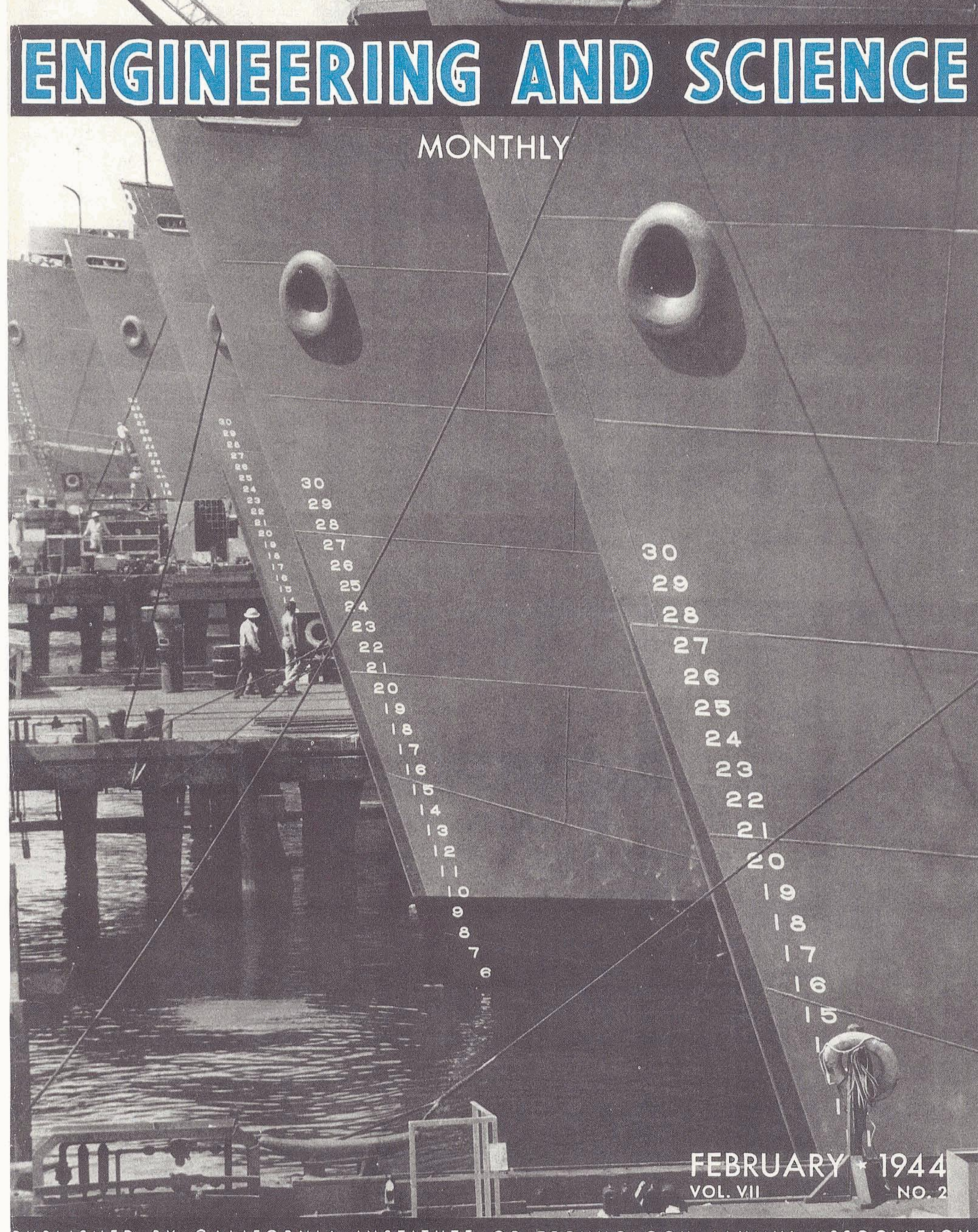
ENGINEERING AND SCIENCE

MONTHLY



FEBRUARY • 1944

VOL. VII NO. 2

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the Jewels A WOMAN GIVES A MAN

MORE planes might be named Diamond Lil if pilots and crews knew what this woman knows—that bombers wear jewels!

This woman is one of a little group of war workers whose job is producing synthetic jewels for electric aircraft instruments. The jewels are tiny bearings for moving parts which must be as accurate, and are almost as small, as the parts of a fine watch. They are made from glass by a secret process at a mass production rate, but each jewel must pass an inspection as exacting as a jeweler's appraisal of a precious stone. These jewels, which women are giving men to fly by, are given in painstaking devotion to precision—in manufacture and inspection.

The development of these jewels is an example of the application of General Electric research and engineering to small things, as well as large. Before the war, and before G-E scientists developed a special process for making these jewels synthetically from glass, we used sapphires for these bearings—importing many of them. Think what it would mean, with America's thousands of planes requiring millions of instruments, if we were still dependent upon a foreign source!

Small things perhaps, these jewels a woman gives a man—but in war, as in love, there are no little things. *General Electric Company, Schenectady, New York.*

Hear the General Electric radio programs: "The G-E All-girl Orchestra" Sunday 10 p.m. EWT, NBC—"The World Today" news, every weekday 6:45 p.m. EWT, CBS.

This magnified glass jewel, one of several types, is actually smaller than a pin head. As one of the largest makers of aircraft instruments, and as a supplier of jewels to other instrument makers, General Electric is unofficial jeweler to many American planes.

GENERAL ELECTRIC

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192,000 employees of General Electric are on their jobs producing war goods and buying over a million dollars of War Bonds every week to hasten victory.

BY-LINES

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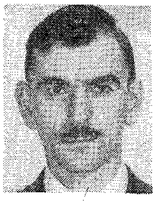

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The Truth Shall Make You Free

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ENGINEERING AND SCIENCE MONTHLY

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Vol. VII No. 2 February, 1944

The Month in Focus

George Washington, the Engineer

IT IS appropriate in this February issue of *Engineering and Science Monthly* to take recognition of the birthday of a great man, not for the part he played in the formation of the government of the United States, but for his engineering approach. While it is not usual to think of George Washington as an engineer, his whole life is characterized by those traits for which every engineer strives.

In December, 1748, at the age of 16, Washington went to William and Mary College to take a course in surveying. The course was undoubtedly simple, involving geometry and trigonometry as well as common practices in the then so-called art of surveying. He obtained his field training under the tutelage of his brother's brother-in-law and was appointed county surveyor in 1749. According to the records, his work was accurate and complete. This work continued for about three years, during which time he became familiar with personnel problems involving the employment of assistants. At the age of 19 he was given command of the local militia composed of several hundred men whom he had to organize, equip and drill for the protection of interests in Ohio. Later, the governor of Virginia employed Washington to assemble men and to build a fort at the head of the Ohio River. Although he did not have a background of formal courses in structures, he did have good judgment and ability to organize. It was these abilities and his eagerness to take responsibility that led him further into civil engineering as it was known then.

Washington's engineering career continued until he became Commander-in-Chief of the forces of the united colonies. His work included, in addition to the management of his wife's and his own plantations, the drainage and reclamation of some 40,000 acres of swamp land containing valuable timber. He was the manager of the company operating the project. In 1769 he was active in "clearing and making navigable the River Potomac from the Great Falls of said river up to Fort Cumberland." The plans for construction and financing the canal project were well along when Washington's civil engineering and business careers were interrupted by the commencement of the Revolution. But even in these new activities he displayed the characteristics which had made him successful in engineering. This was recognized by Patrick Henry at the first Continental Congress in 1774, at which Washington was in attendance. Henry, in specifying the greatest man in Congress, referred to Mr. Rutledge of South Carolina as being the greatest orator, "but if you speak of solid information and sound judgment, Colonel Washington is unquestionably the greatest man on that floor."

After the war he returned to the canal project, planning the work, marking its location and tending to administrative matters. The necessity of cooperation between states bordering on the Potomac led to the formation of a commission under Washington's sponsorship. The discussions of the commission had more far-reaching importance than merely the settlement of problems in interstate commerce, for they ultimately led to the Constitutional Convention in 1787 at Philadelphia. In 1789 Washington became the President of the United States, having come to that position as an engineer rather than as a statesman or a lawyer.

The words spoken by Patrick Henry about Washington could well be used to describe the qualities required of an engineer today—"solid information and sound judgement." With the complexities of present-day structures, machines, and processes which have been brought about by the application of scientific developments, the simple training of Washington's era is no longer adequate for the procurement of "solid information." The engineer now requires an extensive technical training in those subjects which are fundamental to his future work. This training is only the beginning and lays the foundation for professional development and guidance in establishing "sound judgment." Further "solid information and sound judgment" are obtained by experience and more study.

It is not until the engineer has acquired experience in his particular field in conjunction with his fundamental training that he becomes a professional engineer. In this connection, attention is directed to a paper presented before the Michigan Section of the Society for the Promotion of Engineering Education and reported in the Journal of the Society in November, 1943. Dean Freund, in his paper, "Back to the Professional Degree," admirably discusses the status of engineering as a profession. He suggests that the professional degree (C.E., M.E., E.E., Ch.E., etc.), should be awarded to those who have had a certain amount of experience in engineering subsequent to receiving the bachelor's

(*Continued on Page* 17)

MARINE DIESEL POWER PLANTS and Ship Propulsion

By PETER KYROPOULOS

THE revolutions per minute of marine propellers is determined by hydrodynamic considerations. The type of engine furnishing the propeller with the necessary power does not affect the speed for best propeller efficiency. It is the engine designer's task to provide the propeller with the power and speed required by the naval architect. Besides, the power plant is to weigh as little as possible and to take up a minimum of space in the vessel.

In order to obtain an idea of the order of magnitude of the speed for maximum propeller efficiency as affected by forward speed and shaft horsepower, average values for a series of commercial vessels have been collected and plotted. A plot of such data is shown in Fig. No. 1. It is seen that the required propeller speed becomes quite low, especially at low speeds and large power. If the engine is directly coupled to the propeller shaft, the engine size will be excessive, unless the power is subdivided into two engines and propellers. A definition of propeller efficiency and its relation to ship propulsion is given in the appendix. Since the initial cost of an installation is proportional to its weight, direct drive with low engine speed will be both heavy and expensive.

DIRECT AND GEARED DRIVE

The difficulty of direct drive described above has led to the application of gear transmissions to marine Diesel drives. This allows the propeller to operate at its best rate of speed without imposing limitations on the engine speed. It furthermore permits the subdivision of the engine into several independent units, all geared to the same shaft through the transmission. It is usual to gear two parallel engines to one propeller shaft. However, there are installations which have four engines driving a single shaft. The gear transmission enables the engine speed to be selected within wide limits. As a result of high engine speed a considerable gain in weight and space is obtained. The cost of the installation is decreased in proportion to the decrease in weight.

To illustrate the saving in weight and space for a given vessel. Fig. No. 2 shows sections of a cargo vessel with a displacement of 8,000 tons and 2,500 shaft-horsepower (*shp*). Installation *A* represents a direct drive Diesel engine. Propeller and engine speed are equal (80 revolutions per minute). The weight of the installation is 242 pounds per shaft-horsepower. Installation *B* shows two parallel engines geared to the propeller shaft through a transmission. Propeller speed is 80 revolutions per minute, as before, and the engines are running at 250 revolutions per minute. Weight of the twin engine installation is 116 pounds per shaft-horsepower. The saving in weight and space is appreciable.

In common Diesel engine terminology such an installation would be called a high speed installation. It should be kept in mind that this term is applied to any Diesel engine running at or above about 250 revolutions per minute.

As mentioned above, direct drive limits the number of engines to the number of the propeller shafts. An example will illustrate the effect of this limitation on cruising economy: A given vessel is designed to run at 15 knots at rated full power. Cruising speed, at which most of the operation will be maintained, is 11 knots (i.e., 73 per cent of full speed). For this speed, only 40 per cent of rated full power is required. Fig. No. 3 shows a curve of specific fuel consumption for a typical two-stroke marine Diesel engine plotted against load. The consumption at full power is 0.361 pounds of fuel per brake power hour. At 40 per

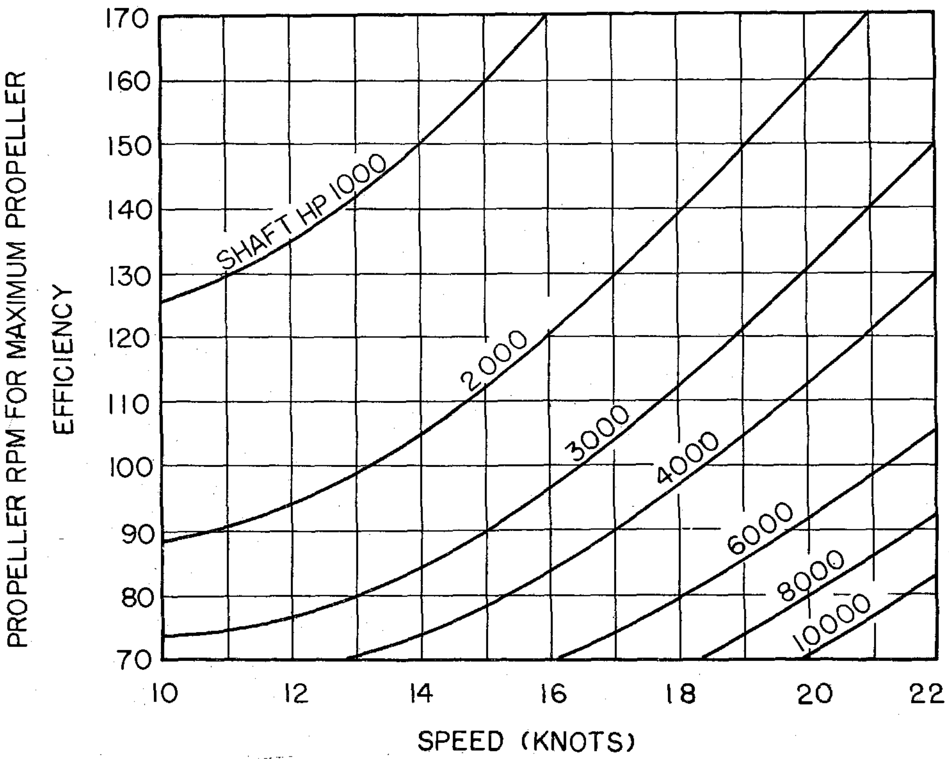

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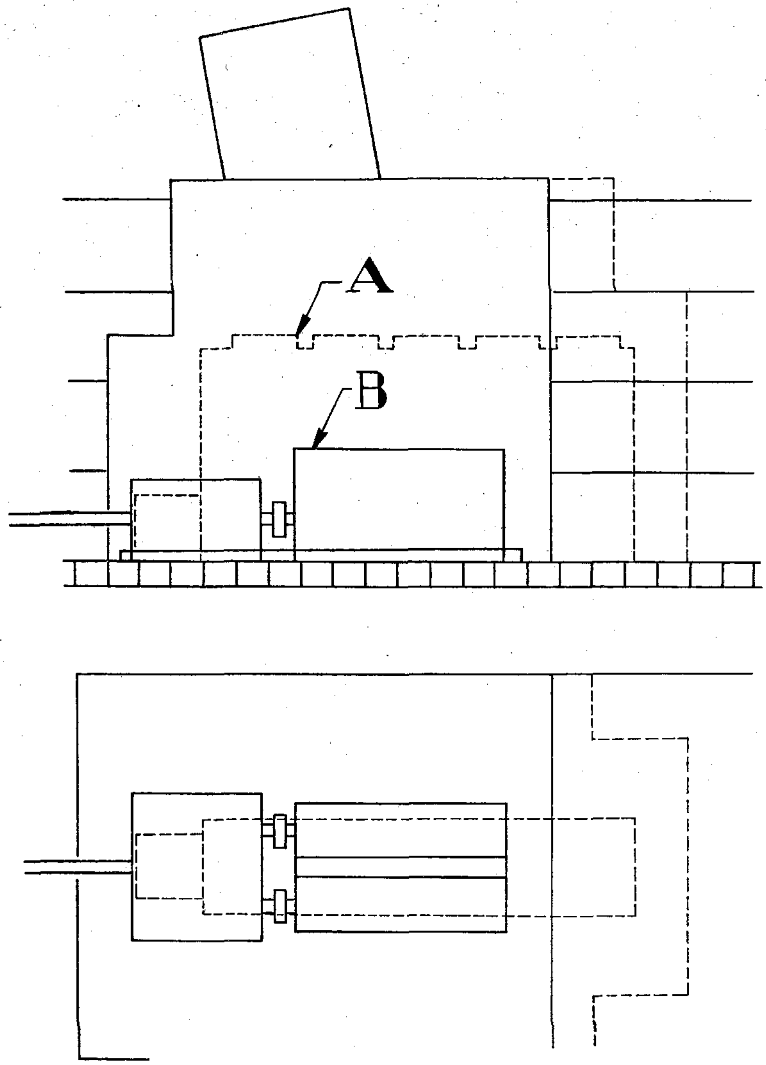
FIG. 1—Propeller revolutions per minute for maximum propeller efficiency vs. speed for different shaft horsepower.



