil or storing it, 100 percent of the time. It is not affected by tides or temperature, it does not get into collisions or wrecks, and it ignores the weather. It is flexible in that it can be made to move its cargo either way, if necessity demands, and it can share its cargo at any waypoint.

It is often said that the materials necessary for the construction of pipe lines—from 400,000 to 750,000 tons of steel plate will be needed for the Texas-Bayonne line—may not be obtainable under national defense priorities, that these materials should be put to other purposes. Whatever may be the final outcome of this particular argument, sight must not be lost of the fact that oil is just as essential to national defense in all of its multitudinous aspects as are guns and ammunition, men and materiel. The oil has to be transported; whether steel goes into pipe lines or tankers is a question that can be settled only by a meeting of the minds of those who control the materials of construction and those who have the valuable background of experience in transportation of petroleum products.



Oil companies own or lease 148,000 tank cars; capacity of each to 10,000 gallons

From the facts given it can be seen that the subject of whether or not John Q. Public, in any particular part of the nation, can buy gasoline at his favorite filling station in any quantity desired or can purchase sufficient fuel oil to heat his home during the coming winter, is not one to be settled merely by deciding on the relative merits or costs of one method of transportation over another. It is, rather, a case in which there must be a balancing of the economic features of all methods in an integrated whole that will insure adequate supplies of petroleum products to the entire country at reasonable costs to both producer and consumer.

All illustrations courtesy American Petroleum Institute

Combination tank farm and marine terminal for petroleum products

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OIL

Coal Reserves Would Yield Oil for 3000 Years

ENOUGH oil for 3000 years at the present rate of consumption could be made from the three trillion tons

of United States coal reserves, if it ever becomes necessary to make oil from coal, the Bureau of Mines reports. A hydrogenation process developed by the Bureau in one of its experimental laboratories has been tested on 13 different American coals, and has proved that crude oils, similar to crude petroleum and yielding large quantities of gasoline and other oil products, readily can be produced from all the coals tested. Tests are continuing on other important types of coal.

Total potential quantity of oil that could be produced from America's coal, based on the samples so far tested, amounts to about 3,800,000,000,000 barrels, the Bureau reports. Samples tested ranged from high-volatile bituminous coal down to the poorer quality lignites, with yields of crude oil from 168 to 78 gallons per ton of coal processed. Average yield from the total coal reserve, however, is estimated at about 50 gallons per ton, to include the quantities of coal which would have to be used for fuel and power in the processing plants.

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CLEAN-UP: Special vacuum hose is used in one of the largest airplane company's plants to suck up and carry away any loose bolts, nuts, or shavings that may be in the hulls of bombers after their completion.

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The government experts did not estimate costs of production, but these are known to be considerably greater than the present cost of producing crude petroleum from oil fields. Hence this process, and alternative possibilities of producing crude oil from oil shales, probably would not be introduced commercially until the unknown future day when America's liquid oil reserves are in serious danger of depletion. Several European countries, notably Germany, have been using hydrogenation and other processes commercially for a number of years under government subsidy, and are producing large quantities of oil products from coal.

Necessity for the introduction of coal hydrogenation or other processes in this country probably lies in the remote future, according to petroleum geologists. At a recent meeting they reported little evidence that America is anywhere near finding its last oil field. They charted huge areas in the United States, Alaska, and Canada as possible locations of undiscovered petroleum reserves.

FREEZE-RESISTANT

Synthetic Rubber Resists Low Temperatures

ONE of the drawbacks of synthetic rubbers in many automobile and aircraft applications has been a tendency to become hard and brittle when exposed to sub-zero temperatures. A new type of neoprene, recently announced by Du Pont, is claimed to be as freeze-resistant as natural rubber and still to retain the oil-resistant qualities which make neoprene so valuable in many cases.

GENERATORS

Portable Engine-Driven Units, Water or Air-Cooled

WHEN electric power lines fail, due to uncontrollable conditions, manufacturing plants of all kinds must stop operations unless they are provided with stand-by generating units. In hospitals, theaters, and public buildings, power failures may result in loss of life or serious injury.

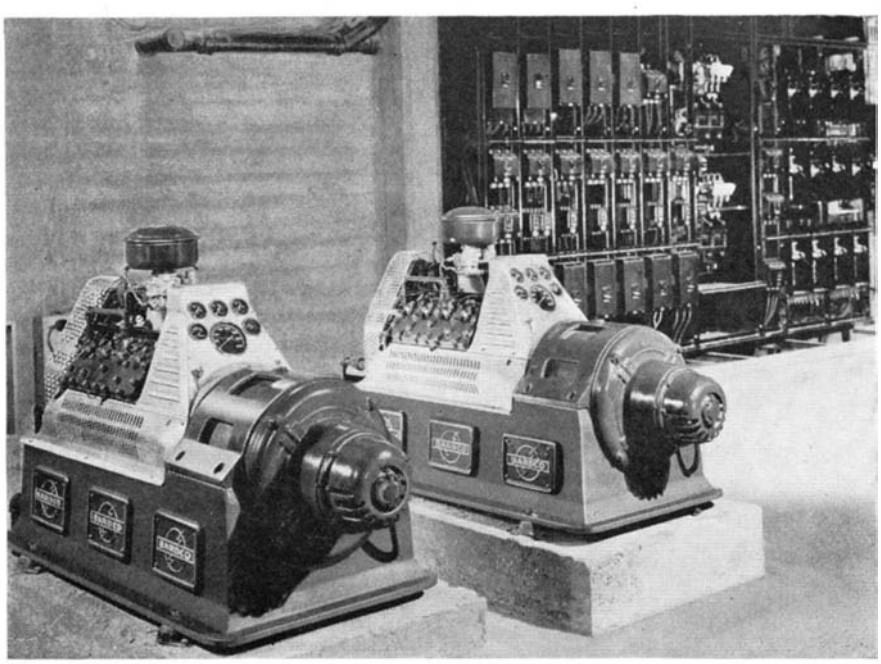
A new series of stand-by generating plants designed to protect against the loss and hazards of power failure has recently been announced by Bardco Manufacturing and Sales Company. One of our illustrations show two of these stand-by plants in the film laboratory of Warner Brothers in Burbank, California. Claims made for these generating plants, which are available in a range of capacities from one kilowatt to 200 kilowatts, alternating current, and from one kilowatt to 100 kilowatts, direct current, are that they start and stop automatically, have automatic voltage regulation and safety controls, and can be run in parallel with accurate synchronization. It is claimed that the units can take over operation within three seconds after a power-line failure. They are supplied to operate on Diesel oil, gasoline, gas, and butane. Both water-cooled and air-cooled motors are available in a wide range of powers.

SELF-CLEANING

Industrial Equipment Protected by "Graphoid" Surface

A SIMPLE method of obtaining a combination of dry lubrication, rust-prevention, and a "self-cleaning" action, worked out in connection with equipment for the manufacture of corrugated fiberboard, appears to have some interesting possibilities in connection with the protection in operation of other types of industrial equipment.

The development originated in an attempt to eliminate the sticking of sodium silicate to the hot platens of corrugated fiber-board



Provide quick take-over for power emergencies

making machinery. It was discovered that when the platens were provided with a "graphoid" surface, they then became virtually self-cleaning, in addition to being rust-proofed. Furthermore, the lubrication provided by the graphoid surface minimized wear on corrugating rolls.

At first it was thought that the use of graphite would tend to discolor the work passing through the machinery. It was found, however, that when "dag" type of colloidal graphite, produced by Acheson Colloids Corp., was used that the extremely fine particles adhered closely to the platens. After the excess graphite had been wiped off in the first few feet of travel of the material over the rolls, after each application, no noticeable transfer of graphite to the work occurs.

The colloidal graphite was applied to the hot platens in an aqueous suspension. Under the elevated temperatures, the water readily evaporates, leaving a film of graphite particles on the surface. Under heat and pressure these particles form a graphoid surface on the platen.

ACCIDENTS

Often Due to Attitudes of the Victims

THE "jinx" that causes some workmen to have repeated accidents at their jobs has been identified as the attitude of the accident victim himself by Dr. Alexandra Adler, of Boston Hospital and the Harvard Medical School, reports *Science Service*.

The accident-producing attitude is different in different workers and in different nationalities, it was revealed by study of 100 industrial workers in Europe and 100 applicants for workmen's compensation in Massachusetts.

In America, over one-fourth of the accident-prone workmen were over-fearful. That fear of accidents can produce them was demonstrated by a test on soldiers, quoted by Dr. Adler in her report to the *American Journal of Psychiatry*. Half the soldiers on a cross-country ride were told that a ditch lay ahead of them. The other half were not informed. Three-fourths of those who fell into the ditch were from among those who had been warned.

More than 23 percent of the American accident-prone workers had a fatalistic attitude that they were sure to be unlucky. Nearly 20 percent had a longing to be pampered and were happy while being nursed after an accident. Over 13 percent had a revengeful attitude toward parents or educators. In these, Dr. Adler considers that the repeated accidents are a sort of substitute for suicide.

These were the attitudes most frequently to blame for accident repetitions among American workers. Among the European workmen, a revengeful attitude was responsible in 56 percent of the individuals. Alcoholism accounted for 12 percent (as compared with only 3.3 percent among Americans), the "unlucky" attitude for 10 percent, and the longing to be pampered for 6 percent.

Aside from the alcoholics, only eleven individuals could blame disease or mental deficiency for their repeated mishaps.

SCRAP SALVAGE

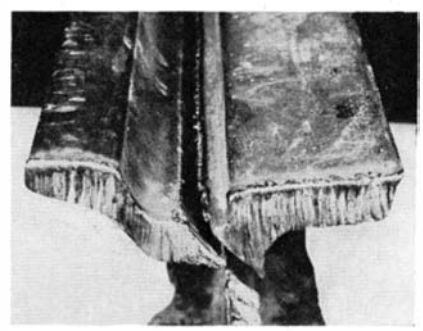
Street-Car Tracks are Important Source

TIGHTNESS in available scrap, especially of the proper grade, is becoming a threat. Steel mills cannot produce full-capacity tonnage because they must use low-grade melting steel; and they are being forced to dip deeply into their inventories of scrap, reducing them to an abnormally low point, at a time when they would normally be building up their stocks for the winter months.

Slices imbedded rails . .

In the light of this condition, steel mills, municipalities, and various types of traction companies should investigate the fact that thousands of tons of scrap rail can be obtained by the removal of abandoned streetcar tracks which are now embedded, unused, in the streets of hundreds of cities throughout the country. Furthermore, the removal of these rails can be economical and efficient through a method, recently developed, in which a portable, oxy-acetylene cutting machine is used.

Aside from the simplicity and high speed of cutting, which make this method so efficient, there also are economies which can be realized. The method permits removal of the rail without breaking adjacent pavement, even when asphalt, macadam, stone blocks, or brick have been laid flush with the top of the rail. Thus repaving costs



. . which can be pried loose

are kept at a minimum, and cost of removal is more than covered by the sale of the scrap rails.

In this method, the cutting machine is positioned on a special track; two or more sections of such a track can be used so that the cutting operation can be carried on continuously. The cutting blowpipe of the machine is equipped with a bevel-cutting nozzle, and a single cut is made at an angle along the groove of the rail so that the top of the rail is severed from the web in two longitudinal sections. The cut rail can then be easily removed with a pinch bar.

SHAFT HARDENING

Inductive Process Reduces Rejects

HEATING time for hardening crankshafts has been cut from 12 hours to less than five minutes by 2000-cycle inductive heating at the Chicago tractor plant of the International Harvester Company. Involving five different sizes and types of shafts for Diesel and gasoline engines, the method has simplified balancing, obviated the normal pickling processes, and increased core toughness. With this installation, which was the first

licensed by the Ohio Crankshaft Company, more than two million shafts have been so produced without a rejection for incorrect hardness.

Formerly the drop-forged shafts were normalized, hardened and drawn, pickled or shot-blasted to remove scale, then machined and ground. Though durability of main bearings and connecting-rod bearings is almost directly dependent upon their hardness, this physical property was limited by machining operations after hardening. Carburizing these particular shafts was not a practical means of increasing hardness, because distorted shafts could not be satisfactorily straightened afterward. Final hardness was between 25 and 30 Rockwell C. Shafts are now normalized, completely machined except for final finish, then heat-treated on the wearing surfaces only to a hardness of from 55 to 62 Rockwell C, drawn at 350 degrees Fahrenheit, and ground. Pickling is no longer necessary, since inductive heating introduces no scale. Using conventional hardening methods, shafts previously were made of a nickel-alloy steel, which has been made currently almost unavailable by defense restrictions. With inductive heating, the more costly nickel steel has been replaced by a readily available carbon-chrome steel. Total rejections for metallurgical defects have been cut from the previous 5 percent to an average of less than one percent.

Inductively hardened shafts take a better final finish than those produced by the old method, because of their increased hardness; and breakage of shafts in service has been reduced materially by the greater toughness of the shaft core.

NO CORONA

Effect Eliminated by Semi-Conducting Paint

ELIMINATION of corona in the air spaces between coils of the end windings of rotary machines has been accomplished by treating the end-turn insulation with Coronox, a new semi-conducting paint. Since machines of above 10,000 volts came into use, corona has been a troublesome element in high-voltage generating equipment. Resulting from ionization of electrically overstressed gases, corona may appear in any of three locations: in the slots, around coils immediately beyond the ends of the slots, and in the air spaces between various coils of the end winding.

A single proper resistance value, such as the 10 megohms per square inch resistivity of Coronox, can reduce the voltage stress across the end turn insulation sufficiently to eliminate corona. In treating the stator coils, glass binder tape is completely filled with Coronox which results in a thick, firmly anchored, semi-conducting layer on the surface of the coil. The parallel connecting rings and support rings are treated in a similar manner. Finally, a long life insulating varnish is sprayed over the whole end winding to protect the Coronox and increase its stability.

Two often measured properties of electrical insulation are the flashover voltage and the breakdown voltage. The flashover voltage of Coronox-covered surfaces is actually greater than that of highly insulating surfaces. The breakdown voltages for treated coils should be higher than for untreated coils because the Coronox treatment eliminates concentrated voltage stresses at the edge of the slot.

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EXPLOSIVES—During actual transportation by rail of explosives of all kinds in Canada and United States in 1940 there was not a single fatal accident and only one person was injured.

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STRIP MILL

Fastest, Highest, Now in Operation

A NEW 5-stand cold strip mill incorporating a number of "firsts" in electric drive and control for steel mills has recently been put into operation at the Irvin Works of the Carnegie-Illinois Steel Corporation, at Pittsburgh, Pennsylvania. The highest-powered cold-rolling mill for tin mill products in the world, it has been operated at a delivery speed as high as 3750 feet per minute and is capable of 3850 feet per minute without exceeding the specific ratings of the mill driving motors.

A total of 11,400 horsepower is employed to drive the mill. Stands 1, 2, and 3 are driven by direct-current motors rated 800-, 2000-, and 2500-horsepower respectively. Stands 4 and 5 are driven by double-armature D.C. motors of 2500- and 3000-horsepower respectively. For driving the tension reel, a 600-horsepower double-armature motor is employed. All of these motors are of the special mill type, designed by the General Electric Company.

Even more spectacular as to size are the two 4000-kilowatt generators—largest D.C. generators ever built—which supply power to the main mill motors and tension reel at 750 volts direct current. The driving motor of the motor-generator set is an 11,300-horsepower synchronous motor operated at 6600 volts.

Installed between the five stands are four indicating tensiometers which enable operators to read the actual pounds of strip tension as the strip proceeds through the mill. Tapered tension control of tension between stands provides for a more uniform finishing gage at lower strip speeds. Automatically, at low strip speeds, this control system permits the tension to be increased so that the finished strip may be "on gage."

CASEIN

Prices Rise in Step with Steel Demand

CASEIN prices offer an example of the complications sometimes traceable in trade and industry, according to a report on the dairy situation, issued by the United States Department of Agriculture. The increase in casein prices in recent months, says the Bureau of Agricultural Economics, shows how a change in demand for one product may affect a change in the demand for another seemingly unrelated commodity.

In order to increase steel production, more coke was needed. To produce more coke, the coke ovens had to be operated at higher temperatures. This resulted in the production of less phenol. Phenol is used in glues which compete with casein glue. The restricted production of phenol glue caused prices of both phenol and casein glues to rise. As a result casein prices increased. It has been difficult to increase the production of casein because of the demand for dried skim milk and cheese which exists under the food-for-defense program.

INDUSTRIAL TRENDS

NEW PRODUCTS, NEW MARKETS

IF EVER the trend in any industry pointed toward a favorable future, come what may in a troubled world, that of the chemical industry seems, from this observation post, to be the most promising. Although the industry as a whole boasts of an ancient lineage, going back many centuries, there is a peculiar quality of ever-newness that sets chemical manufacture and research apart from other types of endeavor. In fact, it might be said that the chemical industry is reborn about every decade, bringing into extensive use new products hitherto unknown and opening new markets that, strangely enough, appear to profit without making corresponding drains on other industries. Thus, while past performances may serve to indicate general trends for the future, they cannot always be used as signposts pointing toward specific developments of importance to the world at large.

In the calm, halcyon days before World War I, for example, there was little thought that someday the chemical industry of the United States would figure largely in the production of explosives and dyestuffs; German monopolies calmly batted down any ambitious endeavors that attempted to invade their preempted ground. Then came the War. Virtually overnight there was developed in this nation an industry that asked no favor of anyone, that produced needed materials in any quantity and of a quality that bespoke Yankee ingenuity intelligently applied in a vital line of endeavor.

Next came the shining example of lacquers, synthetically produced to give surface coatings with outstanding qualities of durability, beauty, and ease of application. Then an upsurge in the production of rayon, already many years old but awaiting the Midas touch of research and mass production. Cellophane, plastics, new metallic alloys, new dyes, hitherto unheard-of drugs, nylon, synthetic rubbers, anti-knock gasolines, cheaper manganese, and a long list of other products brings the subject of chemistry's contributions to living about up-to-date and serves sufficiently to prove the point regarding ever-newness.

Critical study of advances in the chemical industry brings to light one important factor that, more than any other, will govern the future. Until just recently the industry was busy producing materials with which better work could be done on other materials. Dyes, for example, that would give better and more durable colors to existing fabrics; additives to increase the life and wearing qualities of rubber; ways and means of improving the thousand and one products of industry that were already in use. Tools, if you will, tools with which to extend the usefulness of materials that, of themselves, are usually considered to be far apart from routine operations of the chemical industry.

But now the picture changes, has been changing, in fact, for some time past. Tools of industry become incidental to chemistry; raw materials is the new field of endeavor, and a field that performance has already proved. Not only is the industry producing dyes for fabrics, but it is also producing the very fabrics themselves, and producing them from common, inexpensive materials. No longer is the only rubber aim of chemistry to improve the natural product; synthetic rubber claims a large share of attention. Are there moldable products that need durable colors? Build the color right into them and produce new materials that have characteristics not available in any product of nature—plastics.

Thus the chemical industry as a whole is possessed of a two-tined weapon with which to make its way in the world. It can make the tools of industry, and can produce the raw materials with which industry has to work. And never let it be said that here is an *ersatz* business, built on the need for substitutes. The plastics industry alone is sufficient to give the lie to any such thought. Here has been produced a whole group of new materials that, in a multitude of cases, do a better job than was done by predecessors. Here are materials that can be used where no other products give comparable results. Here, in a word, is a source of raw materials, made available by the chemical industry, that out-rivals anything that nature has ever produced.

With such a background of accomplishment, and with almost daily announcement of new developments from the chemical laboratories of the nation, it is apparent that the chemical industry of the future bids fair to surpass even itself in worth-while accomplishment.

TOWARD BETTER HOUSES

IT IS now becoming more and more apparent that the trend toward complete prefabrication of houses is a limited one, confined largely to the low-cost housing field, but the prefabrication idea is being applied in so many other ways in the building-supply industry that it is assuming a place of no small prominence. This trend is exemplified by increasing use, in new housing construction and in renovation of existing buildings, of factory-fabricated window units, kitchen cabinets, china closets, wall units of plywood and other materials, and so on. Just how far this particular phase of prefabrication will go will depend largely on the ingenuity of manufacturers in supplying units that can be built by mass-production methods, yet will retain sufficient individuality to suit varying consumer tastes.

ALL SILK IS NOT IN STOCKINGS

WHILE the ladies are carefully guarding dwindling supplies of silk hose and keeping a critical eye on the stocking industry's efforts to produce satisfactory limb coverings from high-count cotton, the electric wire and instrument manufacturers are preparing to get along without the silk that they formerly used to the extent of thousands of pounds annually. General Electric, for example, will use rayon and nylon as a substitute for silk insulation on wire when present silk supplies are exhausted. Silk tape, used in some phases of their work, will be replaced by cotton or rayon. And so it appears that a year or so hence many of us may wonder why we ever worried at all about shortage of silk!

—*The Editors*

Escape From Surgery

New Telescopic Technique of Internal Examination is Saving Many from Operations

ANDREW R. BOONE

WITHIN recent months several hundred persons who suffered from ailments of vital organs, which defied diagnosis by X-ray or other standard methods of examination, have escaped major surgery.

An ingenious instrument combining tubes, mirrors, telescope, brilliant light, tiny scissors, and means for inflating the abdomen, enables surgeons to study the organs within the abdominal cavity. In 20 minutes, a doctor, trained to recognize what he sees through the 'scope, can catch close-up glimpses of the tissues, describe their conditions to other consultants, and send the patient back to his room.

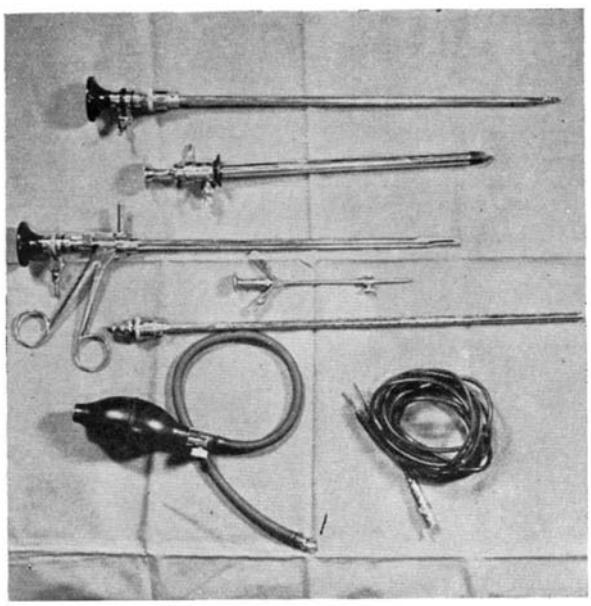
It was Dr. John G. Ruddock, Los Angeles surgeon, who perfected the device, known as the Ruddock Peritoneoscope.

