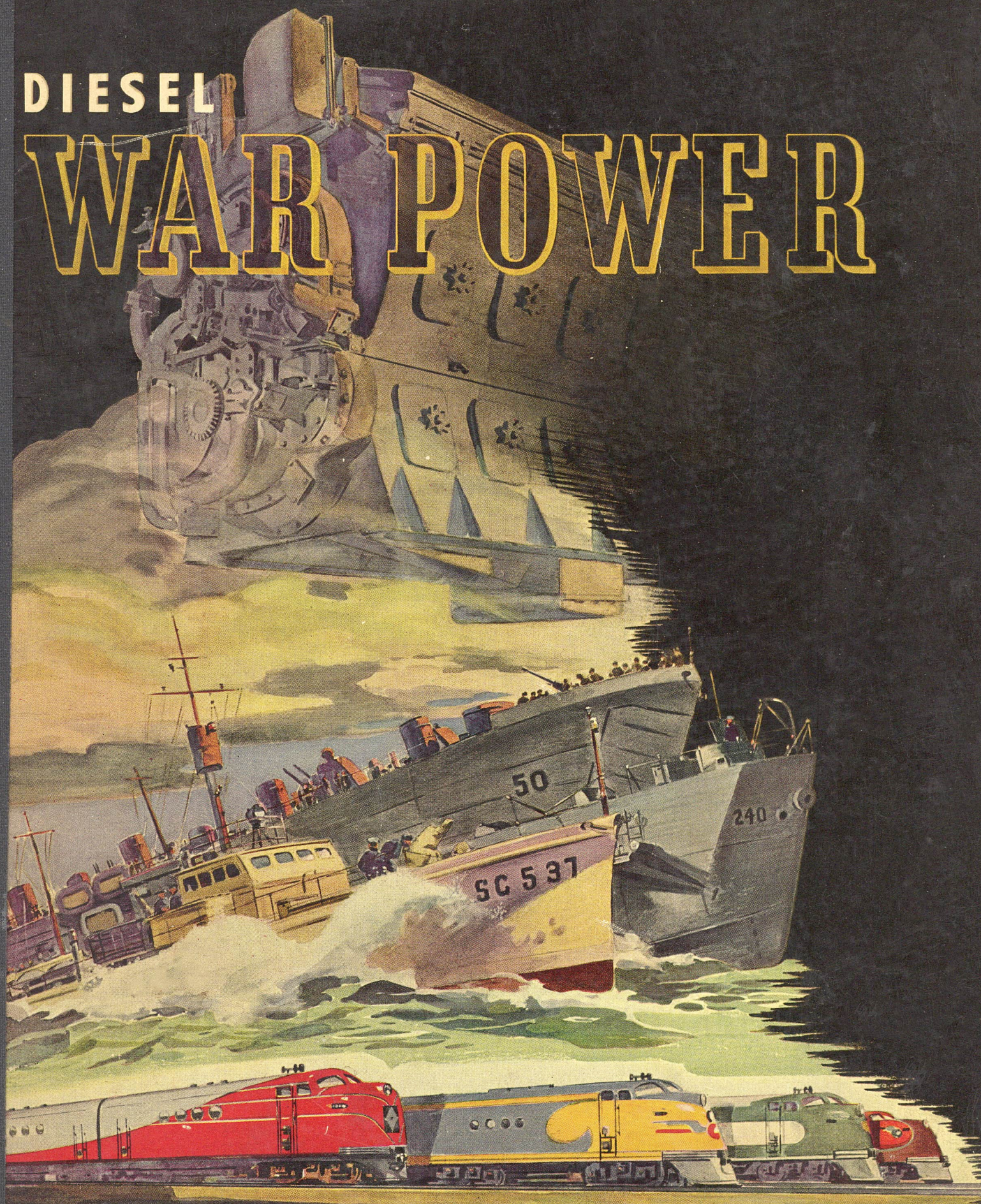


DIESEL

WAR POWER

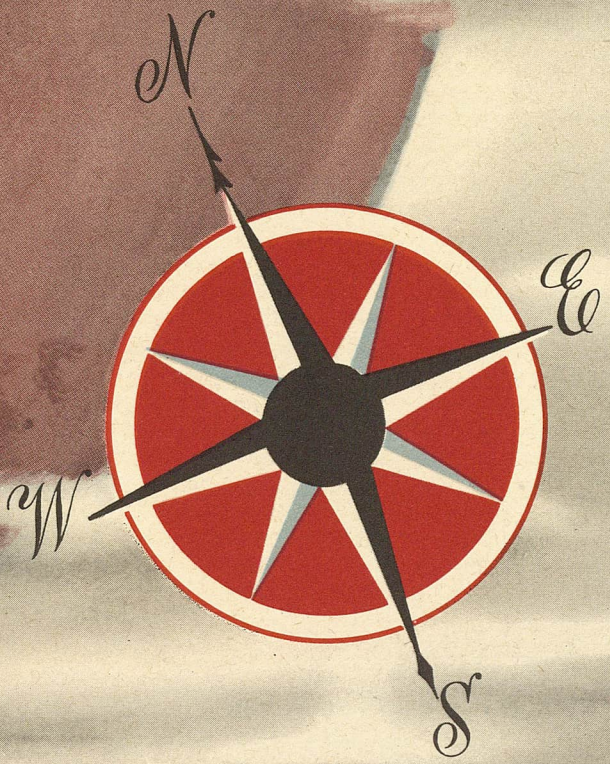


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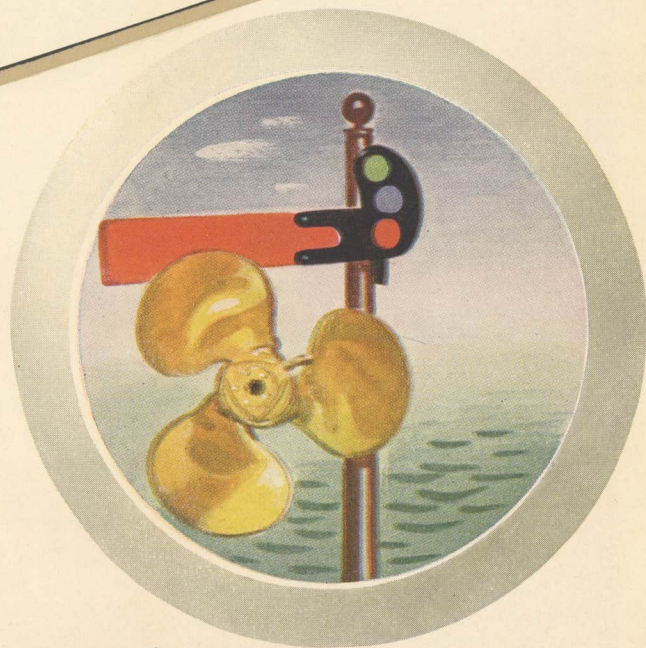
Amphibious assault

operations on a colossal scale have preceded each major move of the land forces of the United Nations in Africa and Europe. The stars shown on the map at the left indicate amphibious assault operations in the European War Theatre.



Diesel WAR POWER

The history of **ELECTRO-**
MOTIVE'S DIESEL ENGINES
in the Service of the
UNITED STATES NAVY
★





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ELECTRO-MOTIVE DIVISION
GENERAL MOTORS CORPORATION
LA GRANGE, ILLINOIS

OFFICE OF GENERAL MANAGER

TO THE EMPLOYEES OF ELECTRO-MOTIVE:

This book, DIESEL WAR POWER, tells a World War II story which we in the Electro-Motive Division think will be of increasing interest as time goes on. While it has been prepared principally for our employees it should prove a useful contribution to the authentic history of these epoch-making times.