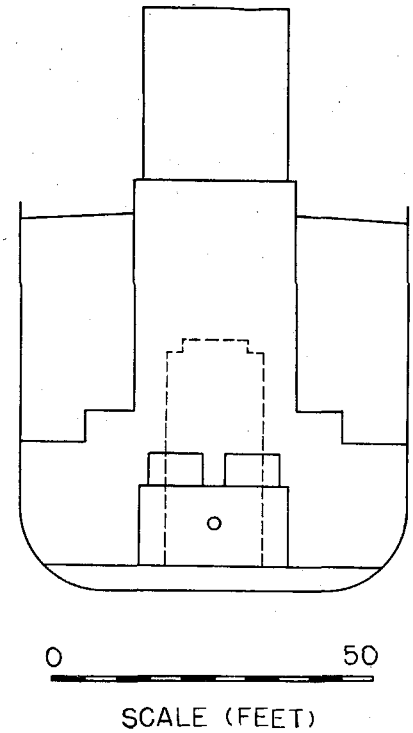


FIG. 2—Space required for direct drive (A) and geared (B) diesel engine installation. 8000-ton freighter with 2500 shaft horsepower at 80 propeller revolutions per minute.

cent power it is 0.361 pounds of fuel per brake power hour. The geared twin engine drive would reduce power for cruising by disengaging one engine completely. The remaining engine would then run at 80 per cent of its full power with a specific fuel consumption of 0.349 pounds of fuel per brake power hour. It has been assumed in this example that the variation of fuel consumption with load is the same for the individual engine of the twin installation and for the single engine of twice the power. This is not necessarily true. However, for engines above a certain power this assumption is permissible.

The twin-engine drive also adds to the safety of operation. In case of failure of one engine, the trip can be continued on the functioning engine. Often, repairs can be made during the trip, thus materially reducing the period for which the vessel is tied up for overhaul.

A NOTE ON RATED ENGINE POWER

In connection with Fig. No. 3 a remark about rated engine power is in order. It will be noticed that the curve of specific fuel consumption has not yet reached its minimum value at 4/4 load, that is, at full rated power. For the engine from which Fig. No. 3 was taken, the rated full power was 3,750 brake power. 110 per cent overload, or 4,125 brake power were listed as allowable continuous overload. The maximum power obtained in the acceptance test was 5,300 brake power, or 141 per cent of rated power. This represents a case of conservative rating. It is clear that such a rating lets the engine show up poorly as far as weight per horsepower is concerned. From a point of view of maintenance and engine life, however, the practice of

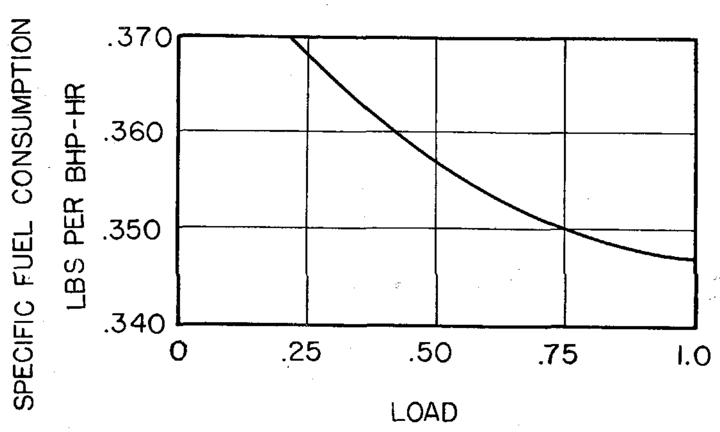


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FIG. 3 — Specific fuel consumption of a typical marine diesel engine (4000 brake horsepower two-stroke).

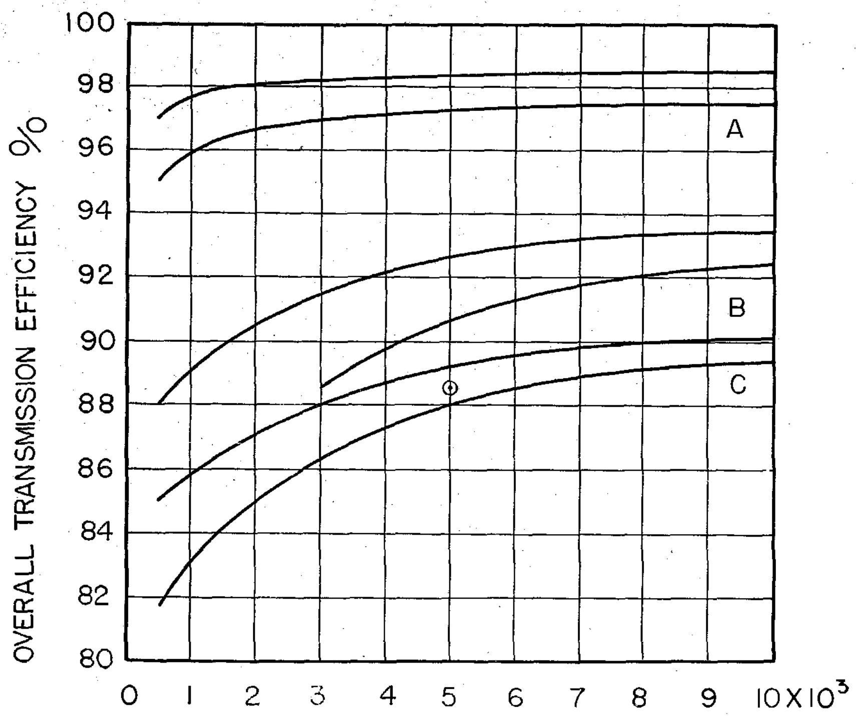

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FIG. 4—Transmission efficiency vs. shaft horsepower for different types of power transmission. Curves (A): Gear transmission; Curves (B): Electric transmission (A.C.); Curves (C): Electric transmission (D.C.). (The circle indicates a point for diesel-electric drive from Fig. No. 5).

conservative rating, sometimes called "rating down," pays by reducing engine wear and failure due to overload. Manufacturers are inclined to present maximum powers in order to make them compare favorably with other power plants.

In a similar fashion, weight figures are often optimistic, since they are based on an arbitrary list of parts assumed to constitute an engine.

TWO- AND FOUR-STROKE ENGINES

For a given power and speed, weight and space required of the power plant will also depend on the type of engine chosen. To illustrate this, Table No. I shows a comparison of three engines having the same power and speed. Engine *A* is a single acting two-stroke engine, *B* a four-stroke engine with exhaust turbo supercharger, *C* an unsupercharged four-stroke engine.

It is seen that the two-stroke engine is both lighter and more compact than the two other types, a reason why two-stroke engines have gained in popularity during recent years. The advent of exhaust turbo supercharging has again put two- and four-stroke engines side by side, at least as far as weight is concerned. The exhaust supercharged four-stroke engine is seen to be only 7.3 per cent heavier than the two-stroke engine, and slightly larger in size. The unsupercharged engine is 25 per cent heavier than the two-stroke engine and considerably longer.

EFFICIENCY OF GEAR TRANSMISSIONS

The foregoing examples have shown the desirability of gearing an engine with relatively high speed to the propeller shaft. As a result, gear transmissions are extensively used, usually in connection with mechanical or hydraulic clutches and couplings. This form of power transmission is, of course, equally applicable to steam turbines and Diesel engines as prime movers. The transmission efficiency (see appendix for definition) of gear transmissions is high, as shown by curves *A* of Fig. No. 4. The upper curve represents single, the lower double reduction gears.

Although high, the initial cost of reduction gears is rarely a deciding factor for or against gear transmissions in comparison with electric power transmission, at least on large installations.

Considerations of safety, simplicity of design, maintenance, noise, and vibration and their evaluation as design factors are subject to personal preferences and allow no general statements.

DIESEL ELECTRIC DRIVE

Because of the twofold power transmission, the Diesel electric drive has a lower transmission efficiency than the gear drive, as shown by curves *B* of Fig. No. 4, representing A.C. installations and curves *C* for D.C.

Since Diesel fuel and fuel oil are comparative in cost and heating value, fuel consumption is a suitable basis for comparing the various Diesel drives with each other and with steam turbine drive. Table No. II shows such a comparison. It is seen that the Diesel drive has the advantage. For a 10,000 shaft-horsepower installation the fuel saving of the Diesel drive as compared with the steam turbine would be 2,200 pounds of fuel per hour. In making this comparison, it should be kept in mind that Diesel power plants are not suitable for very

TABLE I—COMPARISON OF WEIGHT AND SIZE OF DIESEL ENGINES OF DIFFERENT TYPES AND EQUAL POWER

Type of engine:	(*A*) *Two-stroke, single acting engine*	(*B*) *Four-stroke, exhaust-supercharged*	(*C*) *Four-stroke, unsupercharged*
bhp	510	510	510
Engine rpm	350	350	364
Weight of engine (lbs.)	30,500	33,000	45,850
Weight of auxiliaries (lbs.)	4,750	5,400	5,850
Weight of coupling and transmission (1:2) (lbs.)	6,400	6,400	6,400
Weight of installation per bhp	82	88	102.5
Overall length of engine (inches)	134	153	183
Overall height of engine (inches)	92	98.5	95
Increase in weight/bhp over engine (*A*) (per cent)		7.3	25

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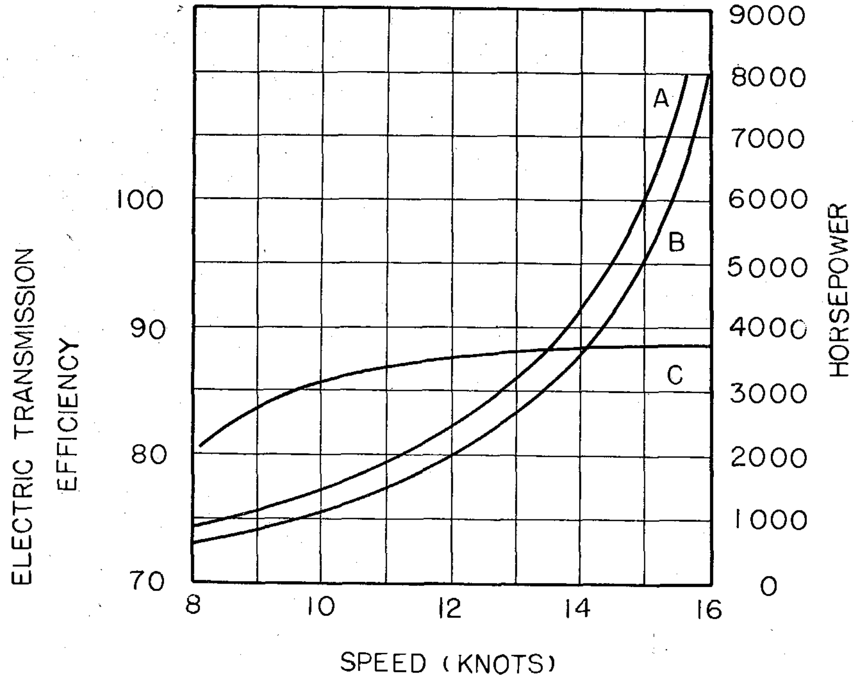
FIG. 5—Power vs. transmission efficiency vs. speed for diesel-electric (D.C.) drive of an 8000-ton ice breaker. Curve (A): Engine brake horsepower; Curve (B): Shaft horsepower; Curve (C): Transmission efficiency.



large powers. For powers above 50,000 shaft-horsepower the steam turbine is definitely the more compact installation.

Fig. No. 5 shows a plot of power and transmission efficiencies vs. speed for a Diesel electric (D.C.) installation of an ice-breaker of 4,330 tons displacement and six 1,500 brake power engines. One point of this plot at V=15 knots and 5,000 shaft-horsepower has also been plotted on Fig. No. 4 and is seen to fall well within the designated D.C. region.

A great advantage of the electrical installation is the fact that the engine-generator unit is completely independent of the propeller motor. This eliminates long shafts and shaft tunnels and numerous bearings. The designer can, therefore, dispose more freely of the space within the vessel.

Propeller rotation is reversed electrically, eliminating the necessity of reversing the main driving Diesel engine. Besides, the drive is controlled directly from the bridge.

D. C. OR A. C. DRIVE

Direct current drive is desirable because of its continuous speed control. Its disadvantage lies in a lower transmission efficiency (Fig. No. 4), greater weight and initial cost, as compared with alternating current drives. Commutators are considered an unpleasant source of maintenance difficulties, particularly in installations with large power. For these reasons, 10,000 shaft-horsepower is the upper practicable limit for D.C. installations.

A.C. drives lack the flexible speed control of D.C. installations. There is, however, no limit to the power that can be handled. Simple construction and the possibility of using high voltages are decided advantages. Use is also made of the synchronous driving motors to synchronize the propellers in order to avoid vibrations of the hull near the propellers.

DIESEL AND ELECTRIC DRIVE AT OVERLOAD

The geared Diesel engine is essentially a constant torque drive. As long as the fuel cut-off ratio of the engine remains unchanged, the torque developed will remain constant, regardless of speed.

The electric propeller motor is a constant power machine; i.e., the electric power supplied by the Diesel generator remains constant and the torque in the propeller shaft increases as the propeller speed decreases due to increased propeller load. Such an increase in load may result from increased wave or wind resistance or increased draft. The speed loss will be smaller in case of the constant power electric drive. On the other hand, the increase in torque is accompanied by an increase in stress in the propeller shaft and blades, requiring larger shaft diameters and heavier blades.