For two decades, physicians and surgeons have sought an efficient means for looking inside the body without resorting to surgery. To insert the peritoneoscope, an incision only one half inch long is required. A single stitch closes the wound. Patients undergo the examination in comfort, a local anesthetic preventing pain, and, because the nervous system suffers little or no shock, they seldom miss a meal when undergoing the novel experience of revealing their inner workings to their doctors.

Dr. Ruddock collaborated with technicians of the American Cystoscope Makers, Inc., in evolving the 'scope. In addition to making it possible to view the organs, the device enables surgeons to take specimens of tissues suspected of being diseased for laboratory analysis; also to make such minor repairs as clipping adhesions.

The 'scope has five essential parts. First, a dull-pointed needle five inches long enables the surgeon to penetrate the abdomen and distend it with air. After withdrawal of the needle, a metal sheath containing a removable tip is inserted. If fluid is present, a suction tip replaces the solid tip.

Next, for making an examination, the telescope is slid into the sheath. The surgeon then simply looks into the eyepiece, and scans his field through the tube and mirrors. A tiny light is placed near the tip, ahead of the optical system.



Instruments used in the examination (see text)

By rotating the 'scope, the surgeon sees in a few seconds a field two inches deep, around a complete circle.

Should tissues suspected of being diseased be encountered, he sends down a pair of tiny forceps. Guiding them carefully under the brilliant light, the surgeon eases the open forceps into the tissue, closes them with thumb scissors, and removes the specimen. When closed, the tip forms a cup to hold the material.

He next observes the sampled area intently, and if bleeding takes place, he touches a switch, sending high-frequency electricity down through the lower end of the forceps to coagulate the blood.

Dramatic medical history is already being written in hospitals all over the nation because Ruddock's genius brought the 'scope into existence. In a western surgery, several physicians met recently to study the case of a girl whose illness doctors had tried in vain for three years to diagnose. Now she lay on the table, discouraged, critically ill, too weak to withstand exploratory surgery.

One of them experienced in use of the peritoneoscope, bent over the patient. He marked a site just below the umbilicus, and carefully measured the point for a short incision. After encircling the site with novocaine, he made the opening, inflated the abdomen with air forced down with a hand syringe, and inserted the 'scope. Through the tube he first examined the liver. Swinging slowly around in a clockwise circle, he viewed the spleen, the parietal wall, the intestines, and finally the appendix. Then he returned to the liver, and studied this organ intently.

THE clock had measured off 19 minutes when he closed the incision. For a half hour he discussed his observations with his colleagues. The girl's affliction, they decided, was actinomycosis, a rare infectious disease involving enlargement of the liver, due to ray-fungus. Medication, not surgery, was indicated; and her physician proceeded with a correct course of treatment.

An early user of the peritoneoscope was Dr. R. Nichol Smith, another Los Angeles surgeon and a friend of Dr. Ruddock. Dr. Smith began using the equipment to examine patients whose troubles had eluded diagnosis. One night his daughter complained of a pain in the right side. The symptoms indicated an inflamed appendix. If it were really the appendix, surgery could not wait.

Next morning, shortly after breakfast, Dr. Smith transported the girl to a hospital. At 11, he conducted a peritoneoscopic examination, but through the lens her appendix appeared to be quite normal and healthy. He found the trouble elsewhere, and a few minutes later the young lady was enjoying the comforts of a bed. At one o'clock she ate a light lunch;

at six, a four-course dinner. Twenty-four hours after entering the hospital, she went home, having suffered none of the discomforts of surgery. Medical treatment corrected the condition in a few days.

Marveling at the ease with which he found a cure for a member of his own family without resorting to surgery, which usually involves a two-week stay in the hospital, considerable expense, and perhaps several months to regain lost strength, Dr. Smith resolved to find some way of teaching other surgeons how to use the peritoneoscope and to interpret their observations.

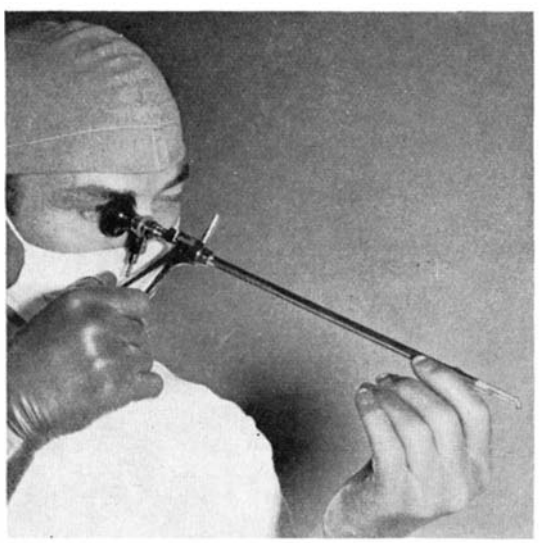
AFTER consulting Dr. Ruddock, he sought out Billy Burke, a Hollywood cinematographer who specializes in making surgical pictures. The Winship Foundation supplied funds. Then doctor and photographer went to work.

Recently, the two men completed the picture. It is an amazing film document which portrays in color the technique from beginning to end. Thirty-seven scenes, moving back and forth between exterior and interior views, reveal alternately the doctor operating the 'scope and close-ups of diseased organs. An enlarged spleen, partial obstruction of the intestines, an inflamed appendix, a hobnail liver, from different patients, parade across the screen. Each appears as a circular image, exactly as a surgeon sees it when looking through the 'scope.

On the title appears these words: "A photographic reproduction of views as seen through the peritoneoscope." So real is the illusion that one gets the feeling he is actually peering down into a living patient. This is precisely the effect Dr. Smith sought.

To get the unusual shots, the surgical photographer attached an 11-inch tube to the lens of his camera, and fitted an iris stop in the lower end of the tube. By stopping down, he obtained a circular field, thus avoiding the stagey effect of filling the screen with these shots. Cadavers in a nearby hospital were the subjects.

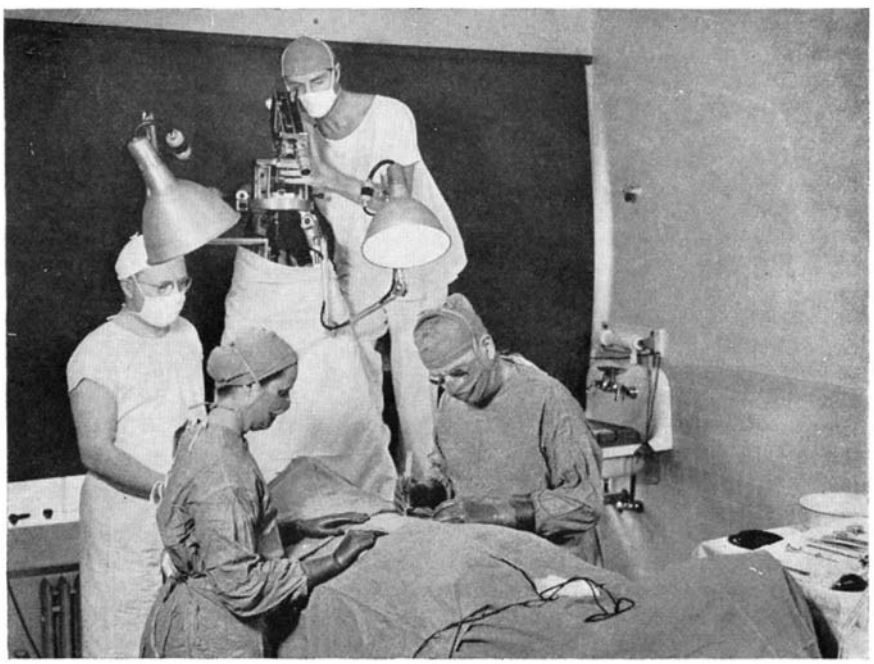
Dr. Smith views gall bladder and liver



How a specimen of tissue is taken

The search for an efficient means of looking into the abdominal cavity dates back to 1901, when Dr. G. Kelling, a German researcher, reported partial success. Dr. Kelling inflated the cavity of a dog, and examined the organs through a cystoscope. Nine years later Dr. H. G. Jacobaeus developed a similar procedure in Stockholm, Sweden. Other scientists in Denmark, Austria, Russia, South America, France, Italy, and the United States worked on the problem. Several of them patented devices for using lights both inside and outside the body to illuminate their field.

Now, through the peritoneoscope, doctors visualize pathologies never before visible. While they cannot visualize all pathologies within the abdomen, frequently they can trace the sources of tumors, determine whether to operate for removal of cancers, and study pelvic organs in their natural colors. Little more than a month is required for a surgeon to learn its use. Dr. Ruddock has reported diagnoses of 44 diseases in 900 patients as he looked through the instrument. It is thought that the peritoneoscope also may permit certain surgical operations without opening the abdomen by making it possible to pass especially designed instruments down through the tube and to guide their work by



Making a motion picture, to help in teaching other surgeons the technique

Viewing wall of peritoneum

means of its tiny mirrors and light. Surgical operations often are performed by means of a remarkable variety of tiny but ingenious instruments inserted through the similar sheath of the cystoscope, though that instrument is used primarily for the examination of the interior of the bladder and for testing the kidneys—and now the same principle may be applied to the peritoneoscope.

• • •

MASTER DIET

How to Attain an Adequate Diet

HOME economists of the United States Department of Agriculture have translated the recently established "yardstick of good nutrition" for the United States into a master diet plan.

The "yardstick" set up by a committee of eminent nutritionists defines an adequate diet in scientific terms—of recommended daily allowances for different elements that human beings need. The master diet plan translation gives the same information in terms of different groups of food that need to be represented in the diet every day.

Follow this diet plan, say the nutritionists, and the vitamins, minerals, and other food essentials listed in the yardstick will take care of themselves.

Milk—three-quarters to one quart every day for a growing child; one quart for an expectant or nursing mother; one pint for everyone else. Tomatoes, oranges, grapefruit, green cabbage, raw salad greens—one or more servings for everyone. Leafy, green, or yellow vegetables—one or more servings. Potatoes, other vegetables, and fruits—two servings or more a day. Eggs—one a day (or at least three or four a week). Lean meat, poultry, fish—one or more servings a day. Cereals—at least two servings of whole-grain products or "enriched" bread. Fats and sweets—some butter or fat rich in vitamin A every day, and enough more fats and sweets to satisfy the appetite.

THIAMIN

A B-Vitamin Deficiency Accounts for Many Ills

SHORT TEMPERS, inefficiency, headaches, backaches, and stomach distress after meals are what come from eating regularly over a long period a diet that is just a little short in the morale vitamin, B_1, diet studies at the Mayo Clinic show, according to *Science Service.* Eleven women, chosen for their previous record of good health, lack of "nerves," willingness and ability to co-operate, were the human guinea pigs for this study just reported by Drs. Ray D. Williams and H. L. Mason.

In contrast to previous studies in which human subjects developed typical neurasthenia on diets with a very low vitamin B_1 (thiamin) ration, these women were given the sort of diet thousands of American families regularly eat. It consisted of white bread, corn flakes, polished rice, sugar, skimmed milk, beef, cheese, egg white, butter, vegetable fat, cocoa, gelatine, canned fruits, canned vegetables, and coffee. It was a little but not markedly low in its content of vitamin B_1.

After three months, one of the women developed such disturbing symptoms that she had to be taken off the diet and given doses of the vitamin. The others continued with the diet for from about four to six and one-half months. Besides low blood pressure, capricious appetites, anemia, and signs of disturbed heart action, these women, after several weeks on the diet, showed the following changes in their normal behavior:

The subjects became depressed, irritable, quarrelsome, and fearful. They became inefficient in their work because of generalized weakness, were inattentive to details of their tasks, were confused in thought, uncertain of memory, and lacked manual dexterity. These abnormalities progressed to a degree which disabled six subjects in the performance of work to which they had been accustomed for a long time.

Headache, backache, dysmenorrhea, soreness of muscles, gastric distress after meals, sleeplessness, tenseness, paresthesia (burning or prickling feelings), intolerance to noise, and increased sensitivity to painful stimuli were frequent complaints, although these signs and symptoms were entirely of a subjective nature. The significance of these evidences of abnormalities was increased, however, because of the careful selection of subjects, their continuous co-operation and ability to work before the period of restriction of thiamin (vitamin B_1), and their subsequent normal behavior when, without other change in environment or diet, the allowance of thiamin in the diet was increased.

LAME WING

Arm Ailment Frequently Due to Bearing Deposit

WHEN a veteran baseball pitcher (occasionally a youngster, too) suddenly develops a severe lameness in his "money arm" and is no longer able to throw his "fast one" because of the severe jab of pain he gets in his back shoulder muscles, he is likely to be suffering from the formation of a bony deposit on the bearing surface of his shoulder-joint very much like that which gives older persons arthritis, states Dr. George E. Bennett, member of the Johns Hopkins medical faculty, in the *Journal of the American Medical Association,* reports *Science Service.*

Part of the pain is felt in the shoulder itself, and part is "referred" to the deltoid muscle, which is the broad, triangular muscle spreading out from the shoulder across the upper part of the back. This referred pain is due to the pressure of the bone accretion on a nerve, Dr. Bennett explains. It is possible to remove this bony growth by surgical operation, but this involves cutting loose part of the deltoid muscle, and is at best a risky procedure.

"My experience," Dr. Bennett states, "is not sufficient to advocate this operative procedure with the assurance that a baseball pitcher will be able to resume his profession."

Gold From the Grave

Central American Indian Cemeteries Yield Exquisite Ornaments of Almost Pure Metal

J. ALDEN MASON

Curator, American Section, The University Museum of the University of Pennsylvania

WHEN the first Spanish conquerors came to Panama early in the 16th Century, they found no buildings of masonry such as they were later to encounter in Mexico and Peru; naturally, they did not expect any. They found what they expected, from their experience in the West Indies—Indians living in houses of wood with thatched roofs. They did find, however, what was to them much more important than masonry temples and palaces—a people with a wealth of ornaments of gold, a metal that had been very scarce in the Antilles. As everywhere, they warred upon the natives, captured the chiefs, and demanded enormous sums of gold as ransom. The first expedition to the region of Coclé, that of Gonzalo de Badajoz in 1515, in two months secured gold ornaments to an apparent present gold value of $90,000 to $150,000, and Chief Parita tried to buy them off with baskets of gold objects worth some $250,000 to $300,000.

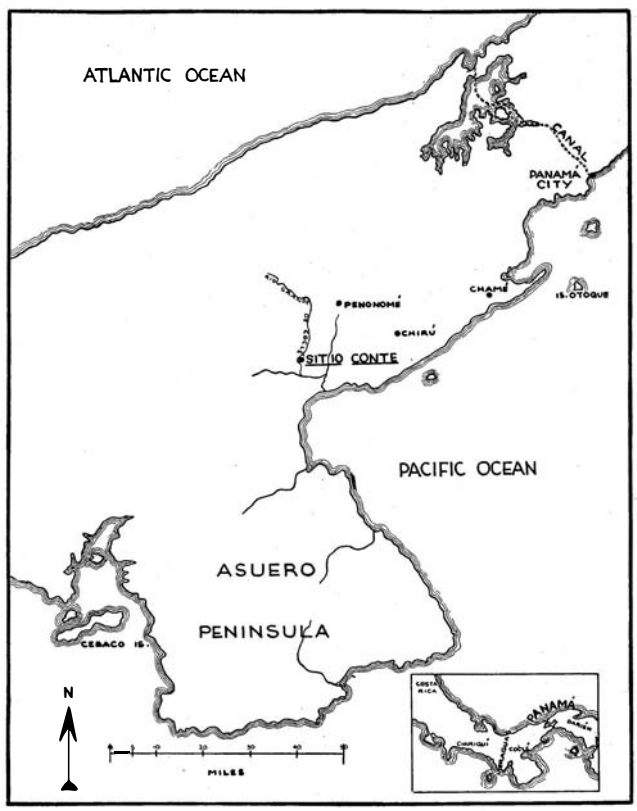
Also, they dug up the Indian cemeteries for the gold ornaments that were interred with the chiefs. Most of these exquisite examples of the goldsmith's technique were melted down and sent to Spain; only a very few examples that were sent abroad intact have survived to the present day.

For over four centuries the digging of Indian graves for their gold content has been a recognized industry in the Isthmian area. In some regions, such as the Chiriqui district in western Panama, the slab-covered graves are discovered by sounding with a metal rod; in others there are no surface indications.

Naturally, very few large cemeteries escaped the careful search of the Spaniards and their native successors. One that did was discovered quite by accident about the beginning of the present century in the province of Coclé, on the Pacific slope about 70 miles west of the Canal Zone. In the flat terrain the rivers frequently change their courses during the high floods of the rainy season, and the Rio Grande de Coclé, in making a new bed, cut through a large pre-Columbian cemetery. Pottery vessels, gold ornaments, human bones, and other buried objects began to wash out of the bank. The owners discouraged private digging and did little themselves. Such discoveries generally take a long time to reach scientific ears, and it was not until 1930 that careful excavations were begun there by the Peabody Museum of Harvard University, which continued work in 1931 and 1933. Seven years later, in 1940, the University Museum of the University of Pennsylvania sent an expedition to the same site; I had the good fortune to be in charge.

The cemetery is known as the Sitio Conte, or "Conte Site," from the name of the owners. In high floods the field is completely covered with water and the deepest graves probably are below water level during the greater part of the

Above is the pit during excavation, showing several graves, excavators, and staff members; also, a small, square grid for plotting and photographic recording by coordinates, such as archeologists employ for permanent record. Below is a map of the region, with a small insert showing its relation to the Canal Zone



year. Only in the dry season, from January to April, is it possible to dig. Unlike the Atlantic slope, the region is open and grassy, cattle-raising being the principal industry. The constant trade winds make the high temperatures endurable, and in the dry season there are no mosquitoes and consequently there is no malaria. Though venomous snakes are found, their proportion among the total serpent population is not large.

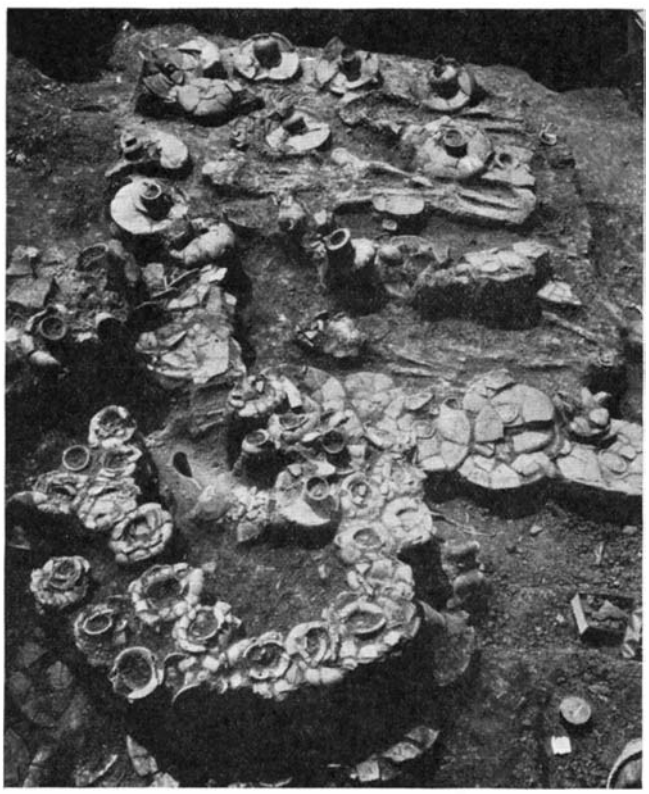
A PIT some 55 feet in maximum length by half that in width was dug, in many places down to the water table at about 13 feet from the surface. Little was found in the upper five feet, and probably part of this was accumulation of the last four centuries. In the space excavated, some 30 graves and caches were encountered, ranging from caches of a few buried pottery vessels or stone objects to graves ten feet in diameter and containing hundreds of vessels and over 20 interments. Nine of the graves might be considered as large.

The task of determining the characteristic types of pottery and other objects of the different periods, one of the major functions of archeological research, could not be done by the usual stratigraphical methods. In a site where soil and debris have collected by gradual accumulation, the older objects are at the bottom, the recent ones on top, but at the Sitio Conte the latest graves are often the lowest, and the temporal relations have to be determined by noting when a later grave has cut through an earlier one. The criteria are often confused, since sometimes in making a later grave, the earlier ones cut through were robbed of their best objects which were then interred in the new grave.

The task of the natives in digging graves ten feet square to a depth of eight feet without the use of metal implements must have been a stupendous one. Since the big, very deep graves could have been made only at the height of the dry season, it is obvious that the bodies of the chiefs must have often been kept for many months, and during this time probably quantities of pottery vessels were made especially for grave furniture.

The accounts of the earliest Spanish chroniclers agree so well with the nature and contents of the graves that it is likely that the cemetery was used until approximately the time of the Spanish Conquest, and the earliest graves are probably not older than two centuries before this, about 1300

Gold ornaments in the richest grave



Left: **A two-grave area showing shattered pottery, skeletons.** ***Right:*** **Pottery that escaped the "killing"**

Gold from the richest burial—four repoussé plaques, averaging eight inches in diameter; also, cuffs, sequins, and crocodile

A.D. Apparently burial was a rite reserved for chiefs, and with them were buried other persons—servants, slaves, and possibly even wives to accompany their masters to the spirit world. These seem to have been first stupefied, perhaps by quantities of chicha, the native beer still made today, and buried alive. In accord with the primitive feeling that mortuary objects also had to be "killed" in order to release their spirits to accompany the dead, almost all the pottery vessels had been shattered, probably by trampling. In many of the graves are large empty spaces which may have been occupied by baskets and such perishable objects of organic materials. Due to the constant dampness of the soil, only objects of pottery, stone, and metal were well preserved. Those of bone and ivory had to be excavated with the greatest of care, and wood and textiles were entirely gone. All the human bones were in too soft a condition to be saved. Relatively few intact pottery vessels were found, but more than three tons of pottery were brought to Philadelphia. As most of the parts of a broken vessel lay together, the task of restoring them is not a difficult one.