We should be happy if everyone in Electro-Motive became familiar with the many steps that have to be taken before work on a production job begins. On every product we have brought out there has been a very extensive amount of preparation work, such as designing, experimenting, testing and redesigning. Almost every job has represented several years of such prior development work.

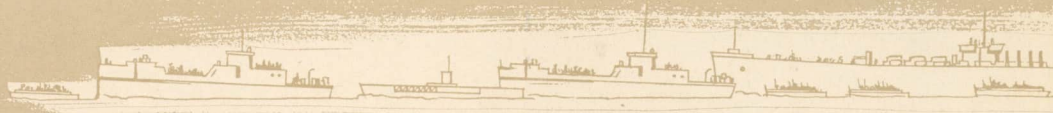
Too, we want to make it easier for our employees to visualize how and where the things we build are being used in the war; also we have an idea that the public little realizes how these products are speeding eventual victory. The special skills and techniques which our folks have developed in peacetime are proving of immeasurable help to our boys who are fighting for us all over the world. The superior weapons and equipment which our men in combat service are now using would not have been available otherwise.

For their splendid cooperation we want to pay tribute to the men of the Detroit Diesel and Cleveland Diesel Engine divisions of General Motors, who are associated with us in this endeavor. We wish also to acknowledge the splendid help of the many sub-contractors without whose cooperation our production record would not have been achieved.