Summarizing, it should be kept in mind that there is not one ideal type of drive applicable to all problems of ship propulsion. The present survey points out some of the main considerations leading to adoption of one type or the other.

It is also well to note the limitations of general studies such as the one presented here. It shows trends, illustrated by specific examples. In the case of a definite design, a detailed study of all questions must be made.

TABLE II—COMPARISON OF SPECIFIC FUEL CONSUMPTIONS OF DIFFERENT PROPULSIVE SYSTEMS (AVERAGE VALUES)

Type of powerplant	*Specific fuel consumption, lbs./shp.-hr.*
Diesel, gear transmission	0.39-0.42
Diesel, electric transmission	0.44-0.46
Diesel, average, all drives	0.44
Steam turbine, average, all drives	0.66

Appendix

PROPULSIVE COEFFICIENT AND EFFICIENCY

In order to show the relation between the power developed by the engine and the speed of the ship, some definitions are presented here.

The power delivered by the working substance to the piston of the Diesel engine is the indicated power, *ihp*, as found from the indicator p-v-diagram.

At the coupling or brake the

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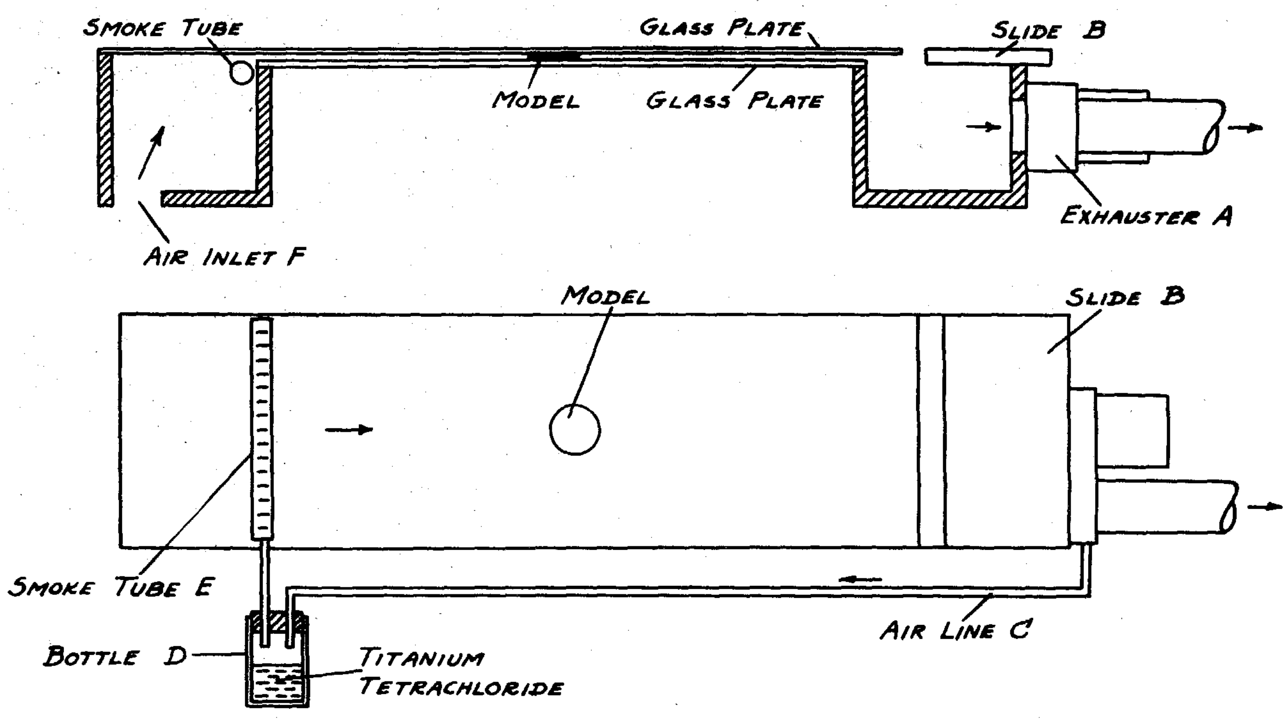

FIG. 1—Main features of simple smoke tunnel.

SMOKE FLOW PATTERNS

By R. C. BINDER

NUMEROUS problems in development, design, and research involve the flow of some fluid through a channel or around a body. For some problems it is essential to build rather elaborate apparatus, instruments, and laboratories. For other problems it is very helpful, and sometimes necessary and sufficient, to obtain qualitative flow patterns quickly by means of apparatus which is simple to construct and relatively easy to operate.

One simple method of obtaining flow patterns is to introduce smoke into an air stream flowing in a channel formed by two glass walls a short distance apart. Various models can be held between the glass plates, and the pattern viewed directly or photographed. Although this method has some limitations, apparatus employing this method can be useful for a wide variety of applications.

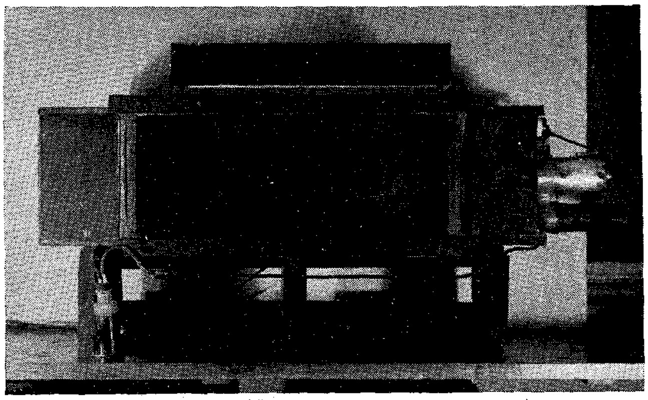

FIG. 2—Smoke tunnel as constructed from available materials.

APPARATUS

Fig. No. 1 illustrates diagrammatically one simple design of apparatus. Air is drawn between the two parallel glass plates by means of the exhauster *A*. The model which is held between the glass plates is the same thickness as the gasket material between the plates along the edges. Slide *B* can be used to vary the rate of flow between the plates.

Air line *C* connected to the discharge side of the exhauster is led to the bottle *D* which contains titanium tetrachloride, a convenient material for making filaments of air visible. As the humid air comes in contact with the titanium tetrachloride a dense white smoke is formed. Titanium tetrachloride ($TiCl_4$) is a light-yellow liquid; when it is exposed to humid air, titanium dioxide (TiO_2) is formed. Titanium-dioxide particles are very small and follow the flow of air in which they are formed.

The generated smoke is forced into the smoke tube *E*. The smoke tube can be a simple cylindrical tube with small holes or slots cut at equal intervals along the smoke tube axis. A valve in air line *C* can be employed to control the amount of smoke generated. As air coming from the inlet *F* flows over the smoke tube, smoke is picked up and streamlines in the channel between the glass plates are made visible.

Many variations are possible in the actual construction of apparatus. Fig. No. 2 shows an improvised arrangement. An ordinary vacuum cleaner unit was used for the exhauster. The glass plates were placed one-fourth-inch apart. The flow channel width is about 12½ inches, and the length about 32 inches. Holes in the smoke tube were placed three-fourths-inch apart. Models can be cut without difficulty from one-fourth-inch thick sponge rubber or wood. Such apparatus need not be expensive, nor require much space in a laboratory, shop, or drawing room.

ILLUSTRATIONS OF FLOW PATTERNS

Fig. No. 3, A to T, gives some illustrations of flow patterns taken with the apparatus shown in Fig. No. 2. In each picture the flow is from left to right. For the same model, pictures in a series are in the order of increasing velocity. In each pattern the relative spacing between streamlines gives some indication of the relative velocity. The streamlines upstream from the model are equally spaced. For an incompressible fluid, a converging of the streamlines is associated with an increase in velocity of the fluid between the streamlines. There is a crowding of the streamlines above the tapered or strut section (Fig. No. 3-H) and in the throat of the nozzle (Fig. No. 3-J). At the nozzle throat, particularly, the velocity is considerably higher than that some distance upstream.

As fluid approaches an orifice or short tube, the streamlines converge; the streamlines continue to converge beyond the orifice. At a certain distance from the plane of the orifice the jet has a minimum area where all the streamlines are parallel. This minimum section of the jet is commonly called the *vena contracta*. This effect is shown in Fig. No. 3-M.

The flat plate and cylinder models (Figs. No. 3-B and 3-D) show a marked eddying wake behind each body at high velocities. This eddying wake, of course, contributes to the resistance. Fig. No. 3-I show a cylinder and a strut in the same stream. The tapered strut at low angle of attack shows no appreciable wake. Fig. No. 3-R, for flow in a baffle

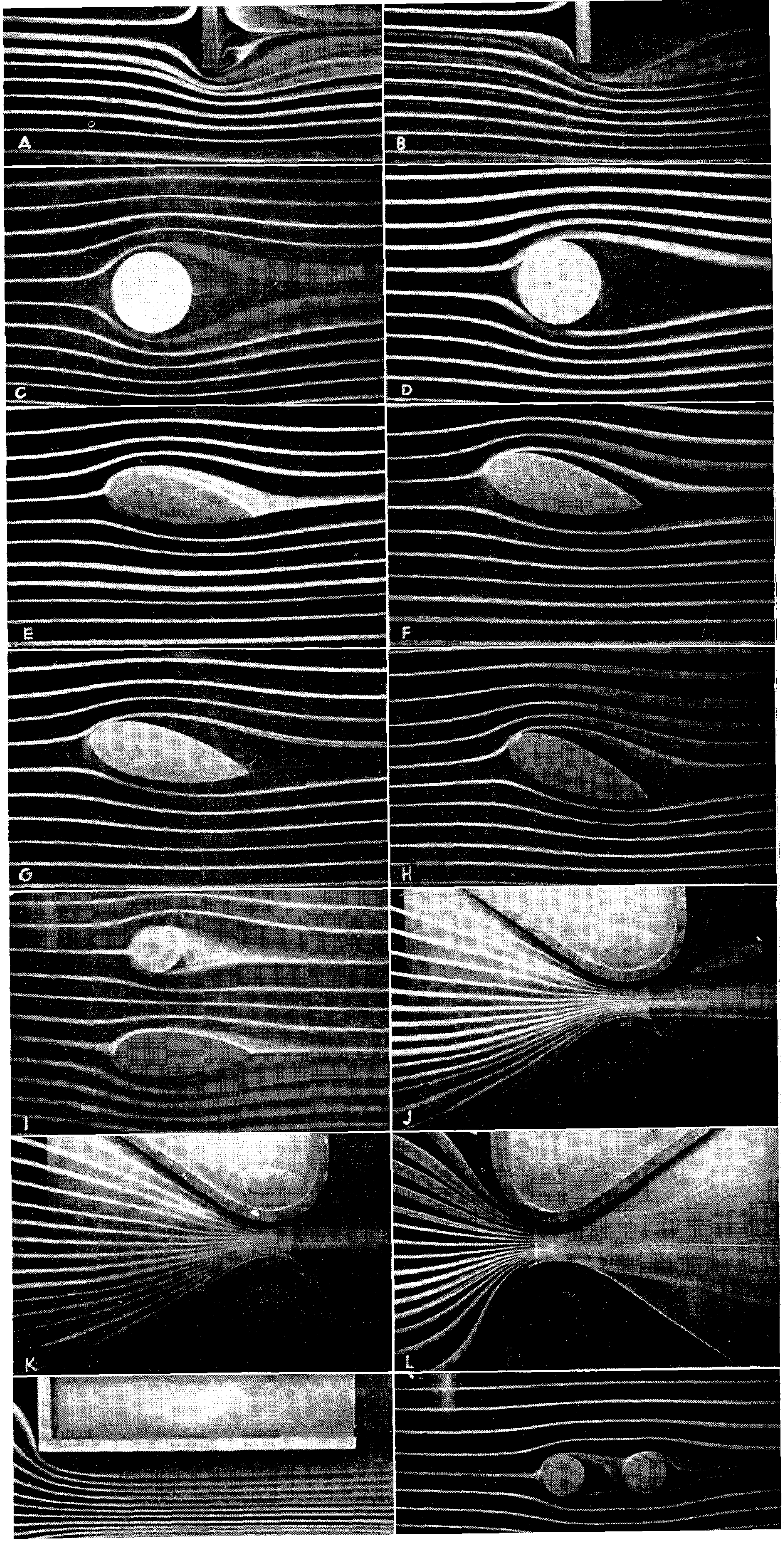

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FIG. 3—Illustrations of smoke flow patterns for various models. In each illustration the flow is from left to right.

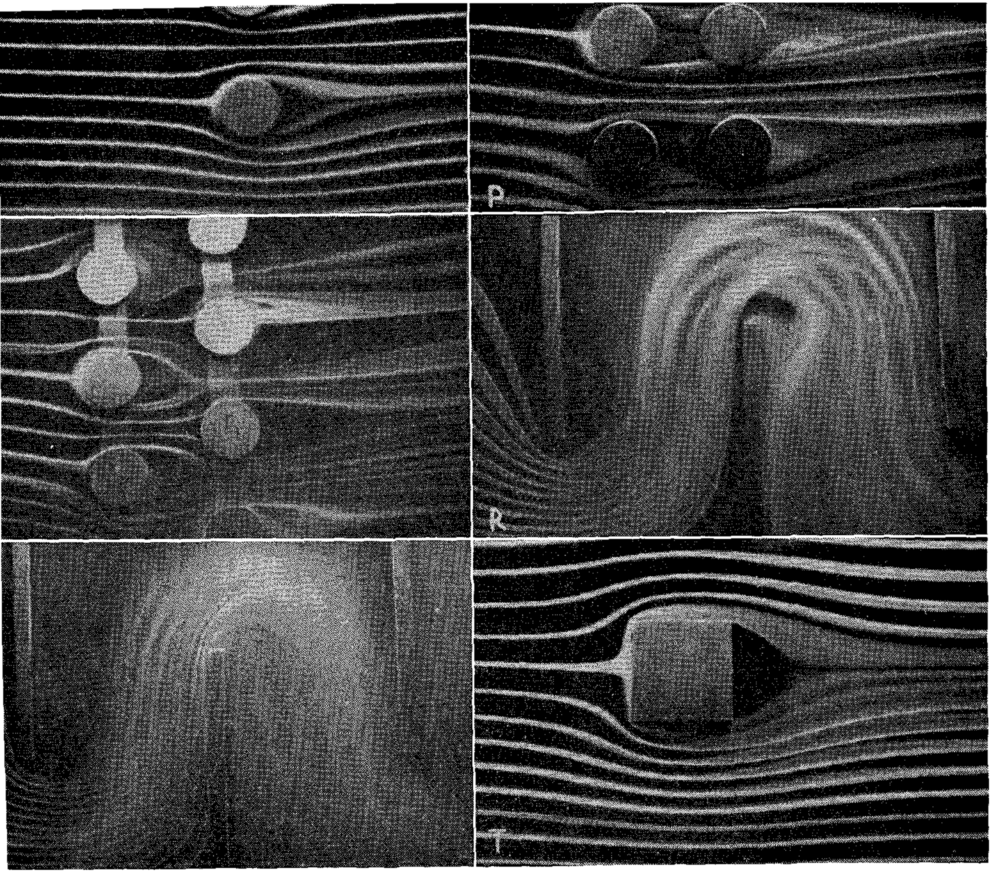

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Fig. 3. (Continued)

arrangement, shows a marked separation of the fluid and a considerable disturbance of the flow.