ONE grave far exceeded all the others in importance and "richness." Though most graves are flat or slightly concave, this one was cup-shaped. Apparently so many pottery vessels were made for the dead that they could not be placed on the bottom of the grave and so were imbedded in the almost vertical walls. From the edge of the rim, found at about five feet below the present surface, the grave extended down seven feet, the bottom being only one foot above water level, which was 13 feet below the surface at the height of the dry season. At the rim, the diameter was 14 feet; at the bottom, eight feet, making the average slope of the pottery-encrusted sides 60 degrees. Three interment levels were found, the main middle one at a depth of six feet below the rim, a lower level one foot lower, and an upper level 18 inches above. There were eight skeletons on the upper level, 12 on the middle one, and three on the lower—a total of 23. All lay parallel, east to west, face down, and those on the middle level in two tiers. Little grave furniture accompanied the interments on the upper level, as its occupants probably had been slaves or servants, but the lower levels were thick with broken pottery, and most of the skeletons bore some gold ornaments. One of those on the middle level, perhaps the principal chief, fairly blazed with a wealth of gold ornament. He wore five great gold plaques, gold cuffs and armlets, several gold pendants, ear-rods, nose-clips, many sequins, small bells and chisels, and quantities of beads.

The gold is heavy and almost pure. Every archeologist gets a great "kick" from digging up pure gold, as it is untarnished and appears in its pristine beauty as soon as the dirt is washed off. Eight great plaques, ornamented with demoniacal designs in repoussé, were secured; these are from eight to ten inches in diameter. The decorations apparently represent the native gods, a crocodile god being especially prominent. Cuffs and some other ornaments were also decorated in repoussé, probably hammered over forms. Most of the jewelry, however, was apparently made by casting, possibly by the lost-wax process. The most spectacular piece is a gold crocodile four inches long, with a large but poor-grade emerald, an inch in diameter, set in his back; the gem may have come from Colombia. Some of the gold pendants are exquisite examples of both technique and art.

By both quantity and quality this "find" was one of the richest, if not the richest, ever made in America by a scientific expedition from the United States. About 92 troy ounces of gold were brought back, in addition to the share taken by the owner of the land. In all likelihood the gold was panned in the local rivers, though today they do not yield enough to make mining profitable. The technique of gold working was a relatively late one in pre-Columbian America; gold was practically an unknown metal to the ancient Maya, for example.

THE pottery is profusely decorated in polychrome colors in which blue and purple, rare colors in other regions, predominate. The shapes are widely varied, from simple silhouettes to complex animal effigies. Objects of stone, mainly celts, spearheads, arrowheads, and agate pendants, but also larger objects, such as metates and mullers, were found in the graves and caches. Necklaces of the teeth of animals are common, as are also spines of the sting ray.

The aboriginal inhabitants of Coclé are almost unknown to history except for the short accounts of the Spanish chroniclers. Today no Indians live in this region, but the Guaymí of western Panama probably are their nearest relatives. The skeletal remains indicate that they were a large people, many of the men over six feet in height. They have no connection with and little resemblance to the Aztecs, Mayas, or Incas; indeed, their objects differ decidedly from those of the Chiriqui of western Panama and even from those of Veraguas, the next province to the west. What little resemblances there are to other cultures seem to point to the southeast, toward Colombia.

High Pressures Within

How Astronomers Derive Such Stupendous Internal Pressures for Earth and Stars

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

A CORRESPONDENT suggests some questions which many others have doubtless asked in their own minds. How do astronomers arrive at the huge values which they give for the pressure at the center of the Earth, and still more of the Sun? Can we trust our methods of calculations to hold good when extended so far beyond the range of experiment?

The answer to the first question, under engineering conditions, is very simple. For a theoretical column (pipe) of imaginary liquid of the same density as water, and which was incompressible, it would come out, by arithmetical calculation, at 4550 tons per square inch. But this is too easy. Successively deeper miles of our pipe would contain equal quantities of fluid, but these would not all have the same *weight,* for the force of gravity inside the Earth diminishes toward the center—where attractions in all directions balance, and there is no net effect. At intermediate depths, Newton showed long ago that (for a spherical distribution of matter) the attraction of parts more distant from the center than the point considered, and forming a shell surrounding it, annul one another completely; so that the actual effect is the same as it would be if these were stripped off, leaving only the portion nearer the center. It follows very simply that, inside a body of uniform density, the force of gravity is proportional to the distance from the center. The average force acting on the fluid in our pipe would then be just half that at the surface, and the pressure at the bottom would be 2275 tons per square inch.

Let us come one step nearer reality by assuming that the density of our imaginary fluid was equal to the mean density of the Earth (5.56 times that of water). We then get a central pressure of 12,700 tons per square inch. The actual pressure must be greater, for the density of our planet increases toward its center—since the density of the surface rocks (omitting the thin surface layer of granite) is about 55 percent of the mean: the density at the center is probably nearly twice the mean. We can get a good general idea of the degree of central condensation, though not of the detailed form, from the relation between the polar flattening of the Earth and the centrifugal force due to its rotation.

If we knew the exact law of distribution of density, we could work out the pressure exactly. Starting at the center, and imagining successive spherical layers to be put on, each with the proper density, it is easy to find the total mass of any concentric sphere interior to the Earth, and hence the force of gravity at its surface—that is, at any given distance from the center. Then, starting at the surface and working downward, we find the weight of each successive mile of fluid in our imaginary pipe—supposing it, of course, now to have the density appropriate to its distance from the center. The cumulative sums will give us the pressure at successive depths, and finally at the center. (The reader familiar with the calculus will realize that the above is a "painless" description of a double integration!)

PERFORMING this calculation for the Earth, we find that the central pressure is about 50 percent greater than it would be if the planet were homogeneous. The outstanding uncertainties in the exact law of increase of density do not alter this conclusion seriously. We thus conclude that the actual pressure at the Earth's center is about 19,000 tons per square inch, or some 2,600,000 atmospheres.

At this point the reader may protest: "This is all very well for a pipe full of liquid, or a liquid planet; but the Earth is made of solid rocks. Won't it act like a set of great concentric arches, and hold up the pressure?"

For a small body, like an asteroid, this argument would be valid.

On Earth, even if the material inside were cold, a pressure would be reached, at a depth of a few hundred miles, under which the hardest rocks would give, and flow not like water, but slowly, like pitch. Farther inside, where the pressures were still greater, the material, under long continued pressure, would show no permanent resistance, and behave like a very viscous liquid. We are therefore fully justified in maintaining that there is a real pressure, at the center of the Earth, of roughly 20,000 tons, or 40,000,000 pounds, per square inch.

WHAT happens inside the Sun? Here there can be no doubt that all of the material is fluid—indeed gaseous—with not a trace of rigidity.

If the Sun were built on a similar density-model to the Earth, the answer would be very simple. Reasoning of the type already described shows that, for the spheres built on the same model, the central pressure is proportional to the product of the square of the radius and the square of the density. The Sun's radius is 109 times the Earth's, and its density very nearly one fourth of the Earth's; so that, on this model, the central pressure would be $(109 \times \frac{1}{4})^2$ or 745 times that on the Earth—that is 14,000,000 tons per square inch.

But there is no reason to suppose that the Sun is built on this model (with the central density less than twice the mean), and very good reasons for believing that it is not. There are some pairs of eclipsing stars in which slow changes in the orbits make it possible to show that the central density is 50, or even 100, times the mean density. Inside such a body the attracting portions are, on the average, much closer together and the gravitational forces greater, so that the central pressure is much larger.

To get any reliable notion of how great the central density is within the Sun, we must have recourse to theory, and an important calculation has just been published by

four investigators. Two of these, Messrs. Lowan and Blanch, are in charge of a W.P.A. project for the computation of mathematical tables, a project which has already done excellent work in other fields; the others, Messrs. Marshak and Bethe, are well-known authorities on subatomic and stellar energy.

The principles on which their work is based are these: We have strong reasons to believe that the nuclear transformations by which the Sun's heat is maintained run so much faster with increasing temperature that practically the whole energy-liberation occurs in the hottest and densest part of the Sun, near its center; the rest of the Sun acts only as a nearly opaque envelope, which keeps the heat from escaping to the surface faster than it does. To drive this flow of heat through these outer portions, there must be a steady rise of temperature inward, and the envelope thus keeps the inner core hot enough to allow the atomic transformations to continue.

Since no heat is generated in the envelope, the total amount flowing outward through a sphere at any depth below the surface is the same as that which escapes from the surface itself, and hence a known quantity. The flow per square centimeter increases inward, since the spheres are of smaller area, but can be calculated at any point.

Now atomic physics has progressed far enough to enable us to calculate what temperature gradient is required to drive any given flow of heat through a gas of specified density, temperature, and composition. So (assuming a fixed composition), if we know the temperature and pressure at any depth, we can find the increase of temperature in the next thousand kilometers, for example—this being but a small fraction of the size of the Sun. We can also calculate the increase in pressure in 1000 kilometers, if we know the density of the gas (which depends on its temperature and pressure) and the force of gravity.

To calculate the latter, we must know how much of the Sun's mass lies farther from the center than the region where we are working. But the density of the outer gases is so small that, for 50,000 miles or so below the surface, we can safely ignore this correction. Under these simplified conditions it is possible to solve the equations, and derive formulas which give the temperature, pressure, and density at any depth, if we know the size and mass of the Sun, and the rate of heat-flow into space from its surface. This gives a good start for the calculation. When it has gone deep enough to "shed off," so to speak, as much as 1/1000 of the Sun's whole mass, account must be taken of this fact, and the "closed" formulas have to be replaced by a process of step-by-step numerical calculation of the changes in each successive layer. This is highly laborious, but may be made as accurate as is wished, by taking the trouble.

This process, however, cannot be carried right down to the center of the Sun, for the assumption that all the Sun's heat is generated "still deeper" becomes obviously absurd close to the center, say within 10,000 miles of it. Fortunately there is a simple way out of this difficulty. The calculated temperature gradient increases steadily toward the center. Now, in any mass of gas, something happens if the temperature gradient is too high, which is illustrated by the familiar "thunder-heads" of summer clouds. The air is warmer near the ground than, say, a mile above. "Warm air tends to rise"; but, if a mass of the warm surface air could be rapidly raised a mile high, and so be exposed to lower pressure, it would cool itself by expansion. Under ordinary conditions, this cooling would be great enough to make it cooler than the undisturbed air a mile up. Being cooler, at the same pressure, it would be denser, and would sink back again. But, if the air near the ground is very much heated, it may reach a state in which, after rising a mile and expanding, it would still be hotter than the surrounding air and tend to rise still higher. Under these conditions our ascending column of air, once started in any way, will rise higher and higher, and draw more and more of the hot surface air into it, until the latter is exhausted; but under normal circumstances a column set ascending would soon sink back, and conditions would be stable.

The same principle applies inside the Sun. So long as the vertical change of temperature is not too rapid, the cooler gases above will lie upon the hotter layers below in stable equilibrium; but, when a certain limit is exceeded, the lower layers will tend to rise, and the upper ones to sink, and a turbulent set of currents will be set up. With gases like those inside the Sun (in which all molecules have been broken up), this limiting condition happens when the percentage increase in temperature is more than 2/5 of the percentage increase in pressure.

The calculations for the Sun show that near the surface this ratio is much smaller than 2/5, but increases, and ultimately reaches this value. Nearer the center, the radiative equilibrium, in which the heat is carried by radiation through the gas, breaks down, and is replaced by convective equilibrium, in which heat is carried by bodily motion of ascending currents of gas.

A gas under these conditions, if considered on a scale large in comparison with the size of the individual eddies of current, presents a relatively simple mathematical problem, and can be easily handled no matter in what part of it the heat is produced.

According to the final calculations, at a depth of one-sixth of the Sun's radius the temperature is 1,070,000 degrees and the density only 1/220 that of water, or 3½ times that of air under standard conditions. Halfway to the center, the temperature is 5¼ million degrees and the density 92 percent that of water, while 95 percent of the Sun's mass is still inside. Three quarters of the way down the temperature is nearly 13,000,000 degrees and the density 24.6 times that of water. The inner core, in which convective currents occur, has a radius only 12 percent that of the outer surface and contains 12 percent of the Sun's mass. The central temperature is 25,700,000 degrees and the density 110 times that of water, or 78 times the mean for the whole Sun. The corresponding pressure comes out 1,700,000,000 tons per square inch. The concentration of matter into a small central region gives so strong a grip to the gravitational forces that this is more than a hundred times as great as it would be if the Sun was built like the Earth. Calculation of the liberation of energy by the now well-known carbon-nitrogen cycle shows that 97½ percent of the heat production would occur in the inner core. The approximation which supposes that it all takes place there is, therefore, a good one.

A Bridge Because of a Dam

Truss Design and Material Used Represent New Departures From Previous Practice

F. W. PENHORST
Bridge Engineer

COMPLETION recently of the Sacramento River bridge at Antler, in Shasta County, California, marks an important step in the fulfillment of the task of relocating approximately 16 miles of state highway in the Sacramento, Pit, and McCloud River canyons made necessary by the construction of the Shasta Dam near Kennett. A combination highway and railroad bridge across the Pit River is scheduled for completion next Spring.

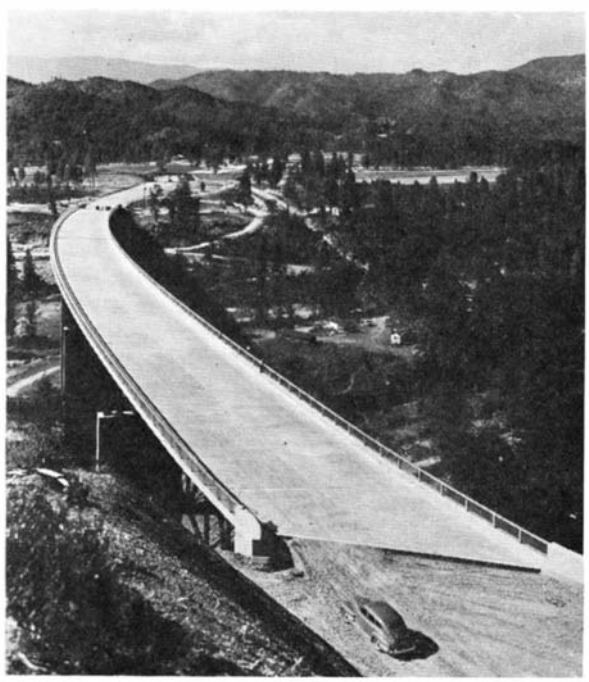
The Antler Bridge is a steel deck structure, 1330 feet in length, on concrete piers and abutments. The roadway is on a 5000-foot radius curve compounding into an 850-foot radius curve about 80 feet north of the south abutment. The entire structure is on a descending vertical curve of —2.5 percent grade at the south end and a —4.25 percent at the north end. The roadway width is 50 feet; two 2½-foot sidewalks are provided.

There are five major spans in the bridge; two of 189 feet, two of 252 feet, and the central span, which is 273 feet long. The 273-foot span consists of a 147-foot truss supported by two 63-foot cantilever arms. A steel stringer approach span at each end of the structure is supported by the abutment and by a 42-foot cantilever arm.

The pier heights vary considerably, the tallest being 172 feet above footing grade. The piers are eight feet wide by 40 feet long at the top and the sides are battered ⅛-inch per foot to provide a pleasing appearance.

They are of cellular construction, using 18-inch walls and interior ribs throughout. Varying amounts of reinforcing steel in these walls provide for the differences in stress at the proper points. All piers are founded on rock.

Three of the piers extend down below river level and required concrete foundations poured under water. Construction joints are provided in the pier shafts at 20-foot intervals, a horizontal distribution girder, or "floor," being located at these points.



Roadway is on a 5000-foot radius curve

As the ultimate water level in the Shasta Reservoir will practically submerge the main piers, openings are provided at various points in the pier walls and floors to permit the free passage of water. This procedure not only eliminates hydrostatic pressure on the pier walls but adds considerable "mass" or "inertia due to weight of fluid" to resist earthquake forces, discussed later.

Next to structural safety, a fundamental requirement, smooth deck surfaces and good railing appearance are probably the two most important bridge factors to the motorist. Considerable care was taken, therefore, to insure good results in the completed structure, as follows:

(1) A railing and gutter profile was established for each side of the bridge, using long 1400-foot vertical curves to give a smooth change of super-elevation over the structure to fit approach alignment.

(2) Truss deflections due to full dead load were carefully computed, and elevations determined for each truss panel point to fit an "unloaded" profile. This "unloaded" profile is the final profile, plus the anticipated deflection under dead load.

(3) The fabricating shop subpunched, or sub-drilled, all main truss connections, then completely assembled each truss in a horizontal position in the shop, placing each top chord panel point in its correct relative position to fit the "unloaded" profile.

(4) All truss joints were then reamed to full size, and all members match-marked for erection.

(5) Trusses were then erected at the bridge site in any desired order as correct position was secured simply by jacking the trusses into shape until all truss connections were fair. No field drilling of these connections was allowed.

(6) The concrete deck was then poured to suit the contractor's working schedule. This was an important feature, as pouring a deck slab uniformly from one end of a structure to the other is much less costly than requiring short individual pours over various parts of the bridge.

To prevent participation of the concrete deck slap in resisting stress set up in the trusses by the weight of the slab, as it would surely do if rigidly attached, the deck has been literally "cut loose" by introducing small expansion joints in the stringers approximately 100 feet apart. This is of no consequence to actual strength of truss members, but has a pronounced effect upon deflection of the trusses. As accurate truss-deflections can be determined only if the slab is prevented from taking direct stress, this procedure is essential to secure a smooth deck.

It is most important in constructing a concrete deck to anticipate accurately the deformation of the various members involved, as cor-

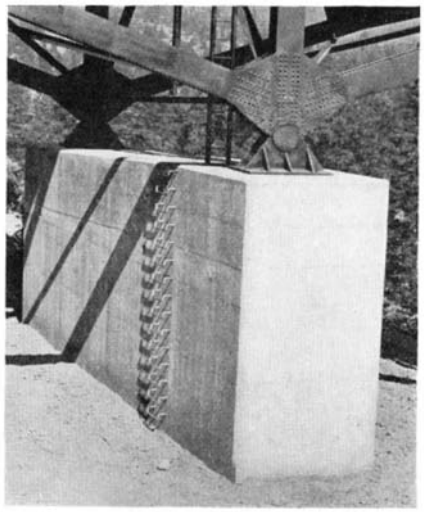
recting a rough or wavy deck after construction is a difficult and costly process.

To eliminate deflection stresses from the piers, temporary expansion rollers were used at the tops of all piers. Upon completion of the deck slab and upon a suitable day of average temperature, the truss shoes were grouted into permanent position.

Piers were arranged so that those on either side of the central span are supported longitudinally by anchor piers of comparatively low height located high up on the canyon walls. A suspended span in the central 273-foot span, with provision for expansion at one end, establishes a symmetrical truss layout, continuous over three supports on each side of this span. Trusses are then fully "indeterminate" only over the center support of the group, the "degree of indeterminacy" diminishing toward the two outer supports of the group, becoming fully "determinate" at these supports and beyond.

IN ORDER to support the main piers in a longitudinal direction, the trusses were attached to the pier tops by a rotating type of joint that will transmit horizontal shear, but no bending movement. This is important, as a rigid type of connection would practically double the temperature stresses in trusses and piers set up by horizontal deflection of the piers.

Transversely, the four high piers must provide their own stability. No temperature stresses exist in this direction, but wind and earthquake forces are quite severe. Analysis of the effect of "wave action" of the reservoir water due to earthquake forces was made. This "wave action" effect refers to the oscillating motion set up by an earthquake, and should not be confused with surface "waves" due to wind or tide. Extensive research and model experimentation has been done in this field by the United States Reclamation Bureau



Rotating joint, no bending

at Denver, Colorado, and use was made of these studies on this job.

Trusses were bent horizontally at two points between each pier rather than at the piers, to fit the horizontal curve of the bridge. A number of advantages result from this:

(1) The eccentricity, or overhang, of deck stringers relative to the trusses is but one-fourth that produced by bending the trusses only at the piers. This eliminated additional steel in the floorbeams located between bend lines.

(2) Bending moment in the truss is very low at the bend line due to the continuous truss layout. These bend lines occur at approximately the quarter points in the span where the dead load moments are practically zero.

Truss joint stresses are correspondingly low, and the torque resulting from these stresses is greatly reduced. While it is true that the torsional stresses set up at the bend lines must be transferred along the trusses to the piers, stresses are so low as to require no additional metal in the main trusses to resist them.

A newly developed alloy steel used in the trusses has 50 percent greater tensile strength than and is five times as rust resisting as ordinary structural steel. Its excellent corrosive resistance permitted minimum sections of ¼-inch thickness, while the additional strength available resulted in large savings in weight of metal.

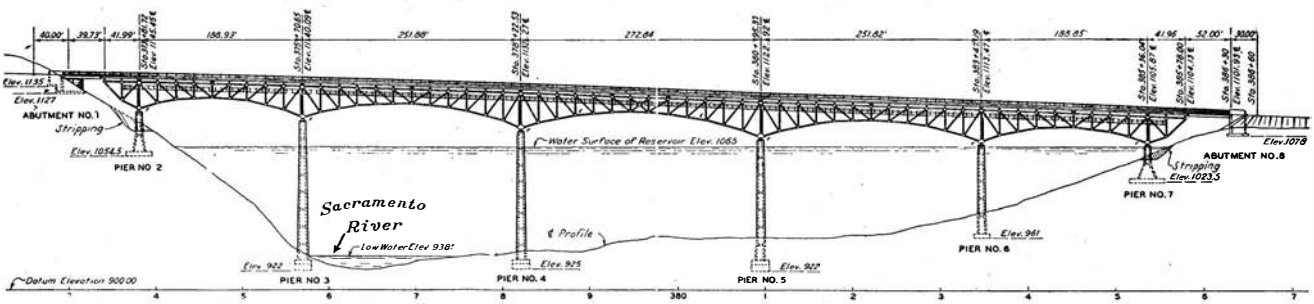
The truss member design represents a considerable departure from previous construction. All members consist of a 14-inch beam section, supplemented when necessary on the compression members with 15-inch or 18-inch channel sections shop welded to the beam flanges. No stay plates or lacing bars, formerly considered indispensable to truss members, were used. This not only reduces shop fabrication, but eliminates excess metal not directly participating in stress resistance.

AS TRUSS members are perfectly smooth and accessible for painting, maintenance costs will be materially reduced.

Bracing members were made from structural tee sections obtained by splitting wide flange beam sections at the rolling mill when hot. These sections became available fairly recently and have proved very economical.