While miracles may happen in world politics, we need not tell you that, in our opinion, the war is not nearly over. This book, therefore, is in the nature of a progress report, written while the battle goes forward. We know we bespeak the sentiments shared by everyone in Electro-Motive when we affirm pride in our war effort, as represented by the vessels powered with our Diesel engines, and voice confidence that both these vessels and our Diesel locomotives will continue to make their full contribution to the nation's all-out war effort.

C. R. OSBORN

C. R. Osborn





THE WAR AND ELECTRO-MOTIVE

When a machine-minded nation makes up its mind to really prosecute a war things happen rapidly. It was only two years ago, or on June 1, 1942, that Admiral Claude Jones, then Assistant Chief of the Bureau of Ships, wrote to the Electro-Motive Division of General Motors Corporation, in part as follows:

"I am delighted that you have struck your stride with the pancake engines. As I foresee the next six or eight months E. M. C. will be forced to give their undivided attention to the LST and LCI(L) programs. It is well that worries about the pancake engine will not demand the attention of key personnel during the coming hectic period.

"It is most important that both programs proceed in step. One must not advance to the detriment of the other. While the two types of craft are for different purposes, they work as a team.

L.S.T. Vessels unload cargo on Empress Augusta Bay, Bougainville Island. The time is New Year's Day, 1944.

"The Bureau appreciates that E. M. C. has accepted an enormous obligation. I have every confidence that it rests in good hands. I know you will agree with me that there are a lot of headaches connected with any venture of such magnitude. Please be assured that the Bureau stands ready to assist in all difficulties that may appear."

Within five months, or on October 31, 1942, we were able to report to the Bureau of Ships that during the month of October Electro-Motive had met its production promises on engines for the LST. Not only had we kept pace with our schedule but we were able, with the installation of new production machinery, to arrange for an increase in the original schedule.



Shipments of another Electro-Motive product, the LCI(L) equipment, also were up to schedule except for a slight deficiency of propellers and shafting. Twenty of the so-called "Pancake" engines for the SC boats were shipped during October, 1942.

Naturally our freight locomotive manufacturing program suffered from the rather sudden emphasis placed upon the production of Navy equipment. However, it was not long until we were able to step up our output of Diesel freight locomotives and this enabled the railroads to increase their contribution to the war. Counting our Diesel freight locomotives as war vehicles Electro-Motive, as this is written, is operating practically 100% for war.

The Navy's recognition of Electro-Motive's 1942 contribution to the achievement of the new ship program soon made its appearance. On January 21, 1943, official acknowledgment was made by Under-Secretary of the Navy James Forrestal, who awarded us the Army-Navy "E" with these words:

"This is to inform you and all employes of the Electro-Motive Division of General Motors Corporation that the Army and Navy are conferring upon your plant the Army-Navy "E" award for outstanding production of war materials."

Sub-Chasers weave a pattern in the calm waters off the Atlantic Coast as they practice an attack maneuver.

Then, on September 1, 1943, a star was added to the flag with this citation:

"The men and women of Electro-Motive Division of the General Motors Corporation have achieved a signal honor by continuing their splendid production in such volume as to justify the renewal of their award. In the first instance it was difficult to win the Army-Navy "E" and, by meriting renewal, the management and employes have indicated their solid determination and ability to support our fighting forces by supplying the equipment which is necessary for ultimate victory."

And again on January 14, 1944, in awarding the second star, the letter of transmittal said:

"The men and women of Electro-Motive Division have continued to maintain the high standard they set for themselves when they were originally awarded the Army-Navy "E." They may well be proud of their achievement. The additional white star, which the renewal adds to your Army-Navy "E" flag, is the symbol of appreciation from our Armed Forces for your continued and determined effort and support so necessary for victory."