In some pieces of equipment it may be highly desirable to induce eddying flow. Figs. No. 3-P and 3-Q show two different types of cylinder arrangements; each might represent a bank of boiler tubes. The flow in Fig. No. 3-Q is probably more desirable as far as heat transfer is concerned.

USE OF APPARATUS

For low velocities the streamlines approximate the two-dimensional flow of a frictionless incompressible fluid. In some problems studies of this type of flow are important, whereas in other problems it is necessary to investigate three-dimensional flow.

The apparatus cannot be operated continuously for a long time because of the clogging of small passages and the depositing of white particles on the glass plates. Thus frequent cleaning is necessary for continued operation. It is necessary to make suitable arrangements for exhausting the mixture of air and smoke so that it cannot irritate the human body or corrode steel surfaces. Piping the exhaust outside to the open atmosphere is usually a satisfactory arrangement.

Placing an open dish of ammonium hydroxide upstream from the smoke tube makes the smoke more dense. Tin tetrachloride can be used instead of titanium tetrachloride. Dry ice might be used for generating smoke, but it offers some disadvantages as far as continuous handling and control are concerned. Kerosene vapor forms a good dense smoke, but it is difficult to control and generate without igniting.

Baffles and screens can be arranged at different places in the air stream to control the flow and make it uniform. For test purposes the glass plates can be arranged in a horizontal plane with the top plate simply resting on the model and the gaskets along the edges. Models can be changed easily with this arrangement. For instructional purposes the glass plates can be clamped together along the edges and mounted in a vertical plane. A series of lights and a reflector along the top edge of the apparatus can be provided for showing the flow patterns to large groups.

Marine Power Plants

(Continued from Page 7)

engine delivers the brake power, *bhp*, which is equal to the indicated power minus the mechanical losses in the engine. From this mechanical efficiency $= \frac{bhp}{ihp}$.

From the coupling to the stern tube bearing, power is lost in bearing friction, and, if a transmission is present, in friction in the transmission. The ratio of power actually delivered to the propeller, divided by the brake power delivered by the engine, is called transmission efficiency.

The power required to overcome the resistance of the ship at a given speed is called the effective power, *ehp*, and is equal to the product of speed and resistance. The ratio of effective power over propeller power, *ehp/php*, is called propulsive efficiency. Propulsive efficiency can be subdivided into propeller efficiency, hull efficiency and relative rotative efficiency, which represents the effect of the wake on the propeller. It is seen that all sources of loss between the combustion chamber of the engine and the power represented by the motion of the ship are accounted for. The product of the above terms is called propulsive coefficient and can be written:

$$\text{Propulsive coefficient} = \left(\frac{ehp}{php}\right)\left(\frac{php}{bhp}\right)\left(\frac{bhp}{ihp}\right) = \frac{ehp}{ihp}.$$

In connection with Diesel drives, propulsive coefficient is often used to denote the ratio $\frac{ehp}{bhp}$.

We then have the relation

$$\frac{ehp}{ihp} = \left(\frac{ehp}{bhp}\right)\left(\frac{bhp}{ihp}\right) = \left(\frac{ehp}{bhp}\right) \text{mechanical efficiency.}$$

For electric drive the above equations remain unaltered. Only the transmission efficiency is modified to account for the losses in electrical transmission.

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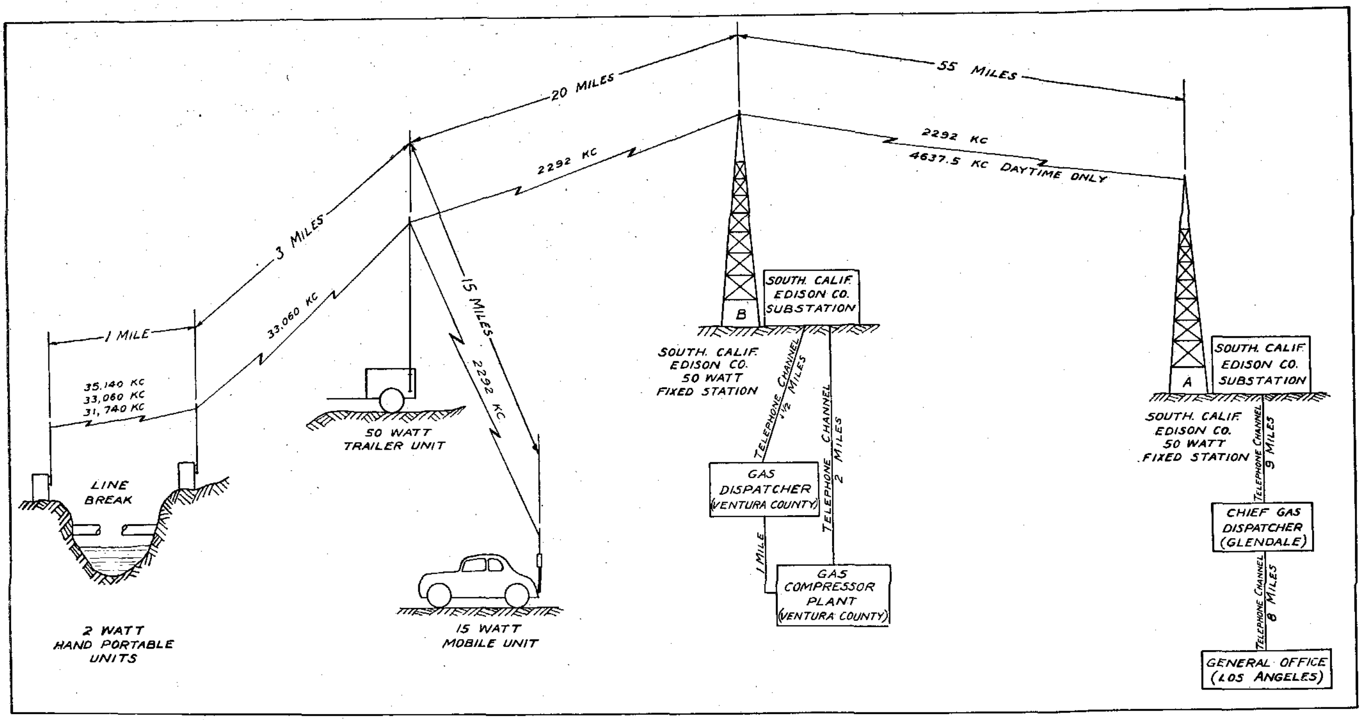

FIG. 1—Diagram showing the typical operation of the Southern Counties Gas Company radio communication system, showing how the different units are used to relay information from a line break in the mountains at a remote point directly to the general office in Los Angeles.

Radio Communication in a Public Utility

By HARRY J. KEELING

FOR many years public utility operating men have dreamed of the day when, through the magic of the radiotelephone, their dispatchers would have instant communication with all field crews and service men. This idea is a natural outgrowth of the rapid increase in the number of two-way radiotelephone sets used by the police and sheriff's departments in communicating with their patrol cars. Unfortunately, the dream may never progress to reality. Although it is always dangerous to forecast what the future will bring in this rapidly changing world, it is safe to say that for a number of years at least, it is not likely that radio communication for ordinary routine business will be possible. The wishful thinkers do not realize that there are only a limited number of usable channels in the radio spectrum, and this number is rather small when compared with the number of services desiring to use them. The army, navy, and government agencies require the use of a large proportion of the radio spectrum, while ships, aircraft, and commercial point-to-point stations require most of the remaining channels.

Because of the extreme congestion, the Federal Communications Commission is forced to restrict the use of radio to services which cannot be handled by wire telephone systems. Police and public utility companies are permitted to operate radio communication systems; however, they may be used only in case of emergencies when there is no other means of communication available.

Electric utilities were quicker in adopting radio communication for emergency service than were gas or other utilities. This is natural when it is remembered that a gas or water utility handles its product in pipes below the ground, where they are fairly well protected from the elements. An electric utility, on the other hand, is more likely to have frequent interruptions to service, since overhead wires are vulnerable to wind, storms and traffic accidents. Although an electric utility may have several hundred minor service interruptions during a year, a gas utility will have only one or two interruptions; but these interruptions are usually more serious.

The Southern Counties Gas Company of California was among the first of the natural gas public utilities to install two-way radiotelephone equipment for emergency communication. The earthquake of 1933, and the severe rains of 1938, brought to the attention of the management the desirability of supplementing the regular telephone system with another means of communication, so that field units would not be isolated from headquarters if the usual channels were not available because of a breakdown or congestion.

The company, with headquarters at Los Angeles, supplies gas to many small communities covering an area of about 700 square miles and operates pipelines extending as far north as Paso Robles and as far south as San Diego. These pipelines in many cases pass through rough mountainous country where they are subject to land slides or floods. In past emergencies, the lack of communication between the repair parties on the opposite banks of a stream greatly increased the difficulty in repairing breaks to the lines where they were washed out by rivers. The same floods that damage the pipelines usually disrupt public telephone facilities, cutting communication lines between the repair

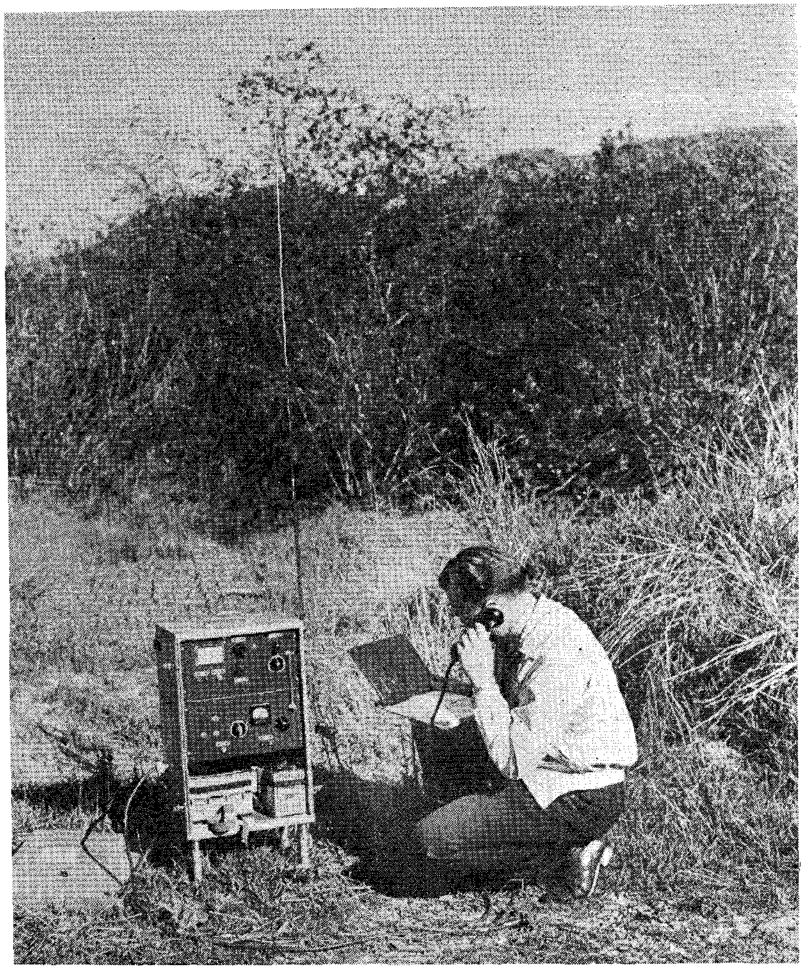

FIG. 2—The two-watt portable radiotelephone unit in use in the field. The removable legs have been installed on the box to raise the set out of the damp grass. The batteries may be seen in the lower compartment. The operator is reporting information to headquarters.

crews and their headquarters at a time when communication is most important.

REQUIREMENTS OF THE RADIOTELEPHONE SYSTEM

After studying the radio communication systems used by the forest service, police department and electric utilities, the specific requirements were formulated from a study of work done by the company during previous disasters. It was found that there was a definite need for emergency communication of three types:

1. Short-range communication (one or two miles) for use between repair parties working on opposite sides of the stream or canyon where pipelines have been washed away.
2. Medium-range communication (five to 20 miles) for exchanging information between the site of the pipeline break and the district headquarters.
3. Long-range communication (20 to 60 miles) for communicating between district headquarters and the Los Angeles general office or between the district headquarters and district emergency crews working a long way from headquarters.

EARLY DEVELOPMENTS

Early in 1937, the Southern Counties Gas Company acquired a pair of two-watt hand portable ultra-high-frequency radiotelephone units. These were custom built since at that time standard commercial equipment was not available. These sets were used to train operators and to gain experience before investing in more elaborate and expensive long-range equipment. Because of the uncertainty of the degree to which it would be used, the management decided to establish a radio communication system gradually by obtaining additional units from time to time. In this way, it was felt that the operating experience would lead to development of additional useful features when newer sets were added. The development of radio communication apparatus is so rapid that in a few years a complete system may become obsolete.

By 1940, six two-watt portable units were in operation, and in September, 1941, two 50-watt trailers and five 15-watt mobile units were added, making a total of $9,000 invested in radio equipment. Plans to install additional units were interrupted by the bombing of Pearl Harbor and the outbreak of the war.

RADIO OPERATORS

The Federal Communications Commission has jurisdiction over all radio equipment. Public utilities operate as a part of the "Special Emergency" section of the "Emergency" service. The equipment must meet the rigid requirements which the Commission has set up to minimize interference with other radio services. All persons operating or adjusting radio transmitting equipment are required to hold a license issued by the Commission. If the transmitting equipment is equipped with foolproof controls so that it is not easily put out of adjustment, it may be operated by a person holding a "Restricted Radiotelephone Permit." No technical knowledge is required for this permit beyond the ability to handle the equipment properly. The person holding it, however, is required to pass an examination on the rules, regulations and laws governing the operation of radio equipment. The Southern Counties Gas Company has trained about 40 of its regular personnel to operate the radio equipment. These radio operators are recruited from its office force as well as its field operating crews, so that during an emergency there will always be plenty of trained people available.

In order to get the greatest use out of the few sets available, the equipment is stationed at strategic points throughout the system so that no matter which area of the territory experiences the emergency, there will always be radio equipment stationed nearby which quickly can be dispatched to the scene of the trouble. For short-range communication, the equipment operates on three ultra-high frequencies. Medium and long-range communication is carried on a special frequency of 2292 kilocycles assigned for the exclusive use of public utilities operating in the emergency service.

TWO-WATT PORTABLE MOBILE UNIT

This short-range communication equipment transmits and receives on three frequencies in the ultra-high frequency band, namely, 35,140 kilocycles, 33,060 kilocycles and 31,740 kilocycles. There were two reasons for justifying more than one operating frequency: first, this feature permits several pairs of units to work in the same vicinity without interfering with each other. Second, when receiving conditions are bad on one frequency, it will usually be found that reception is satisfactory on one of the other frequencies.

The units, which cost about $250 each, comprise transmitting and receiving sets in a weatherproof wood cabinet with an eight-foot collapsible "whip" antenna mounted on the side. Clips are provided on the cabinets, permitting them to be attached to standard "back-pack" frames of the type which ordinarily are used to carry camping equipment on a hike. This feature is a great convenience when the sets are to be carried a long distance by one man on foot. Removable legs on the bottom of the box raise the equipment above the ground and prevent entry of mud or water in swampy or muddy locations. The unit is powered by self-contained dry cell batteries which are capable of operating the receiver for 27 hours continuously and the transmitter for nine hours when used intermittently. The entire set weighs 56 pounds. This is rather heavy for hand portable equipment, but it is felt that the long battery operating life more than justifies the additional weight.