Truss-shoes are built-up assemblies of rolled steel plate, shop-welded together to form a rigid unit. Alloy steel was used, resulting in a strength and ductility equal to that secured in the main truss. The largest truss shoe is approximately five feet square by 2½ feet high, and supports a load of more than 2,000,000 pounds.

Temperature variations of 20 to 120 degrees, Fahrenheit, produce a total movement of nine inches at the one expansion joint in the truss system. A sliding "finger" type of joint was used in the deck slab, featured by a locking device that anchors it rigidly to the deck to prevent noise and vibration due to passing vehicles. The joint is self-cleaning, in that rubbish and dirt cannot collect in the openings, but are pushed off by movement of the bridge.



Illustrations and text courtesy *California Highways and Public Works*

The four high piers must supply their own stability transversely

International Beams

Short-Wave Broadcasts, Directed to Foreign Countries, are "Searchlighted" for Power

RAYMOND F. GUY

Radio Facilities Engineer
National Broadcasting Co., Inc.

DESPITE the fact that heavy penalties are meted out to residents of certain oppressed European countries who are detected in the act of listening to broadcasts from American radio stations, there is ample evidence that a substantial radio audience exists in those areas. Letters received in the United States, often by roundabout means, convey with stirring impact the value of the international broadcasting service which has been available for several years past.

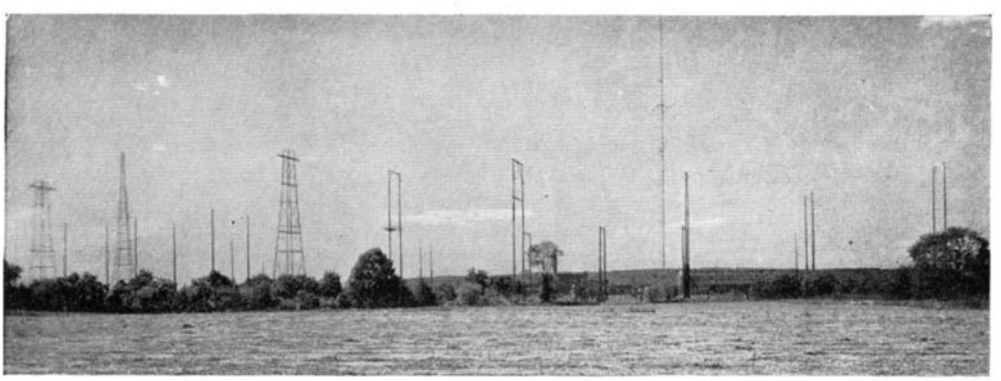
One cannot help but be deeply impressed by many of these communications from Europe, expressing as they do despair and misery which to some extent is lightened by the medium of radio broadcasting. Neither can one read the pleas to continue and expand our broadcasting efforts without more fully appreciating the high patriotic and humanitarian function which is being served by short-wave licensees in the United States. International broadcasting, as conducted by the democracies, has become a powerful instrument which has earned the respect and confidence of foreign listeners through the truthfulness of its reporting and the character of its programs.

Then, too, there are the Americas to the south of us, where news, educational, and entertainment broadcasts are eagerly sought by an audience that is highly receptive to the influences of the unbiased and complete coverage of these transmissions from the United States.

International broadcasts by NBC originate at the Bound Brook, New Jersey, plant where also are located the transmitting facilities of WJZ. A tract of 70 acres is largely devoted to the special antennas which have been designed for transmission to Europe and Central and South America over stations WRCA and WNBI.

IMPORTANT among the developments which have made possible consistent broadcasting to far-distant countries is the beam or directional antenna. With this system it is possible to direct a fan-shaped beam of radio energy instead of broadcasting it to the four winds. The beam antenna thus represents concentrated power, in much the same manner as a search-light beam represents concentrated light. The gain in power through the use of a beam antenna is outstanding. For example, a specific directed antenna used with a 50,000-watt transmitter produces an effective power of 1,200,000 watts. This simplified statement means that if the energy were broadcast in the conventional manner, instead of being sent out through a beam antenna, a 1,200,000-watt transmitter would be needed to achieve the same signal strength at distant points as is now produced by a 50,000-watt station. And the engineers have another trick up their sleeves. When necessary, the two 50,000-watt transmitters at Bound Brook may be synchronized on the same wavelength to get even more effective coverage at very distant points. When this is done the effective power resulting from the combination, feeding a beam antenna, is the equivalent of 1,700,000 watts.

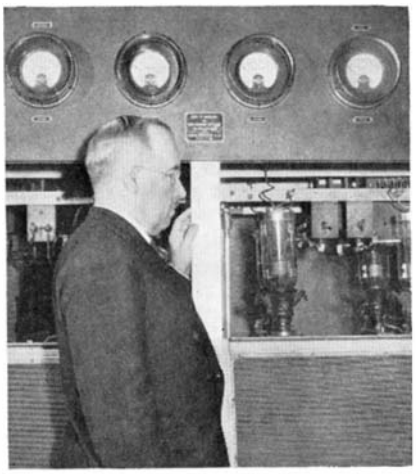
In the design of a beam antenna it is possible to control the width of the beam, but the engineer must decide on the desirable compromise between power gain and beam width; one, of course, is obtained at the expense of the other. Thus a beam broad enough to cover all of South America would have such low power gain that it would not provide sufficient signal intensity at the receivers to give satisfactory service. On the other hand, it would be a comparatively simple matter to increase the power gain by narrowing the width of the beam. This, however, would result in greater signal strength over a limited area at the sacrifice of service to adjoining areas of importance. Thus, to insure satisfactory field intensity to South America, two antennas must be used for each frequency, while a third antenna is required to cover Central America. European service, of course requires another array of antennas.



Above: **Close-up view of the steerable antenna used in serving Rio de Janeiro and Buenos Aires areas from the United States.** ***Left:*** **General view of short-wave antennas at Bound Brook, New Jersey. At extreme left is the steerable antenna shown above. Other arrays are for South American services on other frequency bands**

Another form of aerial which is being used in international broadcasting is the steerable beam antenna, developed by NBC engineers. One of these has been in daily service for some years and another one is now nearing completion. By the use of a suitable electrical system and three groups of antennas, the beam can be steered in such a manner as to place the greatest signal intensity at the receiving end in the area which it is desired to cover at the moment. The technical details of the steerable antenna are somewhat involved; essentially, the result is achieved by throwing two of the three antenna circuits out of phase with respect to the third. Complicated as is the action, it is controlled from a single switch. When this switch is operated, the beam is steered ten degrees to one side or the other of the center line.

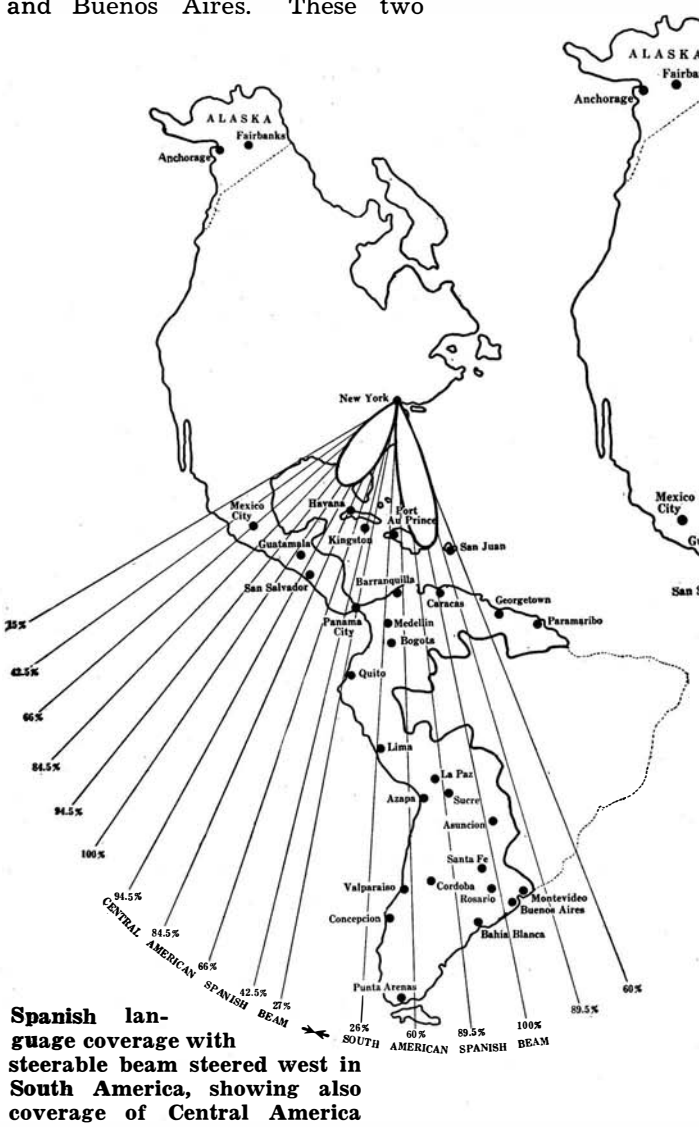
The steerable antenna is of the greatest value in serving the areas centering around Rio de Janeiro and Buenos Aires. These two areas, as viewed from New York, are 20 degrees apart and are the most important language areas of South America. A beam sufficiently wide to cover these two localities would not be as effective in power gain as the steerable beam which permits more satisfactory service and higher signal intensity.



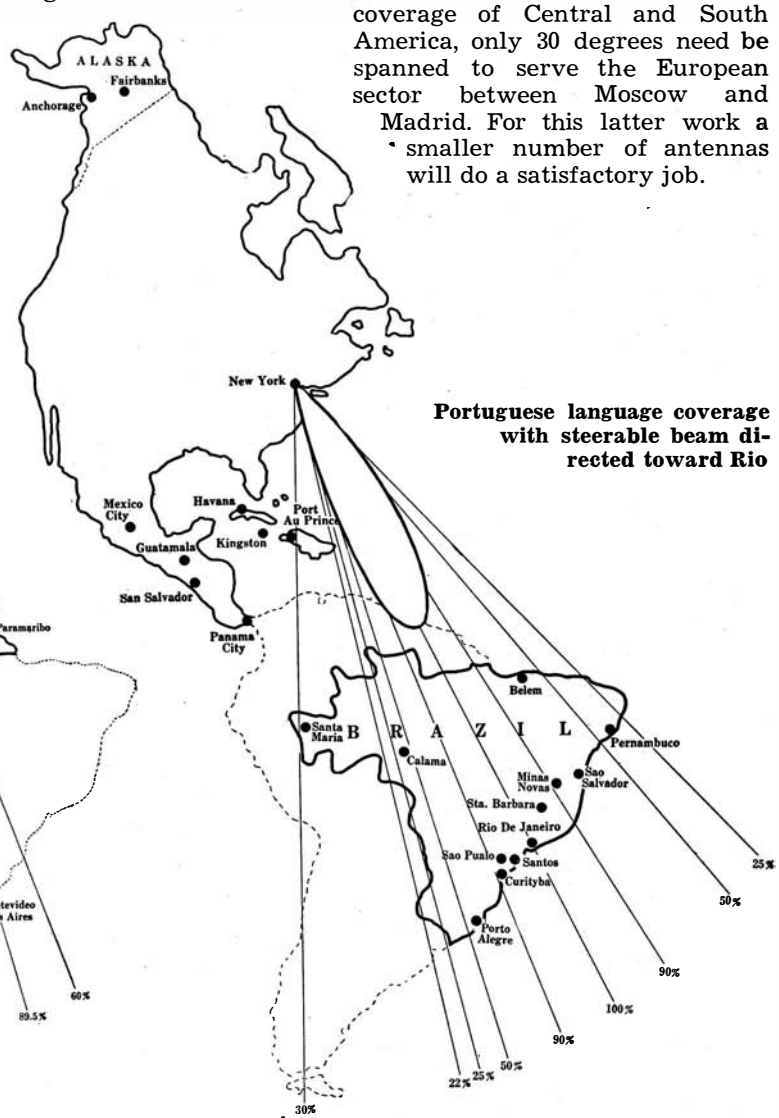
Mr. Guy, author of the present article, at an instrument panel

Brazil is unique among Latin-American countries in that it is the only one having Portugese as its native language. Throughout the balance of South America and in Central America the native language is Spanish. Obviously, listeners in Brazil speaking Portugese are little interested in programs transmitted in Spanish, English, or other languages. Similarly, in other parts of South America and in Central America, people speaking Spanish have little interest in programs in other languages. Hence the necessity for individual antennas and the use of the steerable beam to provide a satisfactory and consistent service to all areas concerned.

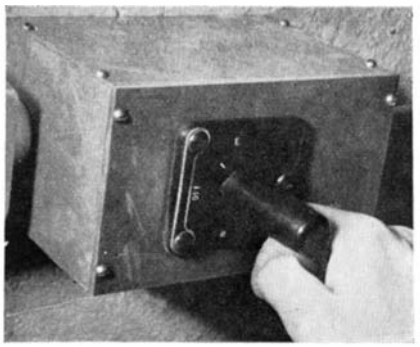
In the case of international broadcasting to Europe, there is not such a wide spread for the beam to cover. While 100 degrees of arc must be considered for coverage of Central and South America, only 30 degrees need be spanned to serve the European sector between Moscow and Madrid. For this latter work a smaller number of antennas will do a satisfactory job.



Spanish language coverage with steerable beam steered west in South America, showing also coverage of Central America



Portuguese language coverage with steerable beam directed toward Rio



A single motion of this switch directs the steerable radio beam

As has been noted before, relatively narrow beams are used for serving the South American area, utilizing the steerable beam to obtain flexibility. In the case of transmissions to Central America, however, the antenna has been designed to emit a beam which will cover an arc of 50 degrees. Here, of course, the power gain is lower than in the case of the South American beams, but the net result is satisfactory because Central America is comparatively close to the transmitter at Bound Brook.

It is impossible to give an accurate estimate of the number of radio receiving sets in Europe which are served by international broadcasts from the United States. In South America, however, it is possible to tabulate the receivers in use and the resulting figures give a graphic picture of the importance of international broadcasts to residents of the southern Americas. Present statistics give the number of radio sets in some of the Latin-American countries as follows: Argentina, 1,050,000; Brazil, 500,000; Mexico, 300,000; Chile, 160,000; Uruguay, 150,000; Venezuela, 138,000; Colombia, 100,000; Peru, 68,000; Panama, 24,000; Guatemala, 21,700; and all other Latin-American countries below the last number. The service which is now being rendered by the international broadcasting system of National Broadcasting Company involves a minimum of 16 transmitter hours per day directed to Europe during the most favorable listening periods on that continent. About 18 transmitter hours of service are devoted to Central American and to the Spanish and Portugese areas of South America during those hours when listening conditions are at their best. At times the transmitter service is continued on both stations for 24 hours a day. A growing proportion of the program material consists of unbiased news broadcasts which are brought to the attention of foreign listeners with the aid of institutional sponsors and, especially to Europe, through the efforts of the National Broadcasting Company itself.

Rarely has there been an opportunity within the past decade for any form of communication to demonstrate such unique feats as are now becoming accepted commonplaces in international broadcasting. Barely sixteen years ago the first rebroadcast from across the seas took place. Scheduled broadcasts from the far corners of the earth have since become matters of but casual interest. But only in recent months has the bewildered victim of catastrophe, propaganda, and censorship so fully appreciated the modern miracle of radio which enables him to listen, perhaps secretly, to free stations thousands of miles overseas for frequent and authoritative reports of world events, at times taking place in his own country, frequently at nearby points.

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Hormones for Plant Growth

Stabilized Organic Compounds in Commercial Fertilizers Give Added Stimulation

GOAL of plant growers for many years has been the development of substances that, applied to the growing plant, will not only provide that plant with the necessary food elements that may be lacking in the soil but will also result in increased root and plant development. Described in these pages in the September 1940 issue were laboratory experiments with a variety of hormone-like substances known as auxins. These are organic compounds, some 50 of which are known to contribute to the desired results, the most common and desirable belonging to the fatty acid group.

At the time this report was published, the experimental work was being carried out on a laboratory scale, with results that appeared to be worth following up. One experimenter, Lionel Weil, a commercial fertilizer manufacturer, started to investigate this intriguing field in order to determine whether the laboratory results could be transferred to large-scale practice on the farm. In early experiments he attempted various means of mixing the auxins with commercial fertilizers and applying the mixture to field crops in the conventional manner.

Results obtained were at first unsatisfactory, in that the combination failed to produce crops that showed any noticeable improvement over those to which

Corn: commercial fertilizer (right of center); with added hormones (left)

commercial fertilizer, less the auxins, was applied. Further investigation and consultation with the Boyce Thompson Institute revealed that the auxins were relatively unstable under field conditions where they were subjected to the actions of sunlight and weather.

Additional experimental work, directed always toward the end of increased crop production from a given acreage, served to overcome this disadvantage of instability of the organic compounds used. Briefly stated, this was accomplished by

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"DARCY": Petroleum engineers have applied the term darcy to their work, the word being used to designate a unit for measuring the permeability of porous rock thousands of feet underground. One darcy means that rock, under conditions of viscous flow, will pass one milliliter per second of a fluid having a viscosity of one centipoise through a one square centimeter cross-section when a pressure gradient of one atmosphere per centimeter is applied.

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mixing the growth-stimulating auxins with a carrying agent and stabilizer formed of a ground or pulverized fibrous material such as peanut meal, peanut hulls, soy bean meal, fish meal, and so on. When the auxins are first dissolved in a suitable solvent and then mixed with the fibrous material, it is found that they can be further mixed with commercial fertilizers and applied in the ordinary manner. The auxins are then no longer unstable, retaining their ability to stimulate root and plant growth even under the adverse conditions found in agriculture and gardening.

So powerful is the action of the auxins in this combination that the proportions used are on the order of 60 to 400 milligrams of the growth substance to a ton of commercial fertilizer, the most satisfactory results being obtained when a ton of fertilizer contains from 120 to 240 milligrams.

Favorable results with Hormo Fert, as the new fertilizer is called, have been found in the growing of snap beans, tobacco, corn, wheat, oats, and cotton. In experimental work with cotton growing, the new fertilizer produced 833 pounds of lint cotton to the acre—89 pounds more than an adjoining acre planted and cultivated in the same way but without auxins in the fertilizer. Furthermore, the auxins speeded up the rate of growth so that 93 percent of the seed cotton could be gathered in the first picking from the treated field; 84 percent was the rate from the controlled field. This factor of early picking is of importance to cotton growers as well as to growers of other agricultural products, as it makes it possible to reach an earlier and more profitable market with a maximum quantity of the product.

SAW

Large Capacity Electrically-Driven Scroll Saw

SCROLL sawing can be done on any length board up to 19 inches in width with the new Moto-Saw recently developed by the Dremel Manufacturing Company. This increased capacity has been made possible by the provision of additional slots in the blade holder which enable the operator to engage the saw blade at an angle of 90 degrees to the frame.

Motorized

STREAMLINERS

Two-Car Units Designed For Mountain Service

RECENTLY placed in use on the Denver to Salt Lake City run, new streamlined trains of the Denver and Rio Grande Western Railroad consist of self-powered, stainless steel cars especially designed for heavy-duty work in the high altitudes encountered on the run.

Each of the two-car trains has a capacity of 62 passengers, operating power being supplied by horizontal Diesel engines suspended beneath each car. Thus the power plants do not occupy space in the car bodies themselves, providing additional capacity for passengers and baggage. Each of the four Hercules Diesels in the two-car units is rated at 192 horsepower at 1600 revolutions per minute. The trains were constructed by the Edward G. Budd Manufacturing Company.

PSYCHIC RESEARCH

• The Scientific American Committee for the Investigation of Psychic Phenomena has under consideration applications from several persons who claim psychic powers and who desire to demonstrate such powers before the Committee. When and if these, or other, applicants present spiritistic demonstrations at a meeting of the Committee in accordance with the rules and regulations announced in our April 1941 issue, a subsequent report will appear in these columns. As stated in our April issue, the sole purpose of the Universal Council for Psychic Research and of Scientific American in jointly posting the award of $15,000 is to offer incentive for cooperation 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. •

OIL HEATING

Economy With Increased Efficiency

EFFICIENT operation of the oil-fired, home-heating plant is of high importance this year both as a means of conserving oil and saving shipping space. Arthur H. Senner, mechanical engineer of the Bureau of Agricultural Chemistry and Engineering, reports observations indicating that firing an oil furnace at a high rate, even though the burning time may be shorter, is likely to be considerably more costly than firing at a lower rate. The results in this case are comparable to those often cited in teaching economy in the operation of automobiles, which use less gasoline per mile at 30 or 40 miles an hour than at 50 or 60.

Senner says that in a home heating plant for an 8-room house, assumed as an example, where the overall efficiency is 66 percent on a firing rate of one gallon an hour, the efficiency would drop to 63 percent if the rate were raised to 1.35 gallons an hour. If the oil were fed at 1.65 gallons an hour, the efficiency would go down to approximately 58 percent. The overall

efficiency means that fraction of the heating-value in the oil that is available for heating the house.

In bringing the different burning rates down to dollars and cents, Senner used an oil price of seven cents a gallon and an electric current cost (for the motor) of three cents a kilowatt hour. At the firing rate of one gallon an hour the gross cost for the season was $138, of which approximately $8 was for current. At the firing rate of 1.65 gallons an hour the gross cost was $153, of which approximately $6 was for current. At the higher burning rate the motor runs a shorter time and some money is saved on current, but the saving is more than balanced by oil cost. At these prices, burning at the higher rate would cost a net of $15 a season more. Where fuel prices are higher, the saving is greater.

This problem of rate firing, says Senner, is not for the householder to solve himself but one to be taken up with the oil burner service department.

VITAMIN TREES

Vitamin B_1 Found Concentrated in Buds of Trees

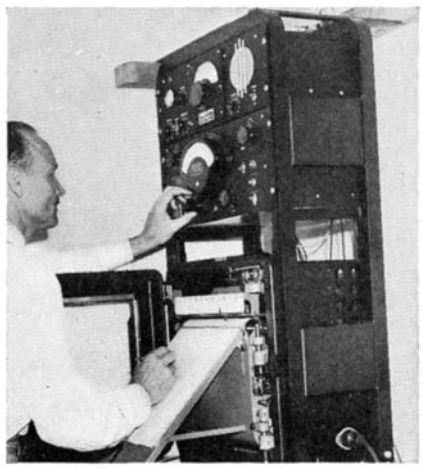
LARGE quantities of vitamin B_1, the "morale vitamin" which exercises a beneficial effect on the human nervous system, have been found in the buds and leaves of many common American trees, by Yale University botanists. The scientists found heavy concentrations of the substance in the buds of oak, red maple, horse chestnut, elm, sycamore, and white pine trees, according to *Science Service*.