Because of the "light-like" characteristics of ultra-high-frequencies, these sets do not operate satisfactorily where there are physical obstructions such as hills, buildings, etc., between the two units. However, they give dependable communication over a distance of one-half mile when used on the ground in ordinary city streets, and two miles in open country where there are no obstructions. When operating from the tops of high buildings or hills, the range is increased to five or six miles. Vertical antennas supported by hydrogen-filled balloons have been used successfully to communicate over distances of from six to nine miles in rugged mountainous country. The balloons make tempting targets for amateur sharpshooters, however. On one occasion most of the radio operator's time was spent in replacing the balloons after they had been shot down by some unknown rifleman.

It may not be apparent that the short range of the sets is definitely an advantage under certain circumstances. Operators working with these high-frequency units on opposite sides of a canyon are not bothered by interference from signals transmitted by distant but more powerful stations, because of the shielding effect of the surrounding hills. When lower frequencies are used, operators in remote points in the mountains sometimes find that their work is interfered with by strong signals from stations many miles away.

15-WATT MOBILE UNIT

The 15-watt mobile installations consist of standard Motorola ultra-high-frequency transmitting and receiving units rebuilt to operate on medium frequency (2292 kilocycles). They are designed to be permanently installed in the luggage compartment in the rear of a conventional coupe or sedan passenger car. The installed cost of these sets is about $500. The equipment is energized from the six-volt auto battery and contains no other auxiliary power supply.

Four of these units are installed in coupes, and one is installed in a pick-up truck. The truck is equipped with a 35-foot collapsible self-supporting antenna. Although the set can be operated with the truck in motion and the antenna fully extended, this is seldom done because of limited highway clearance. Ordinarily, the truck is operated with only the upper "whip" part of the antenna extended, making the overall height about 15 feet.

The coupes originally were equipped with a 10-foot "whip" antenna mounted on the rear bumper. After experimenting with several different types of antenna systems, an improved antenna was developed recently which uses a loading coil in the center of a "whip" to increase its electrical length. Not only is there a greater radiation from this type of antenna, but unlike the simple "whip" antenna, its efficiency is not lowered during extremely wet weather when the supporting insulators are subjected to a continuous stream of water. This is explained by the fact that the voltage across the insulator at the base of the center-loaded antenna is much lower than the voltage across the base of the simple "whip" antenna.

OPERATING RANGE OF MOBILE UNITS

The average dependable operating range of the 15-watt mobile units when talking from one car to another is from five to 20 miles, depending upon conditions. The range depends upon: first, the amount of local interference from noise and static from power lines, street cars, etc., and second, the type of soil. Along the coast where the transmission path may be across salt water, it is possible to achieve satisfactory and dependable communication between cars separated by a distance of 65 miles or more. On the other hand, in other locations conditions may not permit communication at distances greater than eight or 10 miles.

FIXED ANTENNA FOR MOBILE UNIT

An important district headquarters is located in an area where conditions are very poor for radio transmission or reception. Recently a 100-foot vertical antenna was installed at the top of a nearby hill to insure dependable communication with another district, about 30 miles away, using a 15-watt mobile unit. A 275-

(*Continued on Page* 15)

FIG. 3—Close-up of operating panel on 50-watt trailer, with author at the controls. The transmitter on the left-hand side of the panel operates on 2292 kilocycles or 33,060 kilocycles. The two separate receivers and loud-speakers which may be seen on the right-hand side of the panel permit reception on both frequencies simultaneously. The portable all-wave receiver resting on the end gate is used when it is ncessary to receive messages from other radio stations which are not transmitting on the standard frequencies.

Industrial Engineering and Human Relations

By M. T. DAVIS

THE war has pointed out, as never before, the need for more emphasis on human relations in industry. As a consequence, we have seen a number of new developments in industrial relations within the past few years. We hear of a shipyard that employs a specialist in human relations whose sole function is to interview and pacify employees who want to quit. Other companies have invested large amounts of time and money in orientation programs for their new employees. Another company employs counsellors for every 200 employees, whose only duty is to make friends of workers and listen to their personal stories. Some of this is surface progress and some of it is real. But everywhere there is the indication that industry must take more interest in its employees as individuals.

It is easy to see why this might be desirable as an aid to production management or to personnel departments. But it is more difficult to see how it is related to the more technical field of industrial engineering. Yet method improvements, wage incentives and cost reducing plans are all dependent upon human beings for their success. The human factor is nearly always present and crops up in the most unexpected way to ruin otherwise perfect plans. It is therefore inevitable that industrial engineers sooner or later will need to develop human relation techniques to help them solve problems in their own field.

The science of industrial engineering, as it stands today, is primarily concerned with the physical facts of the situation. Textbooks on the subject cover time and motion study, cost reduction, plant layout, etc., and describe techniques for the analysis and application of such factual knowledge. Because of the application of the scientific method to these aspects of management, great progress is being made. But actual accomplishment is falling short of potential progress because the human factors so often are the limiting factors of a situation. What is needed is a technique for analyzing and applying the human facts of every situation as a part of every industrial engineering study. Such a technique should indicate what human limitations there are to a proposal and how to introduce a change with the least possible friction and the greatest chance of success.

You may reply: "But this is not the job of an industrial engineer; it is the job of line management, or the industrial relations department." Yes, I agree, perhaps it is, but the trouble is that line management is too busy with other things to do any detailed human relations planning, and the industrial relations people are generally swamped with the broader problems of wage administration, union negotiations, employment, morale building, etc. Furthermore industrial engineering and industrial relations are both so specialized that they work independently and have little interest in making a success of the other department's plans. In fact, in some companies there is considerable difference of opinion, sponsored by line management, to bring out two opposing points of view.

The result of this situation is that industrial engineering recommendations are generally made without the benefit of detailed human relations planning, and are either opposed, *in toto,* by the industrial relations department, or are approved by management. Any human relations problems are then left to line supervision to solve as they arise. Furthermore, many line supervisors resent having someone from the outside make plans for their departments, and, if they have not been taken in on the plan from the start, will make no effort to insure its success.

What the industrial engineering department usually needs is good human relations counsel, from the start to the finish, for each study it makes. It needs the human relations data on the situation and advice on how to modify its proposal so as to utilize the human factors to the best advantage. In general, it needs the following type of information:

1. Who are the people involved in the proposed change? What type of employees are they?

2. What has been their feeling toward changes in the past? How will the traditions of their group be affected by the proposal? Will they feel they are getting a square deal? Have past experiences developed a cynical attitude toward all company proposals?

3. Who are the leaders of the group affected? How can they be sold on the proposal?

4. What is the immediate supervisor's probable reaction? Are his ideas incorporated in the proposal? How can he be brought into the plan so that he feels favorably toward it? Can he be given the major credit for the plan?

5. What is the attitude of the union toward such a proposal? How is the union contract involved?

6. Will the proposal require that men be laid off or demoted? Can satisfactory transfers be arranged?

7. Will wage rates and incentive rates be fairly adjusted as part of the change? Will men be asked to take more responsibility or do more work without extra compensation? Will men be asked to work against their own interests?

8. How will the proposal affect persons in other departments in the plant?

9. Will the proposal take all the responsibility and skill away from certain jobs? If so, will present employees lose prestige with their fellow workers? Will it be possible to keep present employees satisfied under the new conditions?

10. Have the workers involved had ample opportunity to express their views regarding improvements included in the proposal? Have their ideas been given honest consideration and credit?

11. Do employees trust the data of the industrial engineers? Are they convinced performance standards are fairly set?

12. How are lines of promotion affected by the proposal? Will some workers be cut out of advancement they have worked toward under the present set-up?

13. What kind of appeal would be most successful in getting acceptance from the workers? Who should introduce and sell the plan to them?

14. What is the proper timing for introducing the proposed plan? Are the workers or supervisors temporarily upset about something? When should the plan be installed?

15. What are the long-time human relations effects of the proposal? Can management honestly fulfill the commitments made? Are there other changes which will follow?

We can all remember cases in our own experience where failure to consider such factors has led to the downfall of plans for improvement. The following examples, although in part hypothetical, were suggested by actual experience and serve to illustrate the point:

(a.) An industrial engineering plan called for the transfer of certain grinding machines from the machine shop to the foundry cleaning room. The change was expected to streamline the flow of material and eliminate a bottleneck in the material's handling system. Shortly after the change, the number of castings per day began to fall off despite the fact that the grinders were working on piece rate and no change in equipment or method had been made. The anticipated benefits were completely offset by the lowered production of the grinders.

Investigation showed that the grinders were upset because they had been moved into the cleaning room along with the foundry laborers. Since it was a generally accepted fact that the foundry laborers were lower than machine shop workers in the social scale, the grinder's standing in the factory social organization had been lowered. No amount of persuasion could convince them that it made no difference where they worked as long as their pay remained the same. To them, they had lost prestige. Finally the entire plan was abandoned and the machines moved back to their former place before production could be brought back to normal.

(b.) Another plan called for the rearrangement of the equipment in a plating room to eliminate one of the dipping processes. From the start it was opposed by the foreman of the plating department. Trouble developed with the improved process and things grew from bad to worse. Finally it was discovered that the foreman had made the same suggestion for improvement a number of years before, but had been turned down by a former plant manager. It was only after the present plant manager had been apprised of this fact and the foreman given public recognition for his idea that the new plan began to work properly.

(c.) On the other side of the picture there was the case of the industrial engineering department which was responsible for making all the job evaluations in a steel mill. From the start the system of job evaluation was opposed by the department superintendents and foremen. The job evaluation technique was complicated and difficult to understand. The job evaluations developed by the industrial engineering department seemed arbitrary, and industrial engineering recommendations on rates were generally questioned by department supervisors.

The solution to this problem was to modify and simplify the job evaluation system so as to bring line supervisors' opinions into the decisions. Ranking scales for each factor in the evaluation were developed so that foremen could quickly make and check evaluations against their own background of experience. None of the accuracy of the evaluations was sacrificed, however, and the basic principles set up by the industrial engineers were in use. The result was that bickering stopped and the industrial engineering department was able to check its evaluations and profit from the broad experiences of the line supervisors.

It is obvious that a serious consideration of the human factors, at the time the above plans were developed, would have made it possible to eliminate some of the mistakes made in their application.

It is not inconceivable that at some future date a human relations analysis will be an integral part of every industrial engineering study made. The industrial engineer's report and recommendations may include a section on the human aspects of the plan and a recommended human relations procedure for its installation.

Just how the industrial engineering department will be organized to obtain this data will depend, of course, upon individual circumstances. It may be that someone in the industrial relations division would be qualified, or someone from line supervision, or someone from the industrial engineering department itself. The important thing, however, will be to obtain sound advice from persons who know the employees affected by the plan and their probable reaction to it.

All this will be worked out in the future as industrial engineers appreciate more fully their need for human relations planning. It is inevitable, however, that considerable progress will be made in this field—with surprising results. Industry is slowly learning something about human relations, and industrial engineering cannot afford to be left behind.

Radio Communications

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foot transmission line terminating in the headquarters garage building permits the mobile unit in the garage to be connected with the fixed antenna. Ordinarily, when the car is away from its headquarters, it operates as a mobile unit, using the short center-loaded antenna mounted on the car; however, when it is desired to increase its range or when the car is at headquarters, the short antenna is disconnected and the car set is plugged into the transmission line, connecting it with the fixed antenna. The equipment for doing this has been simplified so that the change-over can be made in 10 or 15 seconds by an operator with a "Restricted Radiotelephone Permit." The 100-foot fixed antenna has not been installed long enough to determine its maximum range; however, during recent tests satisfactory contacts were made with 50-watt units 140 miles away. It appears that dependable two-way communication is possible at all times with other 15-watt mobile units operating within a 30-mile radius.

50-WATT PORTABLE MOBILE UNIT

This equipment comprises two transmitting and receiving units (operating on 2292 and 33,060 kilocycles), housed in waterproof boxes, mounted on a trailer. It is designed to operate on 120-volt, 50- or 60-cycle alternating current power supply through a 50-foot extension cord. Where normal power is not available, the equipment is energized from an emergency source consisting of an 800-watt Kohler gasoline engine generator unit, which is also mounted in a waterproof box on the trailer. The antenna for this 50-watt unit consists of a 35-foot collapsible "whip" which is attached to the trailer. The unit was designed to be as versatile as possible. The two steel boxes housing the radio equipment and power supply may be demounted from the trailer and carried by hand in country where it is not possible to tow the trailer. With the gasketed steel covers closed, the equipment is completely waterproof and is instantly ready for operation even after complete submersion. The entire outfit, including the trailer and power supply, weighs 1500 pounds and costs about $2,000.

The specifications for these trailers provided for mobile operation of the equipment while the trailer was being towed by a truck. The microphone hand set is equipped with a 50-foot cable, allowing the operator in the cab of the truck to transmit while in motion. While traveling on public highways the 35-foot antenna is collapsed to the 15-foot height required to clear highway obstructions. This results in a decreased transmitting range. However, it is possible to receive satisfactorily with the shortened antenna; therefore, a truck towing one of these trailers can be called over the air while the truck is in motion. If the driver has difficulty in answering the call, it is only necessary for him to stop the truck and extend the antenna.

The dependable operating range of the trailer unit under average conditions is about 25 miles on a frequency of 2292 kilocycles and about 10 miles on 33,060 kilocycles. These figures are only approximate. As explained in the discussion of the 15-watt units, under certain conditions the range may be several times the figure given above. For example, regular schedules are maintained between two of these trailers over a distance of 240 miles between the towns of Avenal and Santa Ana, California.

JOINT OPERATION OF FIXED STATIONS

The experience with the 15-watt mobile units and the 50-watt trailer units demonstrated that this equipment filled our needs for medium-range communication. However, for long-range communication, a fixed station with a permanent antenna is required. Investigation of suitable sites for fixed stations revealed that many of the proposed locations were occupied by the Southern California Edison Company, Ltd., which operates radio equipment on the same frequency, 2292 kilocycles.

The three gas companies operating in this area, Pacific Lighting Corporation, Southern Counties Gas Company and Southern California Gas Company, cooperated closely in the establishment and operation of an emergency radio communication system. To minimize the capital investment required in fixed stations, an agreement was reached whereby the three gas companies could share the use of three of the Edison Company's fixed stations located in Los Angeles, Orange, and Ventura Counties. Apart from the saving in the costs, this arrangement is very desirable since there is only one radio network in this area instead of four separate networks. Consequently, there is a minimum of interference over the air.

The three gas companies also collaborated in the purchase of their radio equipment. The same designs and specifications were used by all three companies, and by combining their orders it was possible to obtain custom-built equipment from a Los Angeles manufacturer at reasonable costs. Although the individual gas company each owns and operates its own radiotelephone emergency units, the dispersal of the sets in the various districts takes into consideration the requirements of all three companies; thus duplication is avoided and maximum use is made of the available equipment.

During times of general emergency, the gas companies and the Edison Company combine their radio facilities to form a system of mutual benefit to all concerned. Messages for transmittal over the Edison Company's 50-watt fixed stations are relayed from the gas company offices either through public or private telephone channels or over the air from mobile units. The Southern California Edison Company operates a rather complete radio network comprising several fixed stations, each of which has a number of mobile units operating in conjunction with it. This system gives them 24-hour emergency radio service over the major part of the area served. The gas companies do not intend to provide such complete coverage of their territory because of:

1. The excessive cost due to the large area involved, and

2. The limited number of gas company emergencies where radio communication is necessary.

EMERGENCY OPERATIONS

Fig. 1 shows graphically how with relatively few pieces of radio equipment it is possible to set up an independent communication network through which information can be relayed quickly from a remote point in the mountains to the general office in Los Angeles. In this example, it is presumed that the broken pipeline is located in inaccessible hills in Ventura County. The emergency truck has towed the 50-watt trailer to a point as near as possible to the site of the break, and the portable units have been carried to opposite sides of the canyon where the break occurred. Since the 50-watt trailer can operate on both ultra-high frequency (33,060 kilocycles) and medium frequency (2292 kilocycles), it acts as a control station for the units operating in the vicinity of the line break. The control station is capable of relaying information from the two-watt sets on the opposite banks of the canyon or from nearby 15-watt units to either the Ventura County district headquarters or the general office in Los Angeles. This is done through the Southern California Edison Company's 50-watt fixed station and the telephone company's facilities. There is very little likelihood that all the telephone circuits between the Edison Company's fixed station and the gas company offices would be out of order at the same time. However, if this possibility did occur, the gap would be bridged by stationing a 15-watt mobile unit at the gas company office. The diagram, Fig. No. 1, serves to illustrate how it is possible to fulfill the requirements for short-range, medium-range, and long-range communications, using a limited number of pieces of equipment.

There has been no major catastrophe in the gas company territory since the emergency radio system was organized. The value of the plan has been amply demonstrated by several minor emergencies, however. In January of 1943, severe rains threatened to wash out an important pipeline river crossing in Ventura County. During this time the telephone lines between Ventura and Los Angeles were out of service because of the storm.

It was very important to the Los Angeles gas dispatcher to know the probability of the pipeline being broken at the river. A truck with a 15-watt two-way radio set was stationed at the river bank to observe the flood conditions. At regular intervals this information was relayed through the Edison Company's stations to Los Angeles through the system illustrated by Fig. No. 1. Fortunately, the river did not rise sufficiently to carry away the pipeline. In cases of this kind, the gas dispatchers and the operating crews can work with confidence, since they know at all times the conditions at the vulnerable points in their supply system.

In another district during this same storm, a repair crew was standing by, with men stationed at opposite sides of a river where rising waters threatened to break the pipeline. These repair crews were supplied with equipment for quickly installing a temporary bypass across the stream, should the main line be carried away. Two-watt portable radio sets were used to communicate between the parties on the opposite sides of the stream. Fortunately, the storm subsided before any damage was done.

The radio equipment has been very useful in providing communication between different field crews who may be taking a portion of a major transmission line out of service for a short time in order to install a valve, clean the interior, repair leaks, etc. Since it is imperative that service to the consumers be uninterrupted at all times, valves at each end of the section to be taken out of service are closed to isolate it from the main line. Consumers served normally by the section which will be out of service are supplied with gas from small portable high-pressure storage tanks which are similar to welding gas tanks. Consumers downstream from the section of transmission out of service are supplied through the "line pack" or gas stored in the line. Naturally, when the main line valves are closed, the gas pressure in the section downstream from the closed valves gradually drops. If the repair party does not complete the repair operation in the scheduled time, there is danger that the downstream pressure will drop so low that service to the consumers is interrupted. Here again the emergency radiotelephone equipment fills an urgent need, since main transmission pipelines are frequently located in undeveloped territory far removed from good roads and public telephone service. Information concerning the pressure at the downstream side of the closed valve can be relayed rapidly to the crews working on the pipeline, and if the pressure becomes so low as to endanger the service to the consumer, repair operations can be halted and orders dispatched by radio to the valve crew at the upstream end of the section.

There are innumerable other ways in which a small emergency communication system can be helpful to a public service company. The emergency radio system described in this article was planned long before the present war started; therefore, it was not designed particularly for war emergency service. It is indeed fortunate that this system was built up prior to the war, since it will be invaluable in case of actual trouble in this area. When peace comes to this country, and civilians are permitted again to purchase items that are now reserved for the fighting forces, the gas companies plan to continue the growth of their emergency radio system by adding mobile units and a few fixed stations. Until the happy day of victory arrives, however, it will be necessary to continue to make the best use of the equipment on hand.

SYMPOSIUMS ON SYNTHETIC RUBBERS AND PLASTICS

THE increased production of synthetic rubbers has led to a demand for authoritative technical data and information on the applications and uses of these materials. In answer to this need the spring meeting of the American Society for Testing Materials will feature a symposium on this subject at Cincinnati, Ohio, on March 2. Many experts will present papers dealing with development, properties, testing, specifications, processing and uses of synthetic rubbers. Except in so far as necessary for background information the speakers do not plan to deal with the chemistry or manufacture of the crude synthetics.

On the evening following the A.S.T.M. meeting J. L. Collyer, president of The B. F. Goodrich Company, will speak before the Technical and Scientific Society Council of Cincinnati. He will discuss the development of synthetic rubbers and some of the economic and industrial aspects of this field.

The A.S.T.M. Philadelphia District Committees are to hold meetings on February 21 to 24 to discuss the subject of plastics. This is the first symposium on plastics since 1938 and there have been many notable developments in the field since that time. Many leading technical people in the industry will participate in the symposium, and a feature of the program will be the presentation of data on the leading plastic families by Dr. G. M. Kline, of the National Bureau of Standards. His paper will be based upon data obtained by seven technologists. Many important topics concerning the properties, testing, and uses of plastics will be presented by technologists of several industrial concerns and research laboratories.

The Society has announced that it is planning to issue the symposiums in the form of bound publications.

George Washington, Engineer

(*Continued from Page* 3)

degree and after having submitted a satisfactory thesis describing engineering work performed. Examination of the candidate by a board of examiners also is recommended.

The possession of a degree does not make a man something that he is not. If high standards are maintained by the degree-giving institution, the degree may be a symbol of true attainment. However, many who do not possess degrees are as competent—if not more so—than some who insist on placing letters after their names. A true measure of professional ability might lie in "solid information and sound judgment" as this phrase was exemplified in Washington.

ERRATUM

Attention of the editors of *Engineering and Science* has been called to an error in the item appearing on page 19 of the January issue. Aristotle D. Michal was elected associate secretary, not vice-president, of the American Mathematical Society.

The secretary, J. R. Kline, has also requested that a statement of the aims of the Society should read as follows:

> "The American Mathematical Society is an organization to encourage and maintain an active interest in mathematical science. Its primary object is the promotion of mathematical research. To attain this, it conducts meetings for the presentation of research papers and maintains a publication program of mathematical journals and books on current research."

PORTABLE HANGARS

AIRPLANE hangars of portable design and construction have been developed by U. S. engineers and army air forces for use in combat zones.

Transverse lightweight steel bents are used to support canvas roof covering. The first building constructed on this principle was a combat hangar 130 feet by 160 feet with a clearance height of 39 feet. A three-inch arch truss, tied at the base, forms each transverse bent. The relatively light weight of this temporary hangar permits it to be flown to the erection site complete in all necessary details. Trusses can be erected or dismantled by unskilled labor, and the hangars are easily camouflaged. Although of substantial construction the hangars are fabricated in such a way as to be fairly resistant to explosion. All truss members are made identical wherever possible to decrease the number of different pieces required. In order to reduce shipping space requirements, trusses are required to be shipped one inside the other.

Flame-proofed canvas covers the hangars. It is light in weight, can be easily transported by air, may be erected quickly, is resilient to explosion force, and may be easily repaired. Canvas sections are prefabricated and assembled on the job by lacing, similar to the procedure on large circus tents. Webbing reinforcements, sewed to the canvas section, carry the roof load to the steel frame truss. Each webbing ends in a steel ring, from which points (called pickup points) the canvas is suspended.

Pulleys are fastened to the bottom chords of the trusses at locations corresponding to pickup points on the canvas sections. Ropes, attached to the pickup points on the canvas, run over the pulleys, then parallel to the bottom chords over sheaves provided for that purpose, and are secured to rope cleats on the truss about four feet above the ground.

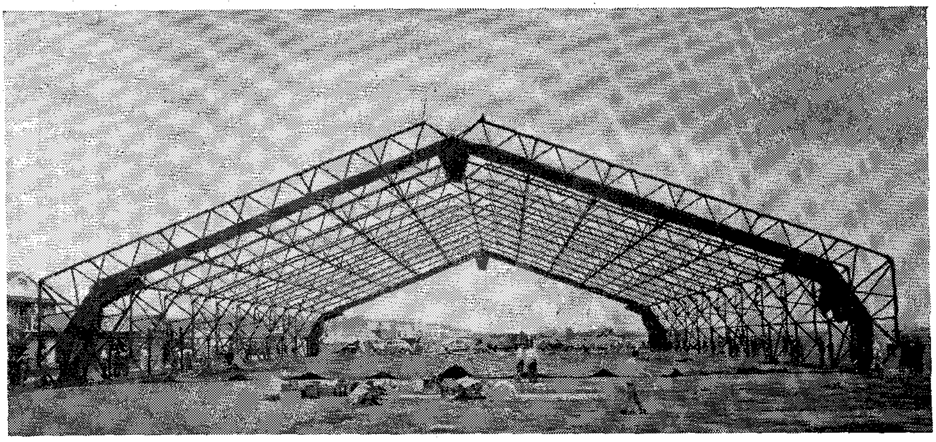


FIGURE 1. After the steel trusses are in place, the canvas roof is assembled on the ground, then raised as a unit.

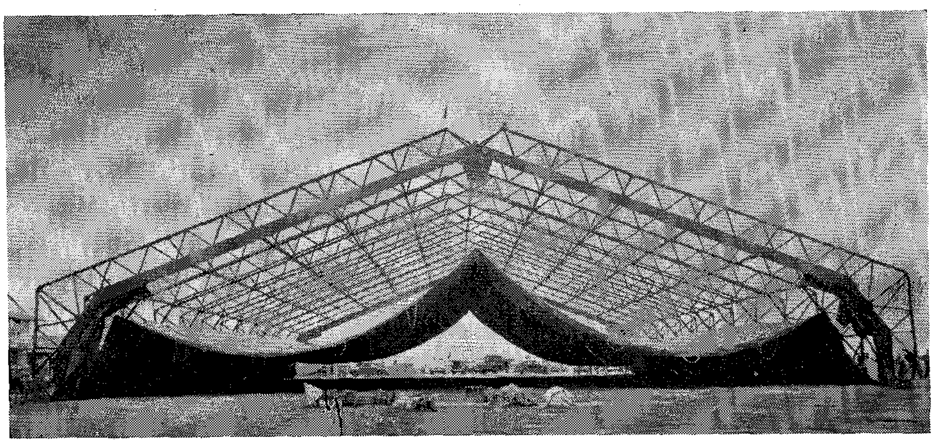


FIGURE 2. After the flame-proof canvas roof has been assembled on the floor of the hangar, it is raised to position as one unit. Ropes fastened to the canvas pass over the pulley on the truss along the bottom chords and over the sheaves to workmen on the ground.

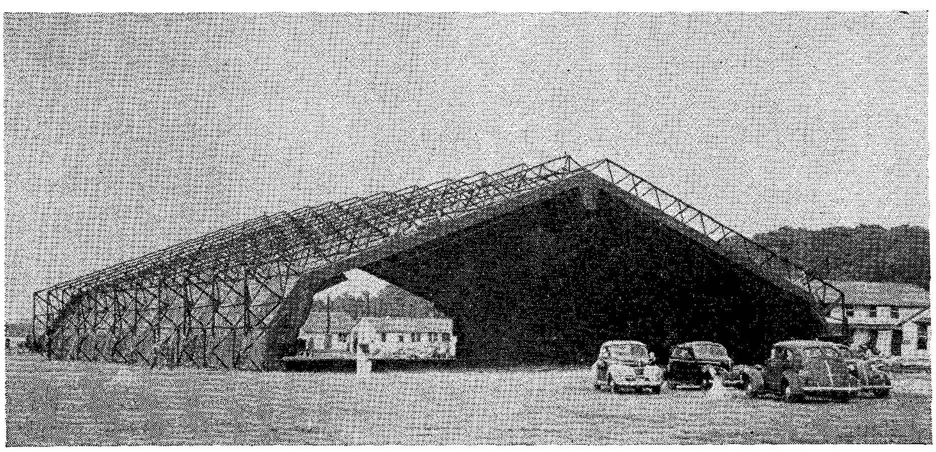


FIGURE 3. Portable airplane hangars with lightweight steel trusses used for combat duty by the U. S. Army Air Forces.

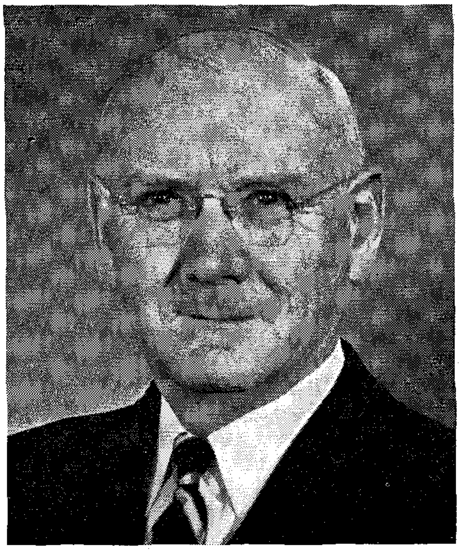
Canvas also incloses the ends of the building. Each inclosure is in two halves and the tops of the chains are suspended by a trolley arrangement from a track, which in turn is secured to the bottom chord of the end truss. When this canvas is released, the doors are opened by gravity to almost full size. To permit a minimum amount of drag on the ground, the center or high part of the canvas is draped as it is lowered.

In addition to being used as a combat airplane hangar, this type of structure is being adapted for other uses such as barrage balloon repair units, recreation buildings, auditorium and training shelters. Another important feature is that whenever insulation is required for extreme cold weather or heavy snowfalls, an ordinary wood or steel roof can be applied to the top chord of the trusses without affecting the installation of the suspended canvas, since it is attached to the underside of the trusses. Consequently, even though these structures are intended primarily to be temporary, they can be converted easily into permanent buildings.

C. I. T. NEWS

ELECTED A.S.C.E. VICE-PRESIDENT

Professor Franklin Thomas was elected vice-president of the American Society of Civil Engineers, to represent Zone IV, the 11 western states, western Canada and Mexico. Professor Thomas is a past-president of the Los Angeles Section and was National Director from District 11 from 1930 to 1933. He served from 1922 to 1933



PROF. FRANKLIN THOMAS

on the special Committee on Irrigation Hydraulics, and in 1937 as chairman of the Committee on Accredited Schools.

Franklin Thomas began his long service at the California Institute of Technology in 1913 as associate professor of civil engineering, becoming professor in 1915 and subsequently being identified with many faculty administrative duties. He was commissioned in the Engineer Corps Reserve in 1918. Since 1924 he has been chairman of the Division of Civil and Mechanical Engineering, Aeronautics and Meteorology at Caltech.