"Although vitamin B_1 is now produced by synthetic chemical processes, this discovery points to a large natural source of vitamin B_1," stated Prof. Paul R. Burkholder. "This finding may offer a clue to the source of essential vitamins for many forest animals."

OCEAN WEATHER

Extending Facilities for Data Collection

RADIO sonde apparatus, which measures and records weather conditions at upper air levels as high as 12 miles, has been installed aboard the three ships of American Export Lines plying between New York and Lisbon, the *Exeter, Excambion,* and *Excalibur*. These are the only American flag ships operating between the United States and Europe on regular schedules at the present time, and the observations made from shipboard will provide the United States Weather



Weather recording on shipboard

Bureau with a wealth of meteorological data which has hitherto been unavailable.

Equipment for the work was supplied by the Weather Bureau and installed by the steamship line. Special "weather shacks" have been built on the mooring bridges of the three ships. Trained meteorologists from American Export Airlines will be in charge of the equipment on trips, making observations twice daily and relaying their findings by radio to the Weather Bureau. Lieut. Commander Vernon Clapp, U.S.N. (Ret.), chief meteorologist of the airlines, is supervising the operation.

Helium-inflated rubber balloons, measuring about five feet in diameter and about six feet in depth, are used to carry the sounding equipment aloft. A light-weight radio transmitter, weighing about two pounds, is attached to the balloon. Inside the transmitting device is equipment for measuring temperature, humidity, and pressure at upper air levels.

Although similar soundings have been made over land by both the Navy and the Weather Bureau, and although some have been made by Coast Guard cutters, this installation is the first effort to obtain daily, regular reports all the way across the Atlantic on commercial ships.

HOT SHOVEL

Electric Heaters Prevent Damage by Cold

COLD-WEATHER damage to the big 30-yard stripping shovel of the Truax-Traer Coal Company has been largely eliminated by the use of General Electric Calrod heaters, which are expected to pay for themselves many times over out of savings. The main problem confronting the Truax-Traer Company was that the dipper handle of its big shovel sometimes snapped dur-

Releasing a radio sonde balloon from the "weather shack"


JOIN
AMERICAN RED CROSS

ing winter operation, as a result of the chilled condition of the metal. Each breakdown meant an expensive repair bill, plus the expense of idleness.

This danger has been averted to a considerable extent by the installation of twelve 2000-watt 230-volt heaters around the inner surface of the dipper handle. The heaters are fastened to the surface

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RUBBER: Present plans, according to the Department of Agriculture, call for the eventual establishment of 7500 acres of rubber plantations in the Republic of Haiti. Although no commercial rubber is grown in Haiti now, experiments indicate that the plan should eventually be successful.

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of the dipper handle in lines of four, one line being placed in the center of the bottom of the handle, and a similar line run along each side of the handle.

Heaters were installed on the dipper itself, to solve another costly cold-weather problem. In cold weather, mud froze to the sides and bottom of the dipper, gradually accumulating until the payload of the dipper was reduced by 50 percent or more. Bonfires and a shutdown of 30 minutes to an hour were necessary to thaw out the accumulated mud.

To solve this problem, hotplates heated by Calrod heaters were welded on each side of the dipper, and on the center panel of the door. Another Calrod heater was formed in a circle around the manhole entrance to the dipper handle, where it joins the dipper.

Two natural-convection heaters, rated three kilowatts each, are mounted in the control cab of the shovel, keeping the cab at a comfortable temperature and thus protecting the health and efficiency of the operator.

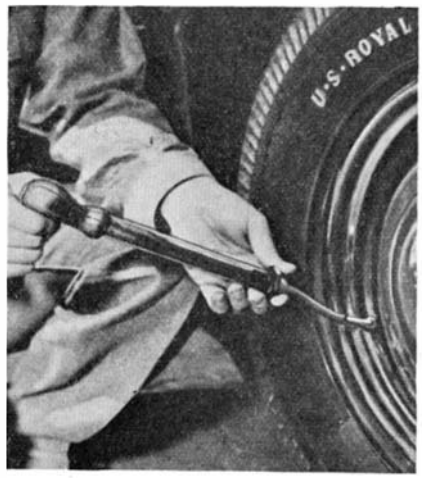
AUTO STATIC

Eliminated by Powder in Inner Tubes

ALL radio static interference and static shock caused by the friction of rotating parts in motor cars, including wheels, fan belts, and tires, is eliminated by a powder which is blown into inner tubes, according to United States Rubber Company.

One tablespoon in each tube, where it remains in suspension like dust in the air, is sufficient to neutralize the static in any make of radio, with any kind of antenna, on any make of passenger car, with any make of tire or tube, on any type of road surface, it is claimed.

Application is made with the tires on the car. Tubes are deflated, valve cores removed, powder



"Insulating" a tire

blown in with an applicator, and tubes inflated. Loss of powder in case of a puncture is so small that full effectiveness remains. The powder has been tested for many months both by the company's field service organization and by automobile manufacturers without one failure.

TERMITE PROOF

Chemically Treated Lumber Resists Invasion

A TEST house built on a Canal Zone island 15 years ago with chemically treated lumber continues to repel termite attack, report inspectors of the United States Bureau of Entomology in the latest issue of *Wood Preserving News*.

Because Barro Colorado island, Panama, is the most heavily infested termite area in North America, wood untreated with preservatives is devoured within a year.

In 1916, the American Wood Preservers' Association supplied yellow southern pine impregnated with zinc chloride to the Bureau of Entomology. Also furnished for the construction of the test house was a quantity of creosoted timbers to be used in the foundations and framework.

Since that time the building has been inspected at varying intervals. Although termites soon built so-called "shelter tubes" along supports reaching in some cases to the roof, it was stated that in no instance had they entered the treated wood. The shelter tubes leading from the underground homes of the pests—responsible for many millions of dollars worth of damage annually—were eventually abandoned.

"Bait stakes" of untreated wood placed underneath the house, were entirely consumed by termites.

Though the moist, hot, tropical climate of the Canal Zone is conducive to rapid wood rot, the Bureau reported its inspection of the test house shows the chemically treated timbers to be in perfect condition on this score as well.

FIBERS

Cotton Still Holds Its Own Fairly Well

USES of fibers have been changing in the last half century, according to the United States Department of Agriculture, but statistical studies made recently by the Bureau of Agricultural Chemistry and Engineering at its Southern Regional Research Laboratory show that, by and large, cotton has been holding its percentage place fairly well. Cotton has done this in spite of the rise of new products.

Cotton has made up about 70 percent of the mill use of fibers in this country during the 50-year period, the quantity used shifting up and down with the shifts in the total of all fibers used.

Compared only with other apparel fibers—wool, silk, rayon, and flax—cotton made up 79.3 percent of the total in 1939, somewhat less than the average of 85.6 percent for the period 1920-29. On the other hand, rayon—for some kinds of which cotton is used as a raw material—made up only 1.6 percent of the total from 1920-29, but reached 10.1 percent by 1939.

CLEANED AIR

Will Protect Records of War Department

WHEN printed records are kept in an atmosphere that contains a minimum of foreign matter, they are protected against deterioration and from becoming yellow and brittle. Such deterioration is largely due to the presence of sulphur particles in the air. Electrically cleaned air, therefore, will soon be used to protect government records

Books on Psychic Phenomena

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Extra-Sensory Perception After Sixty Years

By J. B. Rhine, J. G. Pratt, Burke M. Smith, Charles E. Stewart, and Joseph A. Greenwood

A COMPLETE account of the research conducted to date on extra-sensory perception. This book is a summary of what has been achieved so far, a reference work covering the field as a whole, a treatment of all the evidence, a guide to the literature of the subject, a condensation of the greater bulk of it, and a handbook of methods. It includes a digest of 56 articles of criticism of experiments in extra-sensory perception, mainly as made by psychologists, in which these are dealt with without emotion. A solid, serious study. (463 pages, illustrations.) —$2.85 postpaid.

Forty Years of Psychic Research

By Hamlin Garland

AFTER a lifetime spent in investigating spiritualistic phenomena, the author presented the facts as he observed them. He theorized little, witnessed without emotion, and after a clearly stated, factual presentation, he permits the reader to draw his own conclusions. (394 pages.)—$3.60 postpaid.

Cavalcade of the Supernatural

By Dr. Harold H. U. Cross

HIGHLY valued as one of the clearest, most convincing volumes dealing with manifestations all over the world of water divining, luminous effects, materializations, spirit photography. Illustrated with authentic pictures.—$2.10 postpaid.

Experiments in Psychics

By F. W. Warrick

INTENDED for experienced students of psychic phenomena, this book records the results of years of systematic investigation of direct writing and psychic photography. A large number of experiments, accompanied by photographic studies, all made under test conditions, seems, in view of the convincing nature of results, to rule out the possibility of fraud in the majority of cases and to offer strong evidence in favor of the types of psychic phenomena dealt with. (600 illustrations.)—$7.60 postpaid.

DUNNINGER

YOU, TOO

Can Investigate The

SUPERNATURAL

IN our April issue we announced our intention of exploring the realm of the psychic in an endeavor to determine whether, through mediums, we can communicate with the dead. We want to know if such things as phantoms, ghosts, spirits, or vampires actually visit us. We seek the facts concerning ectoplasmic and other supernatural demonstrations of a physical nature. To aid us in our search, the Scientific American Committee for the Investigation of Psychic Phenomena was formed under the chairmanship of Dunninger, whose world-wide reputation as a telepathist, magician, and psychic investigator is unequalled.

In the course of our search the Committee will welcome sincere and bona fide assistance. Should your interest in the psychic lead you to try to discover for yourself a basic, truthful, scientific explanation, you will wish to follow the reports of the Committee as they appear in ensuing issues of Scientific American. For correlative reading, the books listed on this page will be found informative, helpful, and interesting.

—The Editors

Books on Psychic Phenomena

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Inside the Medium's Cabinet

By Dunninger

A DARING exposé of trickery practiced by fraudulent mediums in presentation of so-called supernatural phenomena. In an exciting series of revelations, this internationally known authority on spiritistic matters divulges the secrets of certain mediumistic personalities who have come within the scope of his experience. Every statement of fact is based on the author's first-hand investigation. (228 pages, profusely illustrated.)—$2.60 postpaid.

Psychics and Mediums

By Gertrude Ogden Tubby

A MANUAL and bibliography for students, this is also an important guide and source book, presenting a scientific analysis of all types of psychic research, both objective and subjective. (210 pages.)—$2.10 postpaid.

Science and Psychical Phenomena

By G. N. M. Tyrrell

IF the world is to be saved from the advance of materialism, the author points out, knowledge of man's psychic processes must be extended. This splendidly informed, thoroughly scientific examination of a controversial but increasingly important subject is a unique addition to the literature on psychical research. Brilliantly concise, carefully evaluated, the history of research and the method of collective experiment are described. —$3.85 postpaid.

Beyond Normal Cognition

By Dr. John F. Thomas, Ph. D.

THIS is an intensely interesting study, evaluative and methodological, of the mental content of certain trance phenomena. The author was for some years associated with the Boston Society for Psychic Research. (319 pages, bound in cloth.) —$3.10 postpaid.

in the entire wing of the new United States War Department Building now under construction in Washington, D. C.

The air in the rooms where these records are kept will be cleaned by electrostatic air cleaners known as Precipitrons, developed by Westinghouse Electric and Manufacturing Company. More than 85 percent of all foreign particles will be removed from air entering the building at the rate of 500,000 cubic feet a minute.

It is authoritatively claimed that, although Washington is a relatively

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HALF MILLION TONS—Silver collected by the human race is estimated at 18,000,000,000 ounces. Of this, about one third is supposed to have been worn away, lost, or so well hidden that its whereabouts are unknown. Another third is supposed to be in the world's monetary stock, and the remainder hoarded or in family plate and other useful articles.

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clean city, each cubic foot of its air contains hundreds of thousands of particles of smoke, soot, and dust. The larger particles may be removed with mechanical filters, but it is the smaller ones that do the real damage to walls, records, and clothing. Electric cleaning, on the other hand, shows no preference for size; it removes all sizes of particles to the extent of 85 to 90 percent of the total.

The War Department installation of Precipitrons will be the third in Federal Government buildings. More than two years ago, the Bureau of Standards installed a number of units in its chemistry building to prevent the contamination of chemical tests and experiments. Six months ago the Rocky Mountain Laboratory of the Public Health Service, in Hamilton, Montana, adopted this method of preventing dirt contamination of bacteria cultures in typhus fever research. Although this laboratory was in an isolated mountain district, one of the cleanest places in the country, tests showed that the air there contained about 200,000 foreign particles to the cubic foot.

The War Department Building will receive its 500,000 cubic feet of clean air per minute through 701 cleaning cells. Of these, 641 will be of standard size, each having a cross sectional area of three feet by eight inches; the others will be half standard size.

The Precipitron's action depends upon the electrification of the dirt particles. Each particle first passes a fine tungsten wire, where it takes on a positive charge. As it proceeds between a set of parallel plates, it is drawn out of the air stream to a pole of opposite polarity, where it sticks. Every few months a hose is used to flush the dirt from the plates and prepare them for another load.

GREASE FILMS

Fast Glassware Inspection in Restaurants

HEALTH officers, whose duty it is to make periodic checks on the cleanliness of glassware in public eating places, now have available a device which enables them to detect more accurately and speedily grease films and dirt which might otherwise pass undetected by the unaided eye.

It finds dirt

This new instrument, called the Rudd Grease-Film Viewer, is a combined light source and microscope. In use, as shown in one of our illustrations, a drinking glass is placed on a rotatable platform. The light bulb, supplied with current from flashlight batteries in the handle, is then turned on and the edge of the glass is viewed through the scope. By rotating the glass the entire rim can be inspected for finger prints, lipstick traces, and similar unsanitary deposits that have not been removed by proper washing.

CHEMISEAL

How Does a Seal Obtain Fresh Water?

THE seal, a meat-eating mammal which lives in salt water, obtains the fresh water necessary to the life of every animal by chemically manufacturing water in its body as a product of food digestion. A special mechanism in the kidney preserves this meager supply of fresh water by preventing the kidney from secreting it rapidly.

These facts were disclosed in a research report by Dr. Edwin P. Hiatt, of the Department of Physiology, New York University, and Dr. Stanley E. Bradley, of the Mount Desert Island Biological Laboratory, in Salisbury Cove, Maine. To study the process by which the water is conserved, Dr. Hiatt fed herring to a seal, studying the operation of the kidney after the feeding. It was discovered, he reported, that the kidney secreted water only when it was necessary for the elimination of wastes from the body.

SNAKESCENT

Rattlesnakes Detect Kingsnakes by Odor

RATTLESNAKES detect their deadly enemy, the kingsnake, by odor rather than by sight, it is strongly indicated by evidence presented by C. M. Bogert of the American Museum of Natural History. Kingsnakes, which average larger and stronger than rattlers, overcome and devour the latter whenever opportunity offers.

Mr. Bogert experimented with a considerable number of rattlesnakes of several different species, and also used one or two species of cannibalistic snakes other than the kingsnake. In general, however, the results obtained were the same for all species of both attacker and attacked.

Rattlesnakes, even those from regions where kingsnakes are unknown, always indicate recognition of their enemy by a peculiar defensive posture. The frightened rattler holds its head close to the ground, and throws a part of its body into a standing loop. With this it strikes against the kingsnake when the latter approaches, as a man might try to ward off an attacker with his elbow. To raise the head and defy the foe with bared fangs, as the rattlesnake does against any other enemy, would only expose it the more to a grab for the neck, which is the kingsnake's favorite hold. Another peculiarity of behavior is the rattlesnake's failure to sound its rattle when menaced by a kingsnake,

although this threatening buzz is also an invariable part of its behavior in the face of any other enemy.

Rattlesnakes dropped into empty glass vessels in which kingsnakes had previously been confined immediately went into this defensive attitude. They did the same thing when exposed to the odor of a kingsnake, scraped off its back with a freshly whittled, clean pine stick. They showed the defense reaction when they were first blindfolded with adhesive tape and then introduced into the presence of the enemy species. But when they were deprived of the ability to detect scent by removing their tongues (which are necessary parts of the smelling apparatus in snakes) they were indifferent to the presence of kingsnakes, although the latter were in plain view.—*Science Service.*

NOSES

Typical American Nose Not "Sam's" Type

UNCLE Sam's "roman" nose is wrong.

The old gentleman traditionally is pictured with a decidedly convex nose whereas it should be rather straight, or only moderately convex, says Dr. Ales Hrdlicka, Curator of Physical Anthropology of the Smithsonian Institution.

Uncle Sam, as a symbolic figure representing the composite American man with a few generations of

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SHORT BUT SWEET—A rifle may serve a hunter or target shooter for a lifetime, but its active life is over in 30 seconds—each bullet passes through the barrel in such an extremely small fraction of a second.

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American and probably Anglo-Saxon ancestry, should comply with this composite, Dr. Hrdlicka says. Some years ago he made extensive measurements of the physical characters of a large group of old Americans of the more cultured and prosperous class. Recently he has made similar measurements on 150 of the foremost intellects in the United States.

In most respects, he points out, the symbolic figure is all right but he has almost never encountered in the two groups an "Uncle Sam nose." Among old Americans at large, 22 percent have straight noses and 42 percent have slightly or moderately convex ones. Among the great scholars the proportion is about the same.

"By 'nose shape,'" says Dr. Hrdlicka, "we understand the form of the dorsal ridge of the nose. This form is interestingly variable in man, and in the white races in particular. It is due in the main to the different developments of the bony and cartilaginous parts of the nose, but also to some extent to the soft parts of the organ.

"The shape of the nose changes more or less, particularly in males, from birth to old age. The shapes may be of a generalized racial character, they may be hereditary family peculiarities, or they may be individual differentiations for which no cause is discernible. In a group of prevalently elderly males the shape may be regarded as that of the fully matured plus some old-age modifications.

"There are four main types of nose. They are the concave, the straight, the aquiline or convex, and the wavy, or concave-convex. The concave as well as the convex may be moderate, medium, or pronounced."

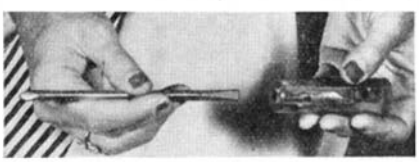
The concave form, Dr. Hrdlicka

says, is the infantile. It tends to straighten out as the individual grows older, and as the fleshy parts of the nose increase in size. Sometimes this straightening is irregular, resulting in the concave-convex form.

SCREW DRIVER

Double Ended, for Phillips' or Slotted Heads

INCREASINGLY widespread use of Phillips' screws, which cannot be driven nor withdrawn by an ordinary screwdriver, has resulted in the design of the "Fitzem-All" screwdriver in which is incorporated a double-ended blade. This blade is readily removable from a sleeve securely set into the handle of the screwdriver, so that either end of the blade may be used. One end is ground to fit Phillips' screw heads and the other for conventional slotted heads.



Versatile screw driver

TUNG

Superior Trees Selected for Cultivation in South

SUPERIOR varieties of tung trees, source of the tung oil highly valued in the paint and varnish, linoleum, printer's ink, and other industries, are being given an extensive test by the United States Department of Agriculture. Because the Chinese war has drastically reduced imports from the principal source of this oil, while domestic plantings now in existence supply only a very small percentage of American requirements, new sources within United States boundaries are very seriously needed.

Department scientists caution that tung cultivation should not be undertaken by amateurs, and that it should not be attempted on a large scale even by experienced planters of other crops, reports *Science Service*. Tung trees are very "fussy" about their soil, highly sensitive to cold, and in any case must reach the age of five years before they come into bearing. Still, any farmer far enough south (within about 100 miles of the Gulf Coast) might find it profitable to set out a few trees, just as an experiment. Tung trees are quite ornamental, with glossy, heart-shaped leaves and beautiful flowers in spring.

Department of Agriculture plant scientists have, during the past three years, selected 500 trees in the extensive orchards already growing in the South as particularly promising. A second selection reduced the number to 80. Thousands of young trees were propagated from this group of parents. Last November's freeze cut down the nursery stock severely, but the survivors—some 40,000 of them—have been planted in 13 test orchards along the Gulf Coast, from Texas to Florida.

In the meantime, chemists in the Department have greatly improved the efficiency of oil extraction methods. American tung oil already commands a premium over the imported product, and the market is far from being saturated.

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NOT MUGGY—The amount of water vapor above the equatorial region of Mars has been found to be definitely less than 5 percent of that in the Earth's atmosphere.

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VITAMIN C

A Good Supply of it in the Good Old Spud

"COOKED potatoes, whether new or old, add considerable vitamin C —ascorbic acid—to the diet regardless of whether they are baked, boiled, or steamed." So concludes Lydia A. Rolf, of the Bureau of Home Economics of the United States Department of Agriculture, after a scientific test to determine the effects both of cooking and of storage on the potato's ascorbic acid content.

The potatoes were cooked by methods commonly used by homemakers. In no instance did the potato lose more than 25 percent of its vitamin C value. In most cases the loss was even less, despite the fact that vitamin C is destroyed easily by exposure to heat and air. Boiling pared potatoes—probably the most common way of cooking —was the method most destructive of vitamin C.

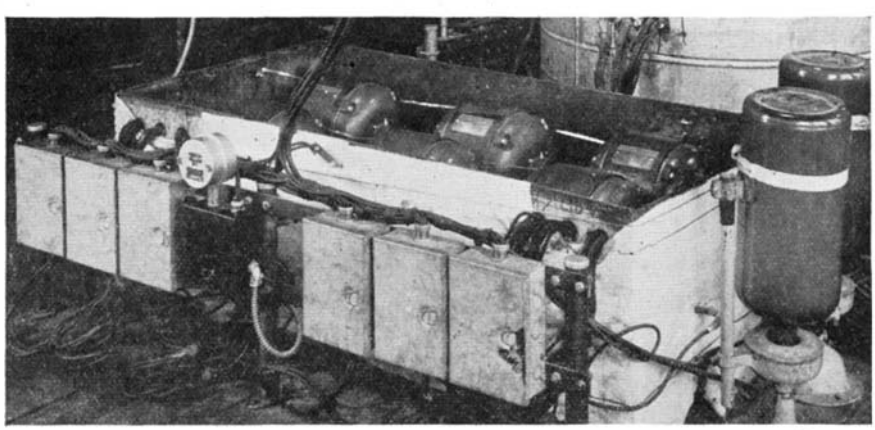
This experiment, the Bureau points out, shows that a person can get a substantial part of his daily vitamin C requirement from potatoes. Army officials find that the potato supplies from one sixth to one fourth of the soldier's daily quota of vitamin C, and consider it a protective food because of this food value as well as its vitamin B_1 content.