Professor Thomas has been active in public affairs and has engaged in many services to the community. He has been vice-chairman of the board of directors of the Metropolitan Water District of Southern California since permanent organization of the District in 1929. He was awarded the Arthur Noble Medal for distinguished service to the city of Pasadena.

INSTITUTE RECEIVES BEQUEST

The will of Laurabelle Arms Robinson, pioneer resident of Pasadena and widow of the late Henry M. Robinson, banker, philanthropist and long-time trustee of the California Institute, was filed for probate December 9, 1943.

After disposing of cash gifts to friends, relatives and institutions to the extent of $285,000, the will gives the residue of the estate to the California Institute of Technology, the income to be used for designated or general research as shall be considered most desirable by the Institute's trustees.

It will be recalled that the Charles Arms Laboratory of the Geological Sciences was the gift of Mr. and Mrs. Robinson in memory of Mrs. Robinson's father, for whom the laboratory was named.

COMMITTEE ON POSTWAR PROBLEMS

ONE of the most active non-governmental organizations in the United States for the discussion and analysis of postwar problems is the Universities Committee on Post-War International Problems. This committee, headed by Professor Ralph Barton Perry of Harvard University, is composed of college and university faculty members in approximately 125 institutions throughout the country. The agenda for the periodic discussions are prepared by the Harvard Committee and distributed in pamphlet form to the various member groups about once a month. The list of postwar problems considered includes among others the following topics: treatment of the defeated nations, economic aspects of the peace, the problem of minorities, collaboration between the United Nations, the disposition of colonies, and education.

Each group studies the problem presented in the pamphlet and the results of the discussion are summarized by the group chairman and forwarded to the central committee at Harvard. There the reports are studied, correlated, and tabulated. The Harvard Committee may use this information in any manner that seems appropriate at the time—by publication, or by presenting it to the proper agency in Washington.

The group at the California Institute of Technology is composed of 32 active members from the staffs of the Institute, the Mount Wilson Observatory, the Huntington Library, and also a few outside members. Included in the group are Dr. Edwin F. Gay, a member of the Central Committee, and also a Vice-Chairman active in organizing the group, and Dr. Robert A. Millikan, a sponsor of the Central Committee. Professor Clinton K. Judy is chairman of the Pasadena organization.

WARTIME ATHLETIC PROGRAM

WITH four distinct Institute groups conducting a strong physical training program, Tournament Park is the scene of great activity throughout the day. The program of each group is entirely separate and is administered by its own staff.

At 6:10 A.M., the 535 V-12 men start the day with 15 minutes of calisthenics. Six other periods during the day are devoted to the program of these men. The civilian students use the fields four periods daily for a conditioning program consisting of calisthenics, obstacle course, distance running, and intramural games. At

3:30 P.M. the 120 Naval officers who are taking courses in aeronautics and meteorology are on the field for an hour for their intramural sports program under the direction of Ensign Kristovich, while the 150 Army Air Corps cadets supervised by Lieutenant Harold Selm report at 5:30 P.M.

The Navy has provided a staff of six men to supervise and conduct their V-12 program. They are Lieutenant (j.g.) Stanley F. Murphy, Chief Specialists Arthur O. Dillenbeck, Marburg T. Lundstrum, Gene Mako, Dan Miranda and Lloyd Morris. All of these men have had considerable experience in this line of work.

Each V-12 student, in addition to his early morning exercise, has one other hour of physical education daily. All men report for swimming one hour each week at the Pasadena Junior College pool, and those who are not proficient in swimming report three days each week. Here the men receive fundamental and functional swimming instruction and participate in abandoning ship and rescue drills. On days when not engaged in swimming, men report to Tournament Park. For the first semester, the periods in the field were devoted to calisthenics and general conditioning exercises. This semester, more time has been devoted to sports. Men whose average was in the upper 70 per cent of the physical fitness tests given at the end of the semester may now participate on intercollegiate and intramural teams instead of reporting for classes.

With all men enrolled in school now eligible for intercollegiate teams, we have had an unusually large number reporting, and for the first time in years, squads had to be cut. About 80 per cent of the men remaining after the cut are V-12 men, which is a little higher ratio than that between the enrollment of V-12 and civilian men.

Regular intercollegiate teams have been maintained this semester in basketball, water polo and cross country with contests scheduled with Oxy, Redlands, U.S.C., U.C.L.A., Pepperdine and various service and club teams. No events will be scheduled for spring sports until the opening of the first semester of the new school year on March 6.

With the V-12 students occupying the student houses, interhouse contests for civilian students have been suspended for the duration. However, intramural leagues are provided for these men in a variety of sports. The V-12's organize their own intramural program, organized by platoons (alleys) and companies (houses).

CALTECH SAFETY DIRECTOR

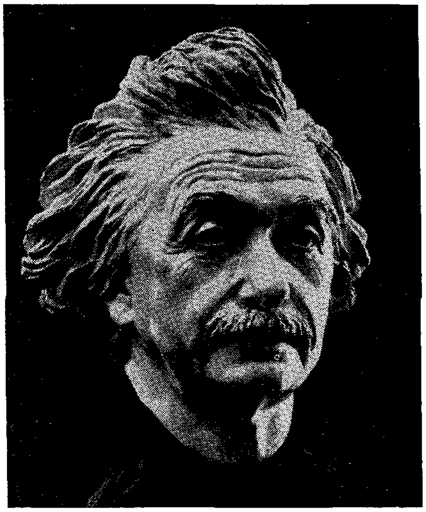
ALUMNI coming back to the Institute may notice that the buildings are now liberally supplied with fire extinguishers. These are a part—and only a very small part—of the work of Lieutenant Colonel Charles L. Wyman, U.S.A. (Ret'd.), who for some time now has been filling the post of safety director. Colonel Wyman joined the Institute staff in July, 1942; and when the war activities and the personnel of the Institute had expanded to the point where safety measures required the full attention of a special official, he was appointed to his present post.

Working directly with local Civilian Defense and particularly with the Southern Security District of the Army, which has general supervision of internal security in this area, Colonel Wyman's work is mainly concerned with accident and fire prevention. The Caltech fire station, which will be described in the next issue of *Engineering and Science Monthly*, was built largely through his instrumentality as part of the campus safety program.

Colonel Wyman is a West Point graduate, class of 1907. He served as a Signal Corps officer in France during World War I, and was with the Army of Occupation in Germany. Retired in 1920, he was later commanding officer of R.O.T.C. units in Cheyenne, Wyo., and in Los Angeles at Franklin and Loyola High Schools.

BUST OF EINSTEIN PRESENTED TO INSTITUTE

ELEANOR PLATT of New York City, well known sculptress, who made the bust of the late Justice Brandeis which was recently presented to the Supreme Court of the United States, has completed a bust of Dr. Albert Einstein. The original work eventually will go to Palestine, but will be on display at the Metropolitan Museum of Art in New York until the close of the war.



There are to be three or four bronze replicas made of the bust, and the first one has been presented to the California Institute of Technology because of the nature of the work done at the school and also for the reason that the Institute was first to offer its hospitality to Dr. Einstein when he arrived in America. The bust was donated by Haight, Goldstein and Hobbs of Chicago.

WHO'S WHO LISTS TECH MEN

Fifteen Caltech students are among those listed in the 1943-44 issue of "Who's Who Among Students in American Universities and Colleges." The book will be released in April.

This publication is compiled through the cooperation of over 600 American universities and colleges. It is the only means of national recognition for graduates which is devoid of politics, fees and dues. These books are placed in the hands of hundreds of companies and others who annually recruit outstanding students for employment.

The purpose of the book is to serve as an incentive for students to get the most out of their college careers, as a means of compensation to students for their accomplishments, and as a recommendation to the business world.

COMMENCEMENT FEBRUARY 18

BECAUSE of the Institute's accelerated program of instruction, the current school year will end in February, and the next Commencement exercises will be held on Friday, February 18 at 4 p.m. Since this season of the year makes the customary outdoor Commencement rather risky, Institute authorities have arranged to hold the exercises in the Pasadena Civic Auditorium on East Green Street.

The Commencement address will be given by Rear Admiral Wilson Brown, U.S.N., Naval Aide to President Roosevelt. Admiral Brown, who earlier commanded a Task Force in the Pacific, will speak on "The Nation's Accomplishments During Two Years of War in the Fields of Research, Production and Engineering."

The invocation and chaplain's address will be given by Lloyd C. Douglas, author of the current best-selling novel, *The Robe*. The members of the Caltech V-12 Unit will attend the Commencement exercises, and the V-12 band will supply the music.

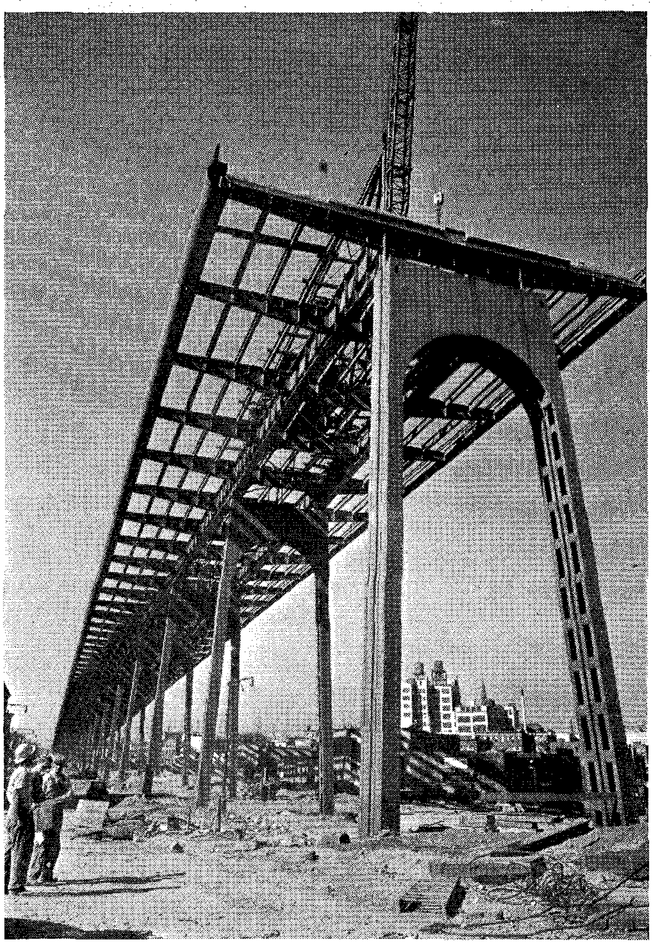
The public is invited to attend.

California Institute of Technology

ALUMNI SEMINAR

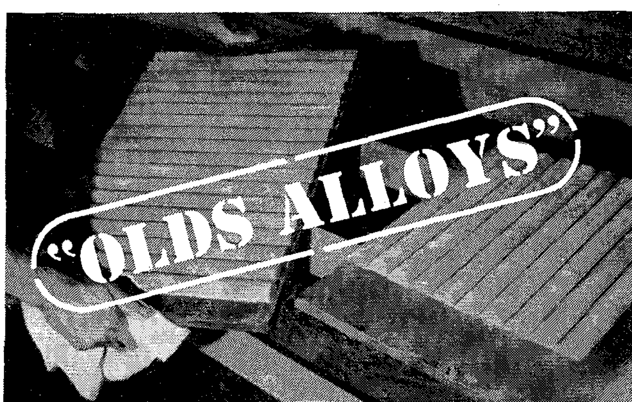
April 16, 1944

Watch for Announcement in March issue



ELEVATED HIGHWAYS

DURING the past few years changes in trends in mass transportation in New York have made a number of elevated railways unprofitable to operate. Some of these discarded elevated tracks have been scrapped. However, instead of tearing down the obsolete railway structure on Third Avenue, Brooklyn, New York, it is being converted to be used as an elevated automobile highway for rapid transit, and now forms a part of the Gowanus elevated highway of New York.



PERSONALS

1921

ERNEST H. MINTIE, west coast manager of La Salle Designing Company of Chicago for over a year, finds it an interesting experience as the company has been designing tools for all the latest type aircraft. He was previously in the building material business.

1924

LIEUTENANT COLONEL GRANT V. JENKINS, chemical officer, Northern California Sector, Western Defense Command, is stationed at the Presidio in San Francisco.

1925

FRANK C. A. CLAYTON served in a consulting capacity on the original plant design of the Fort Worth Plant of Consolidated Vultee Aircraft Corporation and since December, 1941, has been plant engineer. This plant is reputed to be the "World's Largest." He is in charge of design and construction of all facilities and buildings, operation of utility systems, including steam generators and air conditioning system of over 12,000 ton capacity, and maintenance of all buildings, equipment, grounds, and production machines. He is the father of a year-old son.

1926

WILLIAM PORUSH is on loan from the firm of E. C. Taylor, architects and engineers, in Los Angeles, and is now with Bechtel, McCone and Parsons Corporation, engineers, in Los Angeles.

DIMITRI MELNIKOV is now a lieutenant in the Navy, having taken the oath on November 2. He has been training at Camp Peary, Va., with the Seabees.

1927

JOHN CASE is now employed by the Southwest Welding Company in Alhambra.

FRANK S. HALE, a captain in the Corps of Engineers, is now in England.

LIEUTENANT COLONEL THEODORE C. COMBS is stationed at the Engineering Unit Training Center at Camp Claiborne, La. He spent Christmas with his family in Upland, Calif.

1928

PERRY BANTA is the assistant chief of the engineering division, U. S. Engineer Office, Mobile, Ala. His new responsibilities include site investigations, personnel administration, and unusual jobs, such as his current one of supervising arrangements for the installation of a 30,000 KW floating power plant.

1929

LIEUTENANT COLONEL W. H. MOHR attended the last class of the Command and General Staff School at Fort Leavenworth, Kan. The first of December he was transferred to Camp Van Dorn, Miss.

LEONID V. LEONARD is back in the main office of Shell Oil Company, Inc., after having spent 18 months at the Shell Wilmington Refinery where he helped build the "Cat" Cracking Unit, the first one on the Pacific coast.

ALFRED E. TOWNE is with Associated Broadcasters, Inc., San Francisco, as chief transmitter supervisor for International Short Wave Broadcast transmitters, KWID, KWIX, and Standard Broadcast KSFO. He has two children, a girl and a boy.

1930

EDWARD M. THORNDIKE is now an associate professor of physics at the University of Southern California.

CAPTAIN LAWRENCE NYE is now at 20 East Dorothy Lane, Dayton, Ohio.

NATHAN D. WHITMAN, JR., is assistant chief of structures, Avion, Inc., Los Angeles.

1931

LIEUTENANT LAWRENCE KINSLER, U.S.N.R., is instructor at the U. S. Naval Academy at Annapolis, Md.

DR. CHARLES KIRCHER is temporarily stationed at the University of Chicago, doing research for the duPont Company by whom he is regularly employed. In April or May he will go to the Big Bend of the Columbia River for permanent location. He has a son, Christopher, 15 months old.

TED FALLS is located in Flossmoor, Ill., and is the father of a son, William, born November 17.

1932

HAROLD ROACH is president of the Iron-wood Company in Los Angeles doing fabricated timber construction work for the Army and Navy.

CHARLES D. CORYELL has been with the Metallurgical Laboratory, University of Chicago, but is now with Clinton Laboratories, Knoxville, Tenn.

BRIAN O. SPARKS is flying seaplanes for American Export Airlines to Natal as a captain. He is also a technical pilot.

1933

LAURENCE K. GOULD has just completed his third year in the state of Texas representing Cosgrove and Company, Inc., insurance brokers of Los Angeles. Most of his time is now devoted to insurance and safety problems of the Consolidated Steel Navy Shipyard at Orange, Texas. Mr. and Mrs. Gould are parents of a second daughter, Marjorie Laird Gould, born October 26.

1934

ENSIGN GLEN E. WOODWARD has been stationed in Washington, D.C., for several months. His wife and five-months-old baby are with him.

BOB ANDERSON was reported in a recent issue as being a lieutenant (j.g.) stationed in New Guinea. However it has been learned that he is not in the Navy and has never been in New Guinea. He is assistant engineering manager of the Detroit office of Douglas Aircraft Company.

1935

LIEUTENANT FREDERICK PEHOUSHEK, U.S.N.R., is with the Bureau of Ordnance, Navy Department, Washington, D.C. He is the father of a five-month-old daughter, Carol Ann.

CHARLES F. THOMAS recently moved to his new home at 4416 Arcola Avenue, North Hollywood. He has been associated with Lockheed since 1935 and for the past year has been assistant contract officer.

GREER FERVER is chief engineer of the National Iron Works in San Diego. The shop is now building barges and ships' machinery. Mr. and Mrs. Ferver are the parents of a 10-month-old daughter, Barbara Lee.

1936

JOHN LEGGE, JR., is now employed by the United Geophysical Company and lives in Pasadena.

1937

LIEUTENANT H. H. MILLER is in the Medical Corps and is stationed at Deming, N. M. He is the father of a son, Harry H. Miller, Jr., born last September.

LIEUTENANT (j.g.) T. S. HARPER is medical officer on the U.S.S. Beaumont.

CLAUDE B. NOLTE was transferred in September by the Fluor Corporation to Kansas City to establish a Fluid Dynamics Department at their Kansas City office, and he has been retained there to run the department. Much of his time is spent in development work relative to the more economical design of refineries. Mrs. Nolte is recovering from a serious operation. Mr. Nolte would like to contact any alumni living in the Kansas City area. His address is Box 2389, Kansas City 13, Mo.

1938

HOWARD S. SEIFERT has been assistant project engineer on a war project at the Institute since September, 1942. He has two daughters.

ENSIGN JOHN R. BAKER is studying aeronautical engineering at M.I.T. He and his wife are living at 24 Chauncey Street, Cambridge.

STAFF SERGEANT JOSEPH F. WESTHEIMER is with the First Motion Picture Unit, A.A.F., Culver City, Calif., as a cameraman in the Special Photographic Effects Department. He is doing the same type of work as in civilian life when he was with Warner Brothers.

WILLIAM F. NASH is the father of a daughter, Janet Anne, born December 15. He is instructor in physical metallurgy at the Institute.

1939

RONALD CONNELLY is working in San Francisco for the Mare Island Navy Yard, planning shipboard radio installations. He has been employed there for three and a half years and a recent promotion gives him the rating of radio engineer.

JOSEPH WEINSTEIN is an electrical engineer under the supervisor of shipbuilding, U. S. Navy, Terminal Island, Calif.

J. EUGENE STONES is party chief of a Superior Oil Company seismograph party at Seminole, Texas. He has two children, a boy and a girl.

DUANE W. BECK was formerly with Solar Aircraft Company in San Diego, but for the past year has been with Douglas Aircraft Company, Inc., Long Beach, as assistant standards engineer. He has two sons, Danny, two-and-a-half years old, and Tommy, six months old.

EDWIN F. SULLIVAN is an assistant engineer with the U. S. Bureau of Reclamation in the Division of Project Planning. He is working on investigation of possible projects for extension of the Central Valley Project. He has a daughter, Caroline, a year and a half old.

1940

LLOYD GOODMANSON, a former Associated Student Body president at Tech, visited the campus during December while on business for Boeing Aircraft Company in Seattle.

GORDON WEIR is a major somewhere in Africa.

GEORGE F. WHEELER is employed as a staff member of the Radiation Laboratory at M.I.T.

LIEUTENANT (j.g.) HOWARD W. REYNOLDS spent Christmas in the South Seas. He is in weather control work.

1941

RICHARD SILBERSTEIN is a sergeant with a T-3 rating with the Engineers at Fort Screven, Ga. His company recently completed Lazareth Creek Dock there and it was filmed by Paramount News.

WILTON A. STEWART is working in Plant Engineering, Lockheed Aircraft Corporation. He is married and has one son.

EUGENE A. LAKOS is a lieutenant (j. g.) in the Navy, now stationed in Florida.

LIEUTENANT WILLIAM SCHUBERT is doing petroleum research at Annapolis.

LIEUTENANT REUBEN P. SNODGRASS, U.S.M.C.R., was commissioned a second lieutenant at Corpus Christi and a first lieutenant at Camp Kearney, where he is now stationed.

GENE EDWARDS is an ensign in the Navy, has completed Radar School, and is now in Texas awaiting a further assignment.

ENSIGN ROBERT B. GALESKI, U.S. N.R., is stationed at present in San Diego.

LIEUTENANT HARRY W. LEW, U.S. A.F., of the Signal Corps is now in Burma.

FRANK H. SKALECKY spent Christmas in Los Angeles. He was on his way from the South Pacific to Washington, D.C.

1942

LIEUTENANT (j.g.) WILLIAM T. HOLSER was ordered from the South Pacific to attend school at Princeton. He was married last spring and his wife is now with him.

LIEUTENANT (j.g.) FOREST CLINGAN, U.S.N.R., has been in Washington, D.C., for the past year. He recently passed through San Francisco on his way farther west. He is the father of a baby girl, Susan.

LIEUTENANT (j.g.) HENRY W. MENARD spent Christmas in Los Angeles. He was on his way from the South Pacific to Washington, D.C.

ENSIGN CAROL M. VERONDA, U.S. N.R., is at Fort Schuyler, N. Y. He expects to go to Bowdoin College in Maine and the Massachusetts Institute of Technology in Cambridge before being assigned to active duty.

JOHN A. BROCKMAN, JR., is conducting research on an N.D.R.C. project in the chemistry department at the Institute.

KENNETH URBACH is a lieutenant in the Army. He was married in September to Miss Helen Marie McIntosh at Lake Hiawatha, N. J.

DR. W. K. F. PANOFSKY and Mrs. Panofsky, the daughter of Dr. Jessie DuMond of the Institute staff, are the parents of twins, a boy and a girl, born in October.

1943

ENSIGN HERBERT LARSEN, after completing training on the U.S.S. Prairie State in New York City, went to the Submarine School at New London, Conn.

ENSIGN EVERETT MACARTNEY completed his training at Fort Schuyler, N. Y., and San Diego, and is now at the Submarine Base, New London, Conn.

ENSIGN ROBERT BASHOR has completed training on the U.S.S. Prairie State and has been assigned to a destroyer on the east coast.

ENSIGN DOUGLAS RIED has completed his training on the U.S.S. Prairie State and has been assigned to a destroyer on the Pacific.

ENSIGN ORIN J. MEAD is attending Radar School at Harvard after having completed his indoctrination course at Notre Dame.

ENSIGN RICHARD A. SUTTON has been taking a deck officers' training course at Cornell University.

7 things you should do to keep prices down!

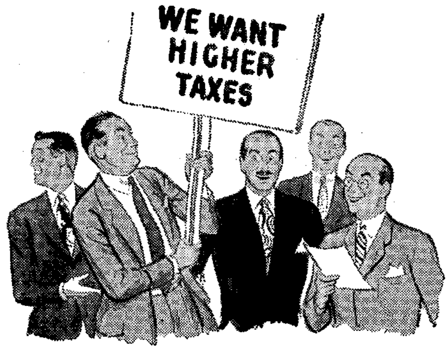
If prices soar, this war will last longer, and we could all go broke when it's over. Uncle Sam is fighting hard to keep prices *down*. But he can't do it alone. It's up to *you* to battle against any and every rising price! To help win the war and keep it from being a hollow victory afterward—you must *keep prices down*. And here's how you can do it:

1. BUY ONLY WHAT YOU NEED

Don't buy a *thing* unless you *cannot* get along without it. Spending can't create more goods. It makes them scarce and prices go up. So make everything you own last longer. "Use it up, wear it out, make it do, or do without."

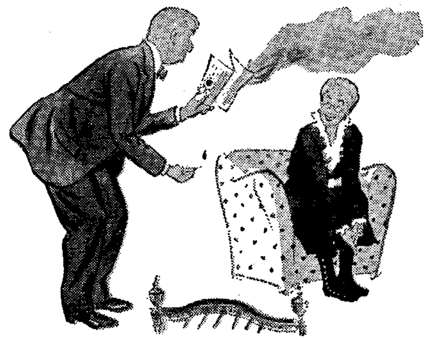
2. PAY NO MORE THAN CEILING PRICES

If you do pay more, you're party to a black market that boosts prices. And if prices go up through the ceiling, your money will be worth less. Buy rationed goods only with stamps.



3. SUPPORT HIGHER TAXES

It's easier and cheaper to pay for the war as you go. And it's better to pay big taxes *now*—while you have the extra money to do it. Every dollar put into taxes means a dollar less to bid for scarce goods and boost prices.

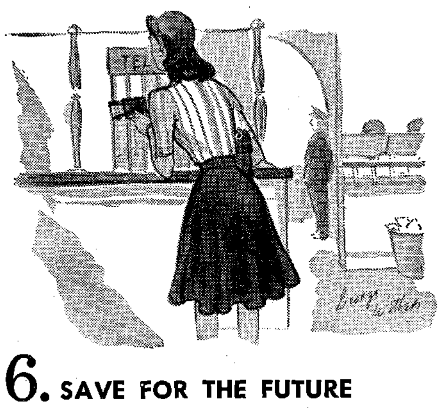


4. PAY OFF OLD DEBTS

Paid-off debts make you independent now . . . and make your position a whale of a lot safer against the day you may be earning less. So pay off every cent you owe—and avoid making new debts as you'd avoid heiling Hitler!

5. DON'T ASK MORE MONEY

in wages, or in prices for goods you have to sell. That puts prices up for the things all of us buy. We're all in this war together—business men, farmers and workers. Increases come out of everybody's pocket—including *yours*.



6. SAVE FOR THE FUTURE

Money in the savings bank will come in handy for emergencies. And money in life insurance protects your family, protects you in old age. See that you're ready to meet any situation.

7. BUY WAR BONDS

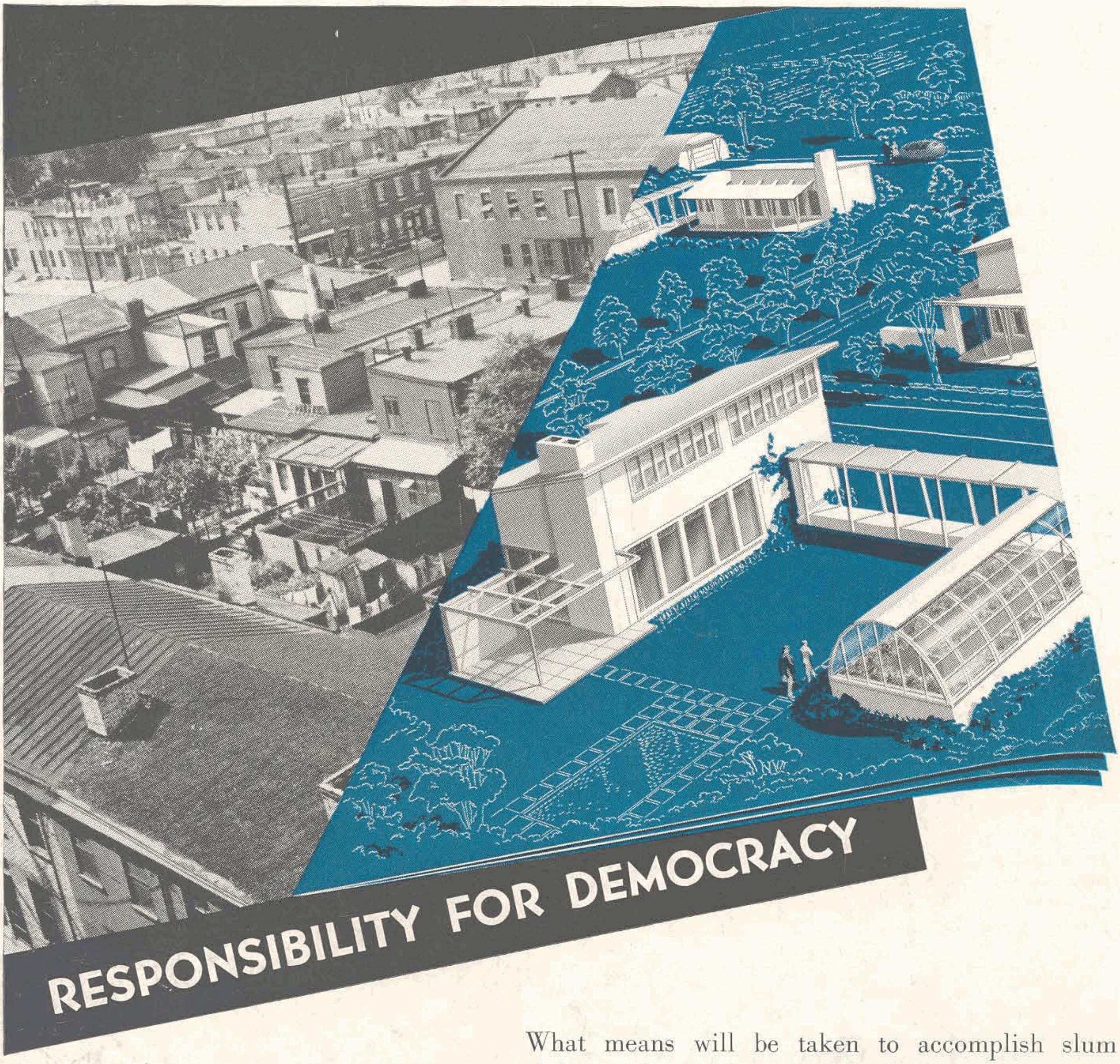
and hold them. Buy as many as you can. Then cut corners to buy more. Bonds put money to work fighting the war instead of letting it shove up prices. They mean safety for you tomorrow. And they'll help keep prices down today.

KEEP PRICES DOWN . . .

Use it up . . . Wear it out . . .

Make it do . . . Or do without.

This advertisement, prepared by the War Advertising Council, is contributed by this magazine in cooperation with the Magazine Publishers of America.



What means will be taken to accomplish slum clearance in the post-war world have not yet been determined. Yet accomplished it must be, for on a decent standard of living depends much that is vital to the future of democracy.

Versatile and efficient, Stran-Steel framing systems provide the building industry with an effective medium of construction for all types of housing developments. They speed erection, safeguard the building investment, and lend themselves to the application of modern methods and materials. Stran-Steel's engineering experience, greatly increased by large-scale wartime assignments, will be at the service of architects and contractors.

Manufacturer of the U. S. Navy's Famous **Quonset Hut**

STRAN STEEL

DIVISION OF GREAT LAKES STEEL CORPORATION
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