Miss Rolf found that loss of vitamin C is great during the first few weeks of storage, greater than the loss during cooking. Comparatively, then, very new potatoes have more vitamin C value than do storage potatoes, although both were found to contain amounts sufficient to make a valuable contribution to diets.

MOTOR TORTURE

Humidity Tank Tests Electric Motors

THE superiority of a new transparent plastic insulation over older types of magnet wire insulation as used in electric motors is dramatically demonstrated by a testing method used at the Lynn, Massachusetts, River Works of General Electric. Test motors are placed in a metal tank, where they rest on steel rails above two inches of water. The tank is then sealed with



Temperature and humidity test electric motors

a heavy cover and electric immersion heaters in the water hold its temperature at the boiling point. Constant water level is maintained automatically. Thus the motors are operated in an atmosphere with a relative humidity of 100 percent, a condition which would probably never be met in ordinary service or which at worst could pertain for only a relatively short time.

RADIO RELAY

Extends Reliable Range of Portable Radios

A "RADIO-WAVE SPRINKLER," a new device which has proved successful in tests during the past year, was used to aid fire fighting crews on the National Forests last summer, the United States Department of Agriculture announced recently.

The sprinkler, developed by the Forest Service, will facilitate emergency communication in the forests. It is known technically as an automatic relay station in that it picks up radio waves from one point and transmits them to another, and is the first known development of an automatic relay of portable size operated by dry batteries. Searching parties and smoke chasers carry the small six-pound portable radio developed for parachute firefighters last spring, but such a radio is dependable only for a few miles although it may sometimes carry for distances up to a hundred miles or more.

In fire control work in mountainous country of the western National Forests, the automatic relay or wave sprinkler can be used to make communication with headquarters certain, the Forest Service says. When the small portable radios carried by forest officers on fire patrol can not send their waves over the mountain, they contact the sprinkler which automatically turns on its transmitter and rebroadcasts with a powerful wave to the base station. Attendants need visit the relay station only at infrequent intervals. It will enable the Forest Service to make dependable use of ultra-high frequencies and thus reduce need for use of other frequencies valuable for national defense purposes.

Searching parties hunting mountain climbers lost in the snow or snow sports enthusiasts who have gotten off trail, have often been unable to keep track of each other by present radio devices. By means of the radio sprinkler, one party

will be able to communicate with another directly under practically all conditions and thus may not only save time but human lives.

UNBREAKABLE

Transparent Container for Light Oils

A NEW method of packaging oil, known as Tri-Pak, is designed primarily for the sportsmen's kit, but also will find use for general household purposes and in machine shops. The oil "can" is said to be unbreakable, dentproof, and leakproof, yet is transparent. Thus the amount of oil remaining in the container can be seen at all times.

This new transparent container for oil has won awards in packaging competitions

INDIAN OIL

The List of Petroleum Derivatives Steadily Lengthens

IT wasn't many years ago that medicine-show men were touring the young United States, selling "Rock Oil" and "Indian Oil," to which they ascribed miraculous healing powers. Their stock in trade was crude petroleum, and in another way that same crude rock oil now is really living up to the advertising the "med-show" men gave it.

A bit of processing, unknown in the days of the medicine shows, is necessary, of course, and out of the processing comes a number of curative pharmaceuticals and such which relieve pain and contribute to cures.

Among them is novocaine, which makes dentists' chairs more comfortable; icthyol, a healing salve made from the crude oil obtained from certain shales; and formaldehyde, in itself an antiseptic, but when mixed with ammonia and other compounds, a drug with healing properties.

Glycol prevents radiators from freezing and helps in the manufacture of low-temperature dynamites. As glycol oleate it becomes an emulsifier which makes possible cosmetics, cold creams, brushless shaving creams, and lotions.

Of petroleum derivation are ethylene, propylene, and cyclopropane, mild anesthetics which can be used in cases where ether is inadvisable. From petroleum sources also come perfumes, astringents, theater sprays, shampoos, and even liquid rouge.

Typical is the production of glycerin from petroleum-refinery gases. Until recently glycerin was obtained only from animal and vegetable matter. Now it can be made from refinery gases by a process which chemists once said could not possibly work.

DIAMOND GRADING

New Instruments Make Standardization Possible

THREE instruments, invented by the Geomological Institute of America, are now making possible the first uniform method of grading diamonds for both color and imperfections. The first of these instruments, developed some time ago, is the Diamondscope, a specially constructed magnifying instrument for examining imperfections in the interior of diamonds and irregularities in cutting.

The other two instruments, just announced, are a mechanical color grader called the Colorimeter, developed by the Robert M. Shipleys, Sr. and Jr., and a uniform lighting unit, known as the Diamolite. With these instruments it is possible to establish an accurate standardization of those characteristics—freedom from flaws, excellence of cutting, and color—which, in addi-

Diamondscope

Colorimeter

tion to size, determine diamond values.

The Colorimeter accurately distinguishes the fine nuances of color in diamonds and compares them to a standard scale. Previous grading methods distinguished only seven color grades; the Colorimeter accurately distinguishes 13 colors within the same range. When the diamond is placed in a compartment in the Colorimeter, it is viewed through a low-powered microscope in comparison with a variable yellow scale. When the

Diamolite

color of this scale exactly matches that of the diamond, the grade of the gem is read on an indicator.

The Diamolite is used for comparing diamonds with the color of master stones. The light used in this unit is an incandescent lamp with a special blue filter which combination gives a spectrum which brings out the color nuances. The design of the instrument is such that it prevents reflection from the surfaces of the diamonds, making it possible to observe more accurately the true body color. Unlike natural daylight, the light in this instrument does not vary in quality or intensity from day to day or from hour to hour and hence gives an unvarying method of comparing diamond colors.

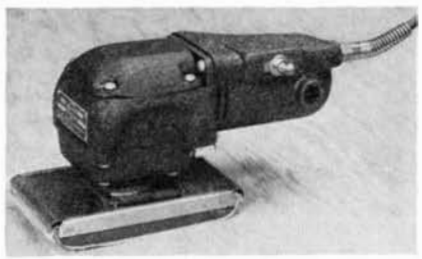
Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

SANDER

Portable Unit With Reciprocating Head

A SMALL and compact unit for sanding operations, which holds a one-third standard sheet of abrasive paper on a resilient head surface, is said to duplicate the hand stroke of the master workman but



It gets into corners

at a rate which makes possible the finishing of four to five times as much work as could be accomplished by hand in the same length of time.

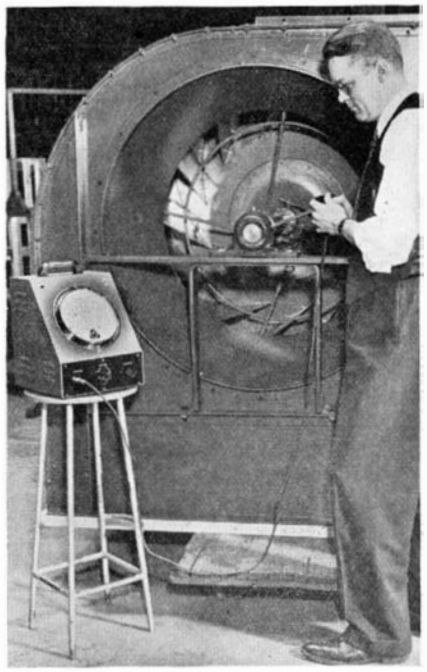
This machine, the Nedco reciprocating sander, will reach into spots where hand sanding and other methods have been ineffective. The pad projects beyond the end of the mechanism housing so that the abrasive paper surface can be applied in otherwise inaccessable corners. The abrasive paper is held in place by a pair of sliding clips equipped with connecting springs, and can be quickly replaced. The unit is intended primarily to sand and rub fillers and paint coats on aircraft, motor car bodies, and so on. It operates effectively on either flat or curved surfaces.

VIBRATION

Traced by Direct-Reading Electronic Device

MAINTENANCE engineers have long realized that periodic vibration checks will prolong the useful life of machinery and equipment, save costly repairs and avoid shutdowns. Such checks, which make it possible to look for trouble before it becomes too serious, can be readily made with an electrical device called the Vibrometer, a simple appliance, made by Televiso Products, Inc., that is sufficiently rugged to withstand hard usage in the shop.

The indicator dial of the instrument operates through four ranges to indicate vibration from zero to



Shown in use is an instrument for routine shop checking of vibration, which, it is claimed, is affected only by vibration at the steel point—not by noises or other extraneous agitations

one inch in amplitude. In operation the prod of the instrument is held in contact with equipment under test; amplitude of any existing vibration is shown directly on the instrument's dial. Smallest readable amplitude is .00001 of an inch; accuracy claimed is within 3 percent.

MARKING STAMPS

Coded to Identify Individual Inspectors

TO MEET conditions arising from triple-shift operation in defense industries, New Method Steel

Stamps, Inc., has designed and is producing a new type of inspectors' stamp. Instead of carrying a variety of designs to identify individual inspectors or operators, the new stamps are numbered from 1 to 99, the numbers in each group being enclosed in identifying shaped borders. Thus, one group has the numbers enclosed in a square, another in a triangle, another in a circle, another still—if needed—in an oval.

The device makes possible assigning identical numbers with different borders to inspectors or operators doing identical work. Thus inspectors can identify the operator making the part, as well as distinguish night from day shift operators or inspectors. Use of these stamps has a tendency to reduce inferior workmanship.

INSULATING BOARD

Light Weight, of Rubber, Easily Worked

CELLULAR RUBBER, a new material of high thermal insulation value that is twice as light as cork, is announced by United States Rubber Company. The name cellular is descriptive, since the material consists of a thin but dense external layer enclosing microscopic cells of nitrogen gas in a matrix of rubber. Each cell in the structure is distinct from its neighbor.

The insulation or "K" value (B.T.U. per hour per degree Fahrenheit temperature difference for a specimen one foot square and one inch thick) of cellular rubber, which will be marketed under the trade name of U. S. Royal Insulation Board, is expressed as .237. This is lower than any of the 37 types listed in the U. S. Department of Agriculture Handbook.

The figure compares with .30 for regranulated cork, .34 for gypsum in powdered form, .39 for laminated fibre board, and .59 for cellular gypsum dry.

Other specific properties claimed for the new rubber are: moisture resistance, rot proof, oil, acid and fire resistance, structural strength, long life, resistance to vermin and termites, and good workability.

Two weights of the insulation board are to be manufactured, only the lighter of which is to be fire resistant. The weights are: 4.5 pounds per cubic foot, and 5.5 per cubic foot for one-inch thick material. For lightness, this compares with 62.5 pounds per cubic foot for

water, and 70 pounds for pure gum rubber stock. Unusual structural strength is combined with this lightness. The 4.5 weight will withstand 22 pounds per square inch without crushing, and the 5.5 weight, 35 pounds.

The boards can be cut to shape with a bandsaw or powersaw, and can even be whittled with a knife. Surfacing can be done with a planer. The material is thermoplastic, and hence can be shaped by heating to 190 degrees or higher and bending while hot.

INFRA-RED HEATING

Inside-Silvered Lamps of New Type

ESPECIALLY developed for infra-red processes in drying, baking, heating, and dehydrating, a new type of Nalco inside-silvered carbon filament lamp has recently been placed on the market by North American Electric Lamp Company. These lamps, the manufacturer claims, produce infra-red

For drying, heating, baking

radiation in the most desirable part of the Angstrom scale for maximum drying efficiency.

Readers interested in this particular type of work are also referred to the article "Infra-Red Does the Trick" which appeared on page 124, September 1941 issue, Scientific American.

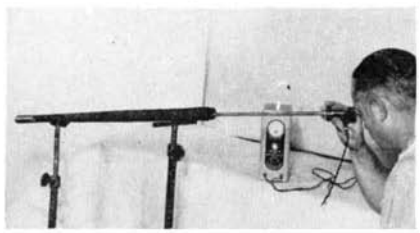
INSPECTION

Telescope To Examine The Interior of Bores

WITH increasing attention being given to the finishing of machine surfaces, it becomes of greater importance to be able to inspect visually internal surfaces, such as the interior bores of rifles and so on. A new telescope for this purpose, known as the Type-A, product of the American Cystoscope Makers, Inc., permits examination of a one-

inch illuminated area of the interior of the bore with the image magnified four times. One of these units is shown in use in an accompanying illustration.

Objective lenses available for this telescope include one for viewing at right-angles to the telescope,



Interior bore examination

and others which permit direct, oblique, and retrospective observation. Sizes include telescopes small enough to enter a .2 of an inch bore. Illumination of the surface to be inspected is provided by a tiny lamp located in the extreme end of the telescope tube. The illuminated image is brought out to a lens at the outer end of the assembly where the eyepiece is provided with an indicating button to show the direction in which the objective lens is facing inside the bore. A rotating contact assembly is provided so that the telescope can be turned without tangling the extension cord.

GAS

Instrument Measures

Fabric Permeability

THE "arsenal of democracy" is now being aided by a new instrument that will probably find many applications in industry, both currently and after the present emergency. This new instrument is the Fabric Permeameter—an accurate, rapid, and convenient means for production testing of the permeability of fabrics which are to be inflated with hydrogen, helium, carbon dioxide, and so on. The rate of permeation through the fabric is quickly determined by equipment utilizing the thermal conductivity method of gas analysis and is indicated in terms of "liters per square meter per 24 hours" of the retained gas.

The Fabric Permeameter determines the rate of gas diffusion through balloon fabrics and other materials and makes possible testing of the effectiveness of various "dopes" with which the fabrics are treated. The instrument was developed by the Cambridge Instru-

ment Company. The sample to be tested is clamped between two recessed test plates, thereby forming upper and lower compartments separated by the fabric being tested. Gas is passed into the lower compartment, while the upper compartment, which is filled with clean dry air, communicates with the metering unit. The gas which permeates through the fabric contaminates the air in the upper compartment and thus changes its thermal conductivity. A measure of the rate of this contamination provides a measure of the ability of the fabric to hold gas.

COLORED FLOORS

Concrete Surfaces Can Be Stained and Painted

COLORING and dust-proofing of concrete floors in all types of buildings is now possible with a new system which provides a surface coating that is alcohol and grease resistant and will retain its color even after being subjected to hard wear.

Materials for this processing of floors, made available by the Wilbur & Williams Company, are applied in two stages. First the concrete is dyed with a penetrating stain. Then the surface is coated with a synthetic enamel which adheres solidly to the stained concrete and which provides a dust-free surface. The enamel is put on in two coats. Even after the enamel coating wears down, as it will over a long period of time, the over-all color of the floor remains the same because of the dyed concrete beneath. The materials for this work are available in four colors.

BURR REMOVAL

Tumbling Equipment In Gun Manufacture

WHEN machine gun parts approach the finishing stages, it is frequently necessary to remove burrs before the gun can be assembled in completed form. Much of this work had been done by hand until the recent development of a new type of tumbling equipment by Hanson-VanWinkle-Munning Company.

The new tumbling units are driven by ½-horsepower motors through worm-gear speed reducers. The small machine parts from which burrs are to be removed are placed in the cast iron barrel of the tumbling unit together with silica sand and oil. Tumbling is then carried on for from two to four hours.

It is claimed that burr removal in this tumbling equipment results in a better finished product than does hand filing.

REFRACTORY

Insulating Brick For High Temperatures

BY EMPLOYING an organic filler together with a plastic refractory clay in the manufacture of a new insulating brick, the Johns-Manville Corporation is now producing a refractory which will withstand temperatures as high as 2600 degrees, Fahrenheit, in exposed service.

The use of the organic filler, which burns out when the brick is fired during manufacture, provides a finished brick with uniform pore structure.

RHEOSTATS

Multiple Range Units For Laboratory Use

CURRENT regulating devices for use in laboratories, either in the electro-technical, electro-chemical or educational fields, are now available in types which give a greater control range than heretofore possible. In the Rex Four-Range Rheostats recently placed on the market, one unit incorporates four different resistance values with corresponding current capacities, taking the place of four separate rheostats.

These control units are provided with two closely wound windings, so placed that each turn of one winding runs between two turns of the other. Both windings, controlled by one slider with lubricated contacts, are of wires of identical diameter but made of materials having different specific ohmic resistances. The resistance materials are insulated by Fiberglas, a material which retains satisfactory dielectric strength at the temperature reached when the rheostat is fully loaded. Because of the terminal facilities provided, four different operating resistances can be obtained by varying the connections to the unit. These rheostats are available in two different wattage capacities.

Keeping Pace

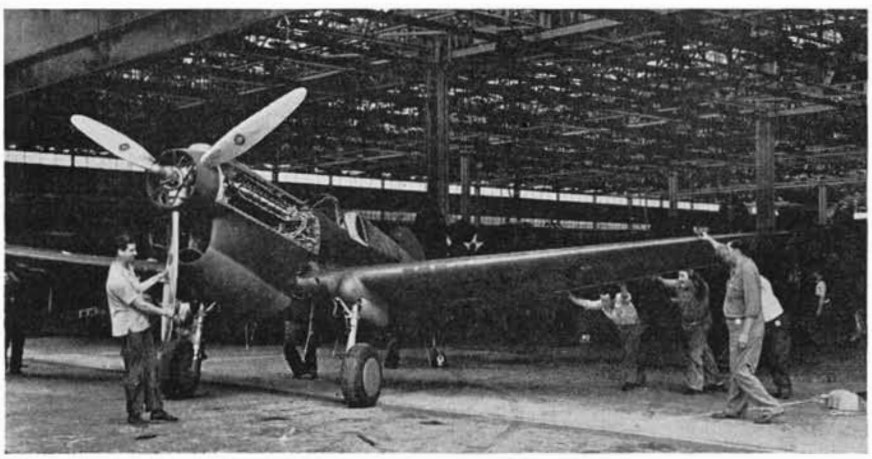
A Brief Glimpse of America's Largest Pursuit Plane Factory

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University.

REPORTS of the progress of our plane production and of the extent to which we are sending aircraft to aid Great Britain at times are in conflict. Opinions vary from extreme pessimism to extreme optimism. Our own view is that in all probability there had to be a warming-up process, that plants had to be built and shops equipped before aircraft production on a really large scale could get under way.

In the meantime, announcements of new plants being put into operation are encouraging. At the Buffalo Municipal Airport, for example, the Curtiss-Wright Corporation has erected the largest American plant for the production of pursuit or fighter planes. The $18,000,000 plant with 1,500,000 square feet of floor space will turn out Curtiss Hawk P-40 Pursuits for the U.S. Army Air Corps, and Curtiss Kittyhawk fighters for the R.A.F. One of our photographs shows a Curtiss Hawk rolling off the production line.

Final assembly section for Curtiss Hawks and Kittyhawks



A Curtiss P-40 comes off the assembly line at Buffalo

America has been production-minded for a long time, but in the past excellent production has been achieved in indifferently constructed factories. Let us see what airplane engineers, working with Albert Kahn, the industrial architect, have been able to do in the modern factory. Disregarding statistics, the following indicates how rapidly industrial architecture is progressing under the impetus of war conditions:

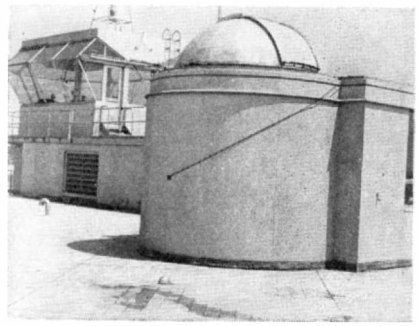
"To assure straight-line, unobstructed production throughout the plant, the cafeteria, locker rooms, and toilet facilities are located underground . . . production of all departments is equalized so that machine shop, press, sub-assemblies, and production departments keep pace with one another in moving a continuous stream of parts, sub-assemblies, and assemblies . . . three sets of doors, each 200 feet in width and each weighing 80 tons, located in the final assembly and flight hangar, may be opened or closed rapidly in units of 100 feet . . . forced ventilation system . . . all windows are equipped with complete blackout facilities . . . a 1000-foot tunnel extends the entire width of the basement and allows employees access from all departments to the parking lot."

MIRADOR

Part of Washington Airport Equipment

IN OUR September issue we described the modern marvels of the Washington Airport, including the glass-walled control tower. A mirador shares the roof of the main building with this control tower. The dictionary defines a mirador as a "bay window, loggia or enclosed balcony, designed to command an extensive outlook" and the new airport mirador meets this definition perfectly. It is placed 75 feet above the level of the field and gives an excellent view of the rolling country surrounding the airport.

At either end of the graceful structure are revolving turrets which are used by observers to operate two theodolites. These are merely telescopes mounted on tripods, through which the observer watches the ascent of a small balloon. The balloon has such buoyancy and weight that it ascends at a constant rate. Knowing the rate of ascent and taking



Mirador and theodolite turret

readings on the scales at the base of the theodolite, the observer can tell the velocity and direction of the wind at various altitudes above the field. Thus it is possible to tell the pilot that he will have favorable winds at one altitude, quartering winds at another altitude, and so on. Theodolites can follow the balloons, which are three feet in diameter, to a height of seven or eight miles, and to a distance of 20 to 25 miles on clear days.—*A. K.*

BLOCK SIGNALS

Bring Aid to Airline Dispatchers

FLIGHT dispatchers on the airways are important men who control all the planes in a given area and must therefore at all times be informed of the position of such aircraft, whether aloft or at the airports. At present the dispatchers depend upon radio messages from pilots. In a new system, recently developed by Transcontinental & Western Air, the radio messages will still be necessary, but the dispatcher will have the help of an "automatic block signal" system which will make his work much easier and more effective.

As one of our photographs shows, the device consists of a panel fitted with a series of tracks, each representing a directional airway. Each track works on a long, electrically driven worm, which turns at the rate of two revolutions per minute, though the exact speed may be regulated to correspond with the ground speed of the airplane on the airway. A small brass block, representing the airplane, travels up or down the track, at the speed allowed for in the pilot's flight plan. Check points on the airway are represented on the dispatch board by slots set at correct scale intervals. As the plane approaches a slot or block and the dispatcher receives a radio message, he closes the block, allowing the symbolic airplane to

pass on to the next checking point.

If the miniature plane reaches the block without appropriate message from the pilot, it drops into the slot and rings an alarm. Thus the Flight Superintendent is notified of the delay and an inquiry is started.

The invention will enable the Flight Superintendent to keep a positive double check on the plane's position — from the dispatch board and corroborative advice from the pilot. The airway panels work in conjunction with a master control or dispatch board. The devices are to be set up very shortly in New York, Chicago, Los Angeles, and San Francisco. — *A. K.*

FLOATS

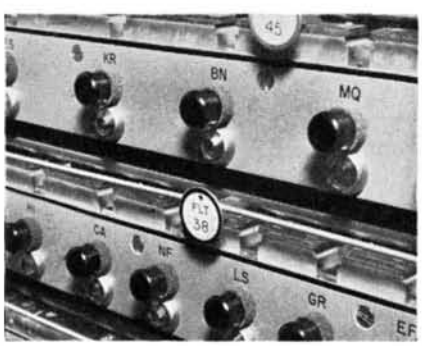
Plywood Construction

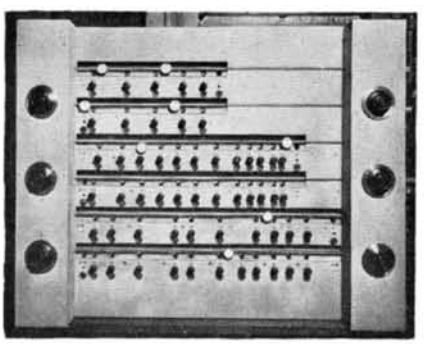
Found Satisfactory

THE aluminum shortage is particularly dangerous for aircraft production, so every effort to substitute plywood for aluminum is helpful. Now we hear of plywood floats, designed by C. K. Wollam, of National Plywood, for use on the Piper Aircraft Cub. Plywood was used for float and hull construction early in American aviation but deplorable service experiences in water absorption and tearing away of the plywood earned it a very bad name.

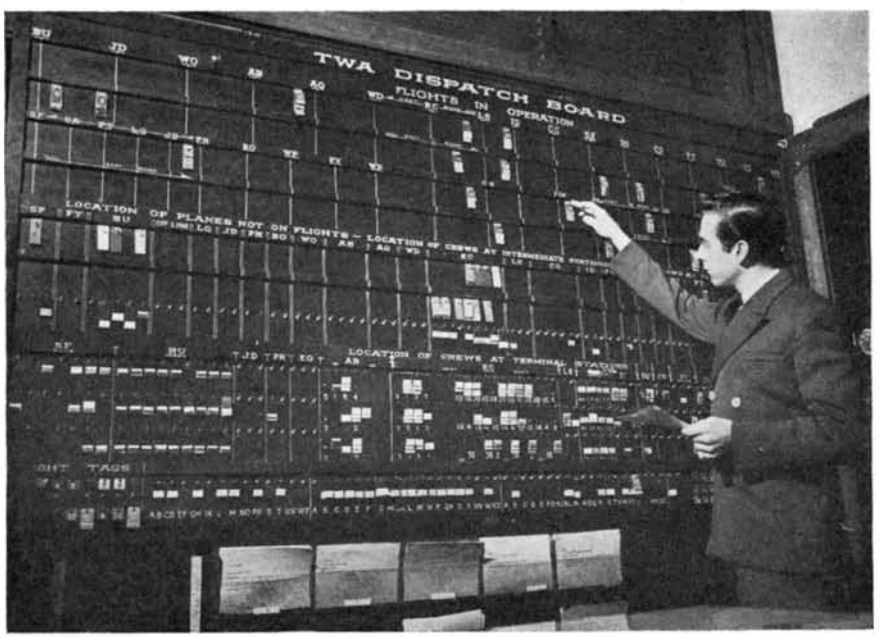
However, Mr. Wollam's present designs seem quite successful. The fundamental reason for the poor showing of earlier types was that in the old plywood no glue then available was completely water resistant or perfectly immune to bacteriological attack. The modern plywood glues, such as the plastic phenol resin type, are perfectly water resistant and immune to bacteria, since they are inorganic in origin.

Float construction is of the advanced semi-monocoque type, with internal bracing, and water-tight compartments provided with bulkheads. Costs are said to be low, and Bakelite varnish finish to be effective. Five-ply birch is used for the float bottoms.





Above: **Close-up of "automatic block signal" board.** *Left:* **A detail of the board with numbered block on worm.** *Below:* **The master control dispatch board which is supplemented by block signals.**



CAMERA ANGLES

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

Coat Your Own Blackout Bulbs

A SIMPLE method by which any amateur may turn out infra-red bulbs by dipping ordinary flashbulbs in a "blackout" formula, was described by Kenneth Murray, of Colon, Michigan, in "Photography Handbook." Mr. Murray offers the following formula for the infra-red varnish:

Eosine, Color Index 768 ..	4 grams
Tartrazine, C. I. 640	6 grams
Acid Violet, C. I. 698	4 grams
Napthaline Green V, C. I. 735	10 grams
Gelatin (Nelson's Hard)	200 grams
Glycerine	100 c.c.
Water, to	1000 c.c.

In attempting to assemble the necessary materials preparatory to a test of the method, we found that all the items were available from Fezandie and Sperrle, of New York City. Because of war conditions, however, a substitution had to be made in the case of the gelatin, the Nelson's Hard Gelatin not having been available for some time. Therefore, a domestic make was used, that of Haslett and Vivorde, called Photogelatin. A half pound is all you need.

Mr. Murray's directions follow:

"Soak the gelatin for an hour in one-half the fluid volume of water, then warm to 100 degrees, Fahrenheit, until it dissolves. Each of the dyes must be dissolved separately in a small quantity of water—the Acid Violet being added a little at a time—dissolving each addition before adding more. The water may be warmed, but to not more than 125 degrees, Fahrenheit. Dilute each solution with a little of the gelatin solution and dilute the glycerine with an equal quantity of warm water. Mix the ingredients, prepared as above, one at a time, and add the remainder of the water. Any air bubbles should be removed by a clean muslin filter.

Figure 1: **With and without**

"Keep the dyed gelatin solution at 96 degrees, Fahrenheit, and immerse the bulbs one at a time. As each bulb is slowly withdrawn, turn it cap downward for a few seconds, then invert it, in order to secure an even coating. Allow the bulbs to dry for at least 24 hours before returning to the original containers for storage."

We poured the gelatin into a small tray containing the specified amount of water and placed this tray in a larger one. After an hour or so, when the gelatin had soaked up the water and therefore had swelled up, we allowed hot water from a faucet to run into the larger tray until the gelatin was dissolved. In the meantime, we mixed the dyes, one at a time, in one to two ounces of water, then mixed a little of the dissolved gelatin in each, and poured the solutions successively into a one-liter graduate. Then we poured in the rest of the dissolved gelatin and finally the diluted glycerine. Air bubbles appeared, so we filtered the solution through clean muslin. Filtering requires considerable patience as it is rather slow work; the solution jells rather quickly as the temperature

Figure 2

drops (which naturally occurs as the dyed gelatin is poured from the graduate, which was kept standing in a tray of hot water) and it was necessary to filter only a little at a time.

The filtered gelatin solution, hot-water jacketed in a tray to maintain the temperature as near as possible to 96 degrees, Fahrenheit, was now ready for the dipping. Two types of flashbulbs were used, Superflash No. 2 and General Electric No. 50, in order to obtain light sources of different intensities. To protect the fingers, we wore rubber gloves. Since the bulbs would naturally have to be dryed by

suspension individually, we cut up some thin wire into short pieces and wound one end around the threaded neck of the bulb and twisted the other end into a loop for hanging.

The bulbs were then dipped individually in the filtered solution and drawn out very slowly with a revolving motion. When completely out, the bulb was turned cap downward, held thus for a few seconds, then inverted again. This was done several times to assure an even coating. Exposed to the cool air, this gave an opportunity for the varnish to jell and prevented dripping when suspended. The operation completed, the bulb was hung on a hook to dry. During the processing, the fingers may become stained by

Figure 3

the dyes, but may easily be washed clean with ordinary soap and water. Should you run short of bulbs for ordinary flash purposes, the entire jacket may be removed simply by placing the bulb in warm water.

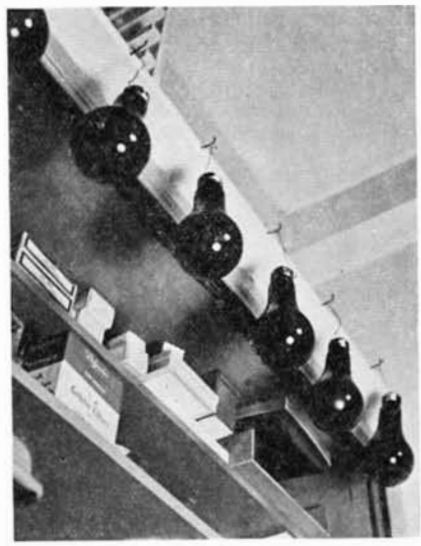
By test, we found that the dye-coated Superflash No. 2 gives a proper exposure at f/8, 1/50 of a second, with the lamp six feet from the subject, and the General Electric No. 50 (which must be exposed by the open flash method), at the same distance, about f/11 or a little larger.

Properly treated, the bulbs give off only a dull red glow. However, there is a tendency for the solution to leave a narrow untreated strip at the extreme end of the neck of the bulb. Also, because air bubbles are inclined to persist, particularly at the ball end of the bulb, particular care must be taken to avoid this. In spite of every precaution, however, the two faults mentioned will persist, with the result that a faint white flash may be seen. Although this does not appear to hinder the characteristic infra-red results, it is obviously to be avoided. We found that the faults could be mended by covering the small areas thus exposed with black masking tape.

Some interesting variations are possible with infra-red that were not treated in our article on the subject

"Horror" by infra-red

in the October number. One is the "horror" picture, a type of photographic slapstick made more startling by "blackout" bulbs. Another is illustrated in Figures 2 and 3, which show the effect of "blackout" make-up. This make-up consists of the application of X6 Shadow tint (dark brown) and the brown eyebrow pencil from the Hampden Panchromatic Make-up Kit. By applying the pencil to the lips, the lips appear relatively as they



Drying the bulbs

do in ordinary photography. Also, flesh tones appear much more natural and exhibit beautiful gradation. Figure 1 is a comparison shot illustrating the effect of infra-red on a normally made-up face and one treated with the special make-up for infra-red.

Marines

MAYBE this is something that needs clarification, and maybe what's the difference. Anyway, what do you think? In a photographic contest sponsored by the Long Island Association, some question has arisen among contestants as to just what the committee meant by dividing the

OVER $1100 IN PRIZES
36 CHANCES TO WIN

Sixth Annual
SCIENTIFIC AMERICAN
AMATEUR PHOTOGRAPHY CONTEST

POPULARITY of the divisional method of judging photographs in the Scientific American Annual Contests, as determined by the enthusiastic response in past years, has been so great that the method is once more being used for the Sixth Annual Contest. In each of the divisions listed below there will be awarded seven major prizes and five honorable mention awards, a total of 36 prizes in all.

Please read the rules carefully and abide by them. Note particularly Rule 6, under which any contestant may enter a total of six prints, but no more than two in any single division.

Divisions In Which Prints May Be Entered

Division 1. Human interest, including camera studies of people, animals and so on. Portraits will be grouped in this division.

Division 2. Landscapes, including all scenic views, sea scapes, and so on.

Division 3. Action, including all types of photographs in which action is the predominating feature.

THE PRIZES

1st. Three $125 LONGINES, Coronation Model, Solid Gold, Men's Wrist Watches.

2nd. Three $90 LONGINES, Presentation Model, Solid Gold, Men's Wrist Watches.

3rd. Three Intercontinental Marketing Corporation PHOTRIX "22" Enlargers, complete, less lens. (List price $54.)

4th. Three Burleigh Brooks FOTH-DERBY Cameras, with built-in coupled range finders. (List price $34.75.)

5th. Three WESTON No. 715 Exposure Meters. (List price $24.)

6th. Three ABBEY Vimo Flash Guns. (List price $13.75.)

7th. Three Raygram LEE Timers. (List price $12.50.)

Five Honorable Mention Awards, each to be a new or renewal subscription to Scientific American for one year.

Address all Entries to

Photograph Contest Editor, Scientific American
24 West 40th Street **New York, N. Y.**

Rules of the Contest

1. The groups will be judged independently on the basis of pictorial appeal and technical excellence. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.

2. Prints must not be smaller than 5 by 7 or larger than 11 by 14 inches. *All prints must be mounted,* otherwise they will be returned immediately.

3. Photographs must be packed properly to protect them during transportation.

4. Non-winning entries will be returned only if sufficient postage is included when the prints are submitted.

5. Each entry *must* have the following data written on the back of the mount: Name and address of contestant, type of camera, and film, enlarger, and paper used.

6. Contestants may submit no more than two prints in each group, but may enter any or all groups. In no case, however, will more than one award be given to any individual contestant.

7. Prints must be in black and white or monotone. Color photographs are not eligible.

8. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher.

9. Scientific American reserves the right to purchase, at regular rates, any non-winning entry.

10. No entries will be considered from professional photographers.

11. All entries in this contest must be in the hands of the judges by December 1, 1941. Results will be announced in our issue dated February, 1942.

12. The contest is open to all residents of the Western Hemisphere who are not in the employ of Scientific American.

13. In fairness to all contestants, failure to comply with any of the above rules will result in automatic disqualification.

THE JUDGES:

McClelland Barclay
Artist

Ivan Dmitri
Artist and photographer

T. J. Maloney
Editor of **U. S. Camera**

Robert Yarnall Richie
Photographer

classification of marine subjects into two parts. So William H. Kniffin, vice-chairman of the committee, explained as follows:

"The contest committee felt that it was necessary to divide the marine classification of subjects into two parts in order to emphasize the desire to secure photographs of scenes along the shore lines and waterfronts. Many people, including a large majority of amateur photographers, always have considered 'marines' as pictures taken only on the water, such as boats, fishing, sailing, flying waterfowl, swimmers, and so on, without including shore lines or waterfronts.

"We especially want photographs of sand dunes and beaches; nature studies of sea and land life along the beach; sand and wave patterns; docks, wharves, jetties, boat moorings and landings. Such subjects are equally in demand with pictures of objects entirely on or in the water."

In view of this explanation, was the committee justified in dividing the marine classification?

Eliminating Variables

MANY workers, particularly beginners, are sometimes bothered and confused by the several variables involved in the exposure routine. Among others, these include the speed of the film emulsion, the *f*/ stop, the shutter speed, focusing, and so on. By eliminating as many variables as possible, photography is simplified and more attention may be given to the prospective pictures themselves.

Suppose we start with the shutter speed. For miniature type cameras, we would recommend a standard shutter speed of 1/100 of a second or 1/50 of a second, to minimize camera shake as much as possible—a point of particular importance with miniature negatives that have to be enlarged to 8 by 10, 11 by 14 inches, and larger. If your shutter speed is always set at 1/100, you can forget that variable entirely, altering only the *f*/ stop.

If you are shooting a number of pictures outdoors with about the same light distribution, you can set your diaphragm at say *f*/8 or *f*/11, or smaller, depending on the speed of the film, and forget that too. By using one film you also eliminate the film speed variable. As for focusing, by using a small stop you can follow box-camera technique and limit all your shooting to objects beyond a fixed distance from the camera.

Color at 5:30 A.M.

A HEAVY fog at the waterfront spelled the possibility of shooting color into the sun after the fog had thinned out a little and allowed the mellow light to come through and cast its warm reflection on the water. This was the prospect as we awoke one foggy morning on a July vacation in Provincetown at the tip of Cape Cod. Fortunately, this was not only the prospect but the actuality as we reached the wharf. The sunlight came through and cast a mellow, golden light on the quiet surface of the bay. Guided by the exposure meter, we exposed Kodachrome at *f*/9, 1/30 of a second. The result was a beautiful record of a scene that reproduced with marvelous fidelity to the original. A black-and-white shot made at the same time did not begin to tell the story or recall the scene that the color shot revealed in all its glory.

From A Ferris Wheel

IF YOU don't take a chance, you'll never find out. So we did. We happened to be in the cage next to the one carrying our companions. At leisure, knowing we would meet

1/200 at *f*/4

again and again as the wheel revolved, we measured the distance by range finder. It happened to be 10 feet. Setting the shutter at 1/200, stop *f*/4, we bided our moment to make the shot in the couple of seconds when the carriages were suitably juxtaposed. Then we edged the lens inside of one of the apertures in the wire screen to give it a free view of the subject, and made the first shot. This was a failure. The second is shown in the reproduction.

Hypo Eliminator

CONSIDERABLE interest has been created recently in Eastman's Hypo Eliminator formula, HE-1, designed to give prints maximum permanency. It is recognized that, due to the fact that the sulfur in the residual hypo ultimately combines with the silver of the image to form yellowish brown silver sulfide stains ("fading"), the complete elimination of hypo from papers is difficult, if not impossible. The Hypo Eliminator

formula, which follows, gives the greatest possible insurance against eventual fading:

Kodak HE-1

Water	16 ounces
Hydrogen Peroxide (3% solution)	4 fl. ozs.
Kodak Ammonia (3% solution)	3¼ fl. ozs.
Add water to make	32 ounces

Wash the prints for about 30 minutes at 65 to 70 degrees, Fahrenheit, in running water which flows rapidly enough to replace the water in the vessel completely once every five minutes. Then immerse each print for about six minutes at 70 degrees in HE-1 solution and finally wash about 10 minutes before drying. At lower temperatures, increase the washing time. For doubleweight prints, washing time should be doubled.

Pipe Cleaner for Local Work

FOR the worker in a hurry a handy little tool for local reduction or intensification is the lowly pipe cleaner. Just bend the end a little bit, making sure the sharp wire tip end is bent up, dunk it into the solution, and you are ready to reduce that small dense area or intensify the thin one. For larger areas, the wire can be bent several times, lining the bends alongside each other. The rest of the pipe cleaner makes a reasonably stiff handle for the purpose.

Weighing Large Quantities

WITH the small pans in use on amateur photographic scales, it is sometimes difficult to avoid spilling chemicals when weighing such relatively large quantities as two or three ounces of such a chemical as carbonate, for example. The usual result is that, as the chemical is poured into the pan, a pyramidal mound is formed which eventually causes a spillover from the sides unless the worker is extremely careful. Here is a stunt that should be helpful in this connection. After pouring part of the total quantity into the pan, dig a "crater" in the cone with your finger. Then pour some more and dig again until the total quantity has been poured. By the "crater" system, the portion already in the pan is not disturbed and the newly poured portion is easily contained within the cavity.

Cleaning Tanks

THE Nikor tanks we use in our darkroom get a pretty thorough workout over the course of months, so it is natural that their interiors, originally as bright and shiny as their exteriors, eventually become dulled. Also, it occasionally happens that, in manufacture, due to the difficulty of drawing the tanks, which are made of very tough stainless steel, the tools used to shape them get caught and in the effort to pull them loose some metallic deposit is left, mixed in with the stainless steel. This eventually causes so-called "rust" spots to appear. These spots are effectively eliminated, we have found, and the general appearance of the tank walls improved, by rinsing the tank with a 10 percent solution of nitric acid— one ounce of nitric acid in ten ounces of water. Fill the tank to the brim and allow to stand overnight. Following this bath, the tank is thoroughly rinsed in plain water and then wiped dry and bright by using paper toweling or a soft cloth.

Lecture-Demonstrations

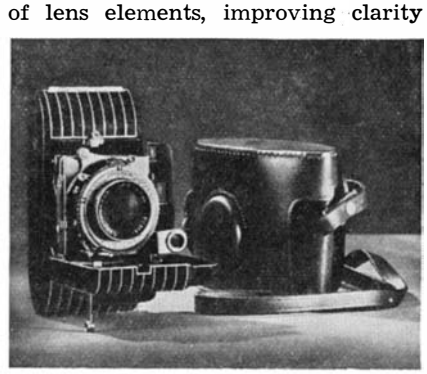
WHEN this issue of Scientific American reaches the reader, there will still be time for those in the vicinity of New York City to attend the last half of the series of six lectures on photography being given on Thursday evenings at the 336 Madison Avenue store of Abe Cohen's Exchange. The lectures begin promptly at 8:00 and are planned for the beginner in photography with the hope of helping him to make better pictures with available equipment. The following lectures are still to come: October 23rd—Getting the Most Out of Color Film, by E. G. Bancker of Eastman Kodak Company. October 30th—Portraiture with your Equipment, by Carlyle Trevelyan. November 6th—Films, Filters and Exposure, by Henry M. Lester.

• • •

WHAT'S NEW

In Photographic Equipment

NEW KODAK BANTAM SPECIAL CAMERA: Now equipped with Kodak Ektar *f*/2, 45mm lens and Eastman's Supermatic shutter. Lens treated with surface coatings 1/50,000 of an inch thick on inner glass-air surfaces of lens elements, improving clarity



and image brilliance. Better contrast with black-and-white and greater color purity with Kodachrome. Improvement achieved by materially reducing reflection from glass-air surfaces within lens. Speed-selecting ring on Supermatic shutter engraved in red for "Time," "Bulb," 1 second, ½, 1/5, and 1/10 (speeds requiring camera to be mounted on tripod or

other firm support; (engraved in black for 1/25, 1/50, 1/100, 1/200, 1/400, for hand-held exposures). Split-field range finder lens-coupled. Range finder eyepiece adjustable for individual eyesight. At left of index mark on engraved distance scale is red index mark for manual focusing compensation when using infra-red film. Accessory: tan leather field case.

WATSON 2¼ BY 3¼ MINIATURE PRESS CAMERA: Designed to take all standard press camera accessories. Telescopic eye level view finder ad-

justable for parallax. Ground glass focusing panel fitted with folding hood. Double extension bellows travels on all-metal V-grooved track. Removable lensboard.

KODAK CHRISTMAS GREETING CARD OUTFITS: No. 6 contains eight negative masks; two vertical, two horizontal for 2¼ by 4¼-inch negatives; two vertical, two horizontal for 2¼ by 3¼ negatives. Each mask includes holiday sentiment, opening for negative, guide for placing paper. Also supplied: embossing guide for 4¼ by 5½-inch cards; metal foil gummed seals, instructions. No. 7 outfit includes two masks, one horizontal, one vertical for 2¼ by 3¼ negatives; six negatives of greeting sentiments, embossing guide for 4¼ by 5½-inch cards, instructions.

LEITZ SLIDE CLEANER: For cleaning cover glass plates. Available in two-ounce bottles with special applicator; latter is pliable, plastic "test tube" having stopper made of sponge rubber, which, moistened with solution, is used to clean glass. Glass is then rubbed dry with clean cloth. Cleaner will remove dirt, grease, smudges, fingerprints. Can also be used to clean outer surfaces of bound slides or for cleaning lenses, condensers, and so on.

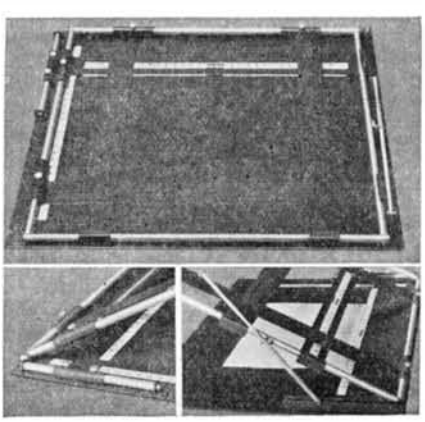
KALART AUTOMATIC SPEED FLASH ($10 for synchronizing unit alone; $14.95 with Compak battery-case-reflector combination; $18.50 with Kalart Master Battery case and reflector): Mechanical type; fully automatic, requiring no winding or cocking before use. Also is universal, fitting practically any type camera having cable release socket. Can be used with miniature focal plane cameras by addition of simple adapter. Measures only 1½ inches long, ½ inch wide. Synchronizer unit itself snaps into jack terminals of battery case; requires no cable release, eliminates all wires. Armored, flexible coupling connects synchronizer to shutter. Coupling adjustable for variations in shutters.

BOLEX FRAME COUNTER ($17.50, special winding handle, $5): Attaches to motor crank shaft of camera and counts individual frames while camera is in forward or reverse motion, whether being run on spring motor, electric motor, or by hand.

NEW BELL & HOWELL BUILT-IN EXPOSURE CALCULATOR: Compensates for film emulsion speed, filter factor, and camera operating speed, in addition to external factors governing exposure: brilliance of light, type of scene, season, time of day. Gives direct readings for Kodachrome at normal speed with single turn of dial.

F-R ENLARGER ($42.50 without lens; tripod model $54): Takes negatives up to and including 2¼ by 3¼ inches. Two models: standard bench or table (No. 5); tripod model (No. 6). Features: Double condenser system, using oversize condensers; negative carriers of revolving, glassless type. Each enlarger supplied with 2¼ by 3¼ negative carrier; other sizes optional. Other negative carrier sizes down to 35mm; lens board carrier takes either metal or wood lens board; distortion control features.

NIKOR ENLARGING EASEL ($7.50): Constant center type easel provided with thin steel base, permitting maximum enlargement and use on autofocus type enlargers. Finished in



"safelight red." Parallel, uniform borders, from ⅛ of an inch up, on paper from 2¼ by 2¼ to 11 by 14 inches, assured by long, accurately machined bearings and unique guide for masking band frame, which stays up or down without catches. Friction material prevents slipping in normal use. Provision made for anchoring in fixed position, if desired.

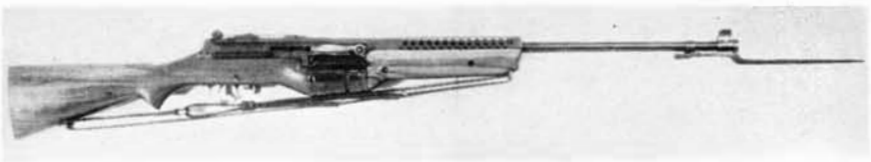
YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is 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.*

The Johnson Semi-Automatic Rifle

FOR FOUR years after this gun was invented—in 1936, by Captain Melvin M. Johnson, U. S. Marine Corps Reserve—intensive development and engineering studies were made with test models to ascertain high and low operating tolerances and to determine whether rifle would operate satisfactorily with interchanged parts. Therefore, when the gun was put into production early this year by Johnson Automatics, Inc., and its subsidiary, The Johnson Automatics Manufacturing Company, it was not particularly surprising that, in view of the records established by this shoulder weapon during its test period, deliveries were started shortly thereafter to a friendly foreign nation. Providing added fire power for the average soldier, the gun will take the place of the regular bolt-action infantry rifle now used by that nation's armed forces.



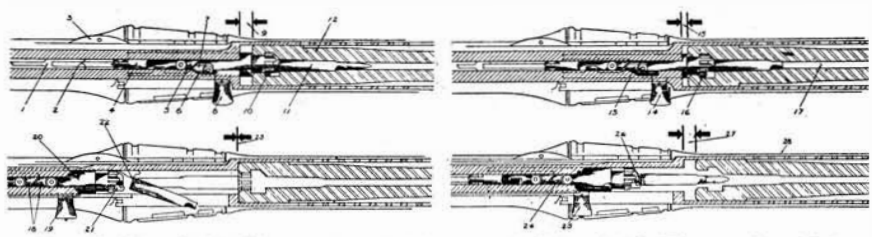
The Johnson Semi-Automatic is a .30-'06 caliber rifle of the short recoil type, equipped with a 10-shot capacity rotary type feed magazine loaded from standard Springfield type clips or with single cartridges. Utilizing the recoil force to operate the mechanism, the gun has a theoretical cyclic rate of fire of 600 rounds per minute, but may be fired as slowly as desired, or as rapidly as dexterity of the operator will permit; operation requires a separate pull on the trigger for each shot. With rifle fully loaded (10 rounds in magazine, one in chamber), 11 aimed shots can be fired in as many seconds. Maximum rate of aimed fire is 40 shots per minute; normal rate of aimed fire is 15 to 30 shots per minute, depending on range, size and visibility of target, and so on.

Exhaustive tests, it is claimed, showed that under sustained rapid-fire conditions accuracy of aim is not seriously impaired by the automatic action. The recoil is partially absorbed in operating the mechanism, and the "kick" against the shoulder is thus substantially reduced. This recoil force is harnessed to motivate action of the gun, which will fire only if breech is closed and locked as in Figure 1—note small arrows.

After ignition, and as bullet travels through bore, the barrel, which has been held in forward position by tension of both recoil and main springs (transmitted through the bolt), begins to recoil *with* the bolt against tension of the springs, as in Figure 2. (Note space between arrows.)

By the time bullet has reached muzzle, barrel and bolt have moved rearward about 1/64 of an inch; when bullet is about two feet out of muzzle, this retraction totals approximately 1/8 of an inch. Camming arm on bolt now engages camming face in receiver and unlocking begins. With bullet some five feet from muzzle, barrel has reached maximum recoil position—3/8 of an inch—bolt has been rotated through 20° to unlocked position by action of camming arm against camming face, and rearward movement of barrel is arrested by a shoulder in receiver. (Figure 3—note arrows.)

After being unlocked from barrel, as above, bolt, actuated by recoil and momentum, continues backward motion while extractor claw loosens empty cartridge case in chamber. Si-



Top, left to right: Figures 1 and 2. Lower, left to right: Figures 3 and 4

multaneously the locking cam, motivated by impetus received during rotation of bolt, delivers sharp blow to bolt, forcing it back in its channel, thereby drawing cartridge case from chamber, cocking hammer, and compressing mainspring. (There is sufficient residual pressure in chamber to assist extraction appreciably by blowing loosened case from chamber — Figure 3.) Coming in contact with ejector, empty case is thrown clear of receiver, rearward action of bolt is arrested by bolt stop, and face of bolt has passed back of base of top cartridge in magazine.

Counter recoil now begins, actuated by compressed mainspring. Bolt moves forward, contacts base of top cartridge in magazine, which is forced up by spring pressure of magazine follower, and drives it toward chamber. Meanwhile barrel has returned to firing position (Figure 4, note arrows), locking lugs enter barrel locking bushing, and locking cam causes bolt to rotate through 20° to locked position. The hammer, cocked as above described, is held in cocked position as bolt group moves forward and must be released by trigger before another shot can be fired. When maximum speed of aimed fire of the rifle is attained, this cycle of action is repeated 11 times in 11 seconds.

The complete and far more detailed story of the Johnson Semi-Automatic rifle is presented, together with 31 excellent illustrations and charts, in the 70-page "1941 Instruction Manual of the Johnson Semi-Automatic Rifle." Herein we could give only an all-too-brief picture of this interesting firearm and a digested version of the fire cycle. The "Manual," by Charles T. Haven, co-author of "A History of the Colt Revolver," contains a list of parts and their detailed descriptions, chapters on Operation, Functioning, Disassembling and Assembling, Care and Cleaning, Accessories, and other data. Mr. Haven has also compiled a chart 25 by 38 inches, showing the Johnson Semi-Automatic in halftone to ¾ scale, with section drawings of parts in normal position, the fire cycle, and a stripped halftone view of the rifle disassembled. These items are now available to anyone interested.

Latest Stoeger Catalog

It's always a pleasure to announce to the firearms fraternity the imminence of a new edition of Stoeger Arms Corporation's catalog. Long known as "The Shooter's Bible," this 1942 publication is more comprehensive than ever, for in addition to shotguns, rifles, and handguns of all descriptions, it depicts a complete line of articles for the outdoorsman, including camp equipment, clothing, boats, outboard motors, and so on; also, equipment for skiing, tennis, badminton, and other sports. The gun section excels, as usual, and contains latest current prices. In our opinion, you can't get along without "The Shooter's Bible"—it's a reference book, an authoritative source of information, and an excellent buyer's guide.

Camouflage Cape

Now comes the science of artistic camouflage to aid duck and crow shooters. Many a nimrod has supposed himself well hidden in his blind, only to discover, when the flight came down, that the wary, sharp-eyed birds had spotted some incompletely covered part of anatomy or equipment, and had veered off before flying into range. With the "Camouflage Cape" and complete immobility, the hunter can simulate to perfection a large tuft of swamp grass, an abandoned corn shock, a sheaf of wheat. When birds come in to the decoys, he rises to crouching or standing position, the cape—weighing but 1¾ pounds—opens and slips back off the arms, permitting unrestricted action. Made of light, durable, olive drab canvas with strips of elastic stitched at intervals to form loops for camouflage, the "Cape" has an adjustable elastic throat strap with black snap fasteners. It is water repellent, is worn over regular hunting clothing. Want a descriptive folder?

To fool the ducks, you emulate a strawstack

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced."

PAPOOSE is what Verl J. Douglas, Santa Paula, California, calls the rather large (as finders go) reflecting finder on his 10" reflecting telescope (Figure 1). He scarcely mentions the main telescope which, however, is itself a sturdy instrument sturdily mounted, but is intrigued by his discovery that he could make a 22×, 1½° finder that would itself split Theta Orionis and show its nebula, also show the rings of Saturn and pick

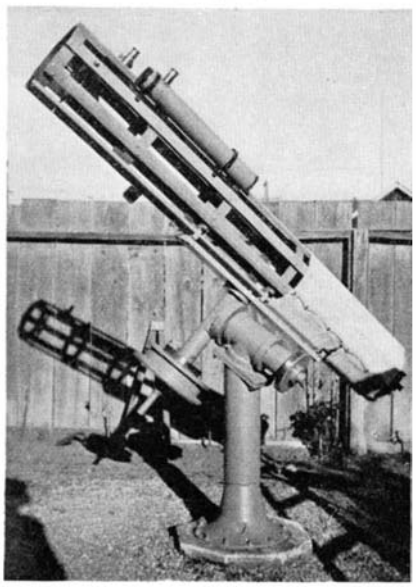


Figure 1: **Telescope, papoose**

out Uranus and Neptune from the surrounding stars more easily than a binocular, from nothing but a ten-cent-store caster cup for the mirror disk and a ⅝" prism from an old binocular. He says it out-performs, as a finder, a refractor as usually used for a finder costing much more than it did—meaning it has the powers of a 3" aperture, which the smaller apertures usually used on finders do not.

PERFORATED sheet iron makes an attractive telescope tube, and one which is well ventilated and thus not subject to the pocketed air current effects that sometimes are troublesome where the tube is solid and the mirror closed in—effects that often cause a deterioration in seeing. Rev. J. F. Peat, Bellville, Ohio, a retired China missionary, who used to do star gazing in China, used this material, bought at an ordinary hardware store, in the 6" reflector shown in Figure 2.

His mounting, a double yoke type with pipe-fitting declination axes, has elements of originality and he says the telescope gives complete satisfaction—"I really have a grand little telescope." It has a celluloid protractor declination circle.

THIS magazine's stock of copies of the book "Amateur Telescope Making" having become once more exhausted, a new printing was made and the opportunity was used to make a few minor corrections and to revise entirely the last 36 pages of the book. Yet we don't think this is enough of a change to justify calling this a fifth *edition*—maybe you'd feel a bit cheated—so it is still the fourth edition. Fourth edition, third *printing*, to be precise.

The old book reviews on pages 469-476 needed revision, likewise the Directory, and, especially, the list of astronomical and telescope making clubs. Wates, of Canada, also didn't like the index; nor did various others, including your scribe, who originally made it. So practically the whole back-yard part of the book was chucked out and a new one made.

Much more space than before has been given to the book reviews, both for their number and detail. Practically all the important astronomical and telescoptical books in the English language are now not merely listed in "A.T.M." but described in some detail. The new printing reviews 76 books (and it was a real job to do the reviewing). Not all are new books—mere newness isn't, in this field, the universal criterion of usefulness—but mainly the books have been published within the last few years. Nearly a page, for example, is given to telling just what's in Conrady's famous "Applied Optics and Optical Design." Few can afford this expensive work, not very many can even understand its mathematics, but nearly all would like to know approximately what it's like. Or just what's in the Ephemeris.

There is also a new list of astronomical journals, a new list of astronomical societies, a list of 70 local groups of amateur astronomers and telescope makers. To compile this and obtain the correct names, also local adresses that are likely to remain relatively permanent, required a large amount of correspondence and sleuthing. This list of clubs—the most complete now available anywhere—should be valuable to many users of "A.T.M."

The "Last Word to the Beginner" was left in and, with misgivings, that odd portrait at the bottom of it.

Wates volunteered to make another index, and now your scribe therefore has a goat on whom to lay future peeves, if any, about the index. (Probably Wates didn't think ahead that far!)

Here are the minor corrections for the main part of the book.

Page 16, line 34, after "flat is," add "one of." (We believed that—years ago.)

Page 27, line 4, delete "our greatest of all mirrors."

Page 34, two thirds way down, substitute "often" for "usually," with regard to Huyghenian eyepieces (when that was written they usually were).

Page 54, third line above bottom, delete "need not be exactly" and substitute "ought to be quite." (This shows how far the amateur standards have moved since this was written.)

Page 58, second line below Figure 47, add "at first." (That, too, was written in 1926 but won't get by today).

Page 60, in line 8, substitute IV, Figure 37.

Page 111, near middle, formula below "Substituting," the minus sign in second term should be an equality sign.

Page 344, line 30, "over" should be "one."

Page 370, fourth line above bottom, "tool" should be "disk."

Page 381, kill final sentence.

Page 382, in figure, alter denominator of formula to F—½(A—a), which

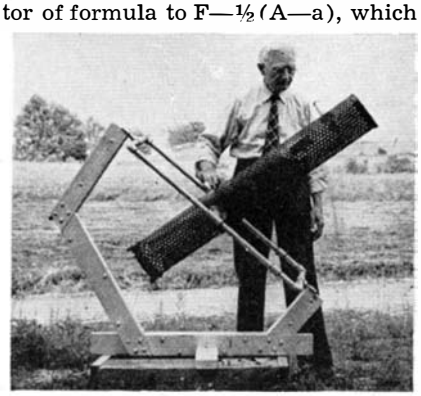


Figure 2: **Gravel grader tube**

Wates points out will be a little more exact, especially where large prisms are involved, as in an R.F.T., for example. Big help, Wates. And now—

NEW method of zonal testing is offered by Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alberta, Canada, in the following discussion:

The increasing popularity of short focus mirrors is making the subject of zonal testing of great importance to the amateur. Of all the mistakes into which the beginner can fall, perhaps the most elusive is the completely erroneous notion that, because a given zone or series of zones tests correctly, therefore that part of the mirror requires no further attention; in other words, that figuring may be confined to those zones which are, by zonal tests, undercorrected.

For the sake of simplicity, consider

a spherical mirror, 8" in diameter and divided into eight half-inch zones. Assume that all zones have the same focal length; that is, zero aberration. In Figure 3, *A* shows a cross-section of a true sphere. *B* represents the same mirror with all zones of exactly the same focal length or, to state the case more correctly, with all zones having exactly the same center of curvature. Than this, there can be no clearer demonstration of the fact that zonal tests are not the final criterion by which a mirror must be judged, but that each zone must be considered in relation to the zones on either side of it.

A step-by-step surface such as that shown in *B* is, of course, never encountered in actual practice. In fact, it would be impossible to make such a surface, since our method of polishing insures that each zone shall blend into

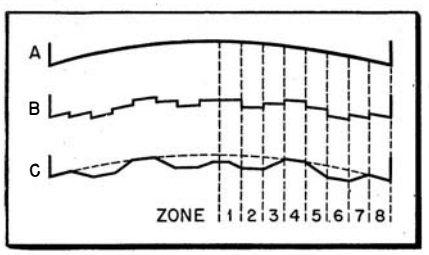


Figure 3: **Some Watesology**

the adjacent zones. We do, however, meet with such surfaces as that shown in *C*, in which zones 2, 4, 6, and 8 are exactly the same as the same zones in *B*, while zones 1 and 5 are undercorrected (short) and zones 3 and 7 are overcorrected (long). Obviously, the entire surface must be worn down to the level of zones 4 and 8, and it is also clear that zones 2 and 6, in spite of the fact that they are apparently "correct," must be polished away; and that, in a lesser degree, zones 1, 3, 5, 7 must be polished down until the entire surface coincides with the dotted line.

In an "all-over" test on a long focus mirror, zones 2 and 6 would show as raised rings, zone 4 as a depressed ring, and zone 8 as a turned edge. In the case of a short focus mirror, when it is necessary to depend upon zonal tests alone, the amateur is hardly to be blamed if he finds himself confused by the apparent "correctness" of the even-numbered zones, and is in doubt as to the practical interpretation of the readings for the odd-numbered zones.

Careful study of an excellent chapter by F. B. Wright, on page 257 of "A.T.M.," will enable the worker to draw a correct graph of the actual surface of his mirror at any time, and will prevent him from falling into the error I mentioned in the first paragraph. The results of Wright's method are quanitatively exact, but the present writer ventures to suggest a somewhat simpler method which will enable the amateur to draw such a graph without the use of mathematics.

The following table refers to an 8" mirror, $f/4$, the radius of curvature, R, being 64", divided into eight zones as before:

Zone	r	r^2/R	Case 1	Case 2
1	.25"	.001	.001	.001
2	.75"	.009	.009	—.100
3	1.25"	.024	.040	—.050
4	1.75"	.048	.085	.020
5	2.25"	.079	.110	.080
6	2.75"	.118	.155	.250
7	3.25"	.165	.165	.300
8	3.75"	.220	.220	.220

Referring to Figure 4, draw the line AA to represent the axis of the mirror. Lay out the arbitrary scale on this line, each division representing .01" aberration. It is suggested that AA may be 10" long, and each scale division ⅛".

Find the point B on the scale at one half the total correct aberration; in this case .110". With B as a center, describe the arc AC, and lay off the equidistant points a, b, c, and so on to represent the zones. On the scale suggested these points may be about ¾" apart. Draw radii from these points toward B.

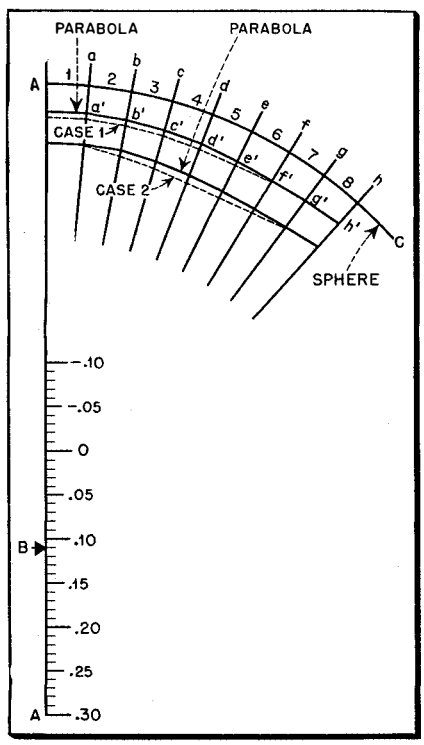


Figure 4: **Graphing a mirror**

Refer to the table and note that the correct aberration of zone 8 is .220". Set one point of the dividers at .220 on the scale and the other point at any convenient place h' just within the circular arc. Prick h' and g'. Now set one point of the dividers at .165", the aberration for zone 7, and adjust the other point to rest at g'. With this radius, prick f'. Continue this process until each radius has a prick-point according to the table. Join these points with a straightedge and pencil. The resultant "curve" represents the correct parabola.

Referring again to the table, note that in Case 1, zones 1, 2, 7, 8 are correct, but that the other zones are all over-corrected. Starting at point h', prick off the points as before, taking the readings as shown under Case 1. The resultant "curve" is the actual surface of the mirror. It will be seen that the actual surface in zones 7 and 8 coincides with the parabola, but that the surface in zones 1 and 2, for which the readings were also "correct," is parallel to, but not coincident with, the parabola. It is apparent that glass must be removed from the center, tapering out to f', and that something in the nature of a small star lap, and the use of a stroke which will bring the points of the star to f', is called for.

Referring again to the table, Case 2, it will be seen that zones 1 and 8 are "correct," zones 2, 3, 4, 5, greatly under-corrected, and zones 6, 7, over-corrected. When the curve is plotted, as shown in Figure 4, it will be found that zones 1 and 8 actually coincide with the parabola, but that the rest of the surface constitutes a raised band, which is highest at zone 5. A ring lap seems to be the remedy, with a stroke which will confine the abrasive action between a' and g'.

It will have been noted that in both these cases the graph was started at the edge, with the idea of getting all the surplus glass outside the parabola, but in some cases it may be necessary to start at the center, or even at some intermediate zone. A little experimenting will soon make this point clear. If the scale and radii are drawn in ink, the various graphs may be drawn in pencil and erased as often as desired.

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