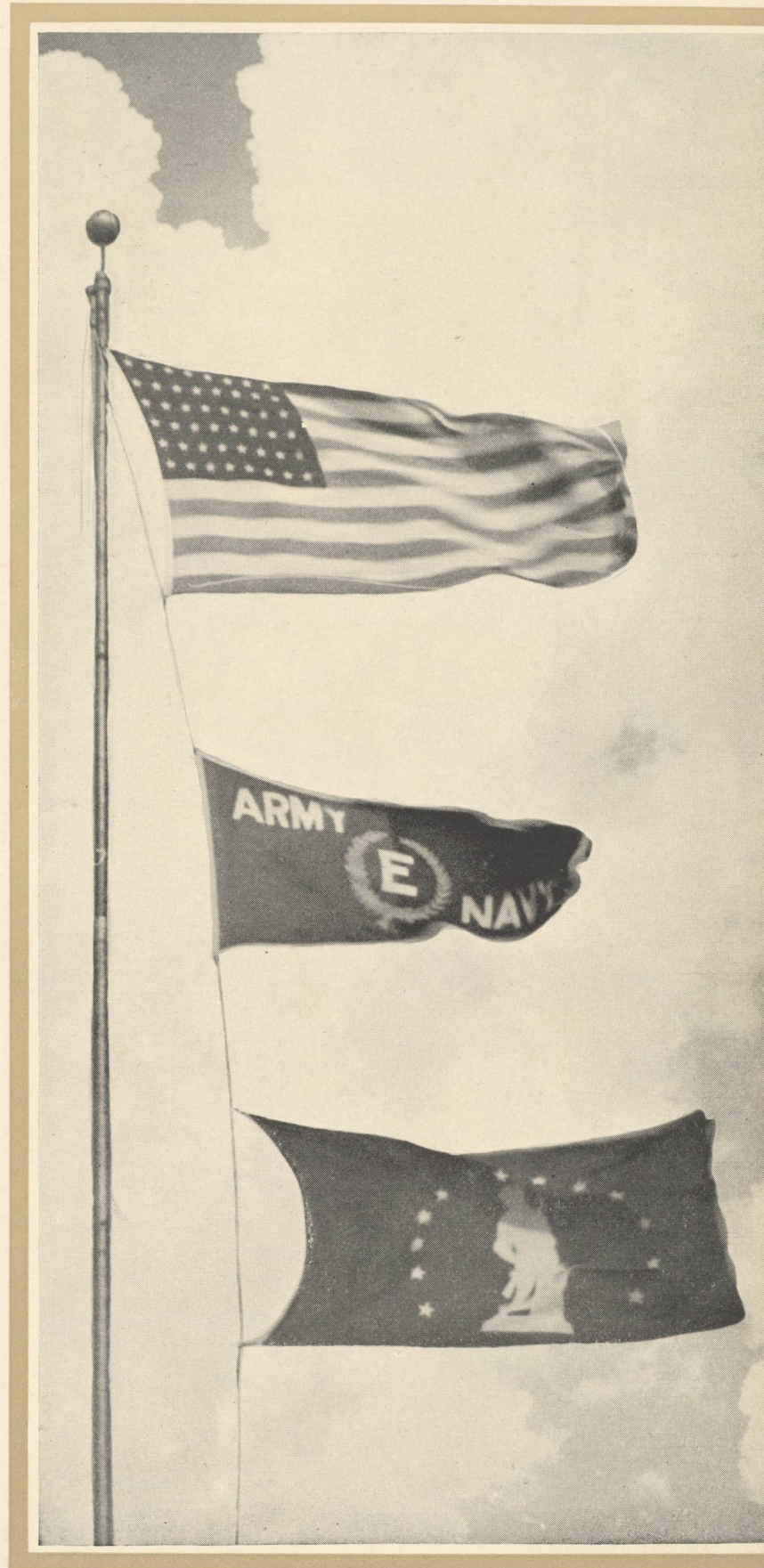
The preceding quotations from official Navy Department communications briefly summarize the accomplishments in the period during which Electro-Motive turned aside from its peacetime operations and devoted its attention to production for war. As most manufacturers will doubtless appreciate, the job was not simple or easy.

To be remembered, however, is that Electro-Motive had been a going organization for almost twenty years. The big plant southeast of LaGrange, Illinois, had been in operation—and rapidly expanding—since 1935. The sum of the situation was that the war gave us an opportunity to be of unique service to the nation at a critical time.

It is interesting to reflect on how fortunate it was for our country that the Diesel locomotive, long before Pearl Harbor, had been in process of development into one of the world's most useful power mechanisms. When war broke out more than 4,000 persons were on our payroll. These employees were familiar with our manufacturing processes, worked as an experienced team and knew how to turn out Diesel locomotives efficiently. Hundreds of locomotives were hard at work switching, hauling passengers and freight even as the Japanese bombs rained down on Hawaii.

In other words, in creating in peace time a new type of motive power for the railroads of America, the Electro-Motive Division of General Motors had been unwittingly preparing to supply the nation with a proven type of ship power in war. In acquiring our Diesel locomotive "know how" we had automatically prepared ourselves to quickly build a newly applied, and efficient, motive power for use on the high seas. The application of this motive power to ocean-going military vessels, moreover, aided materially in solving the age-old problem of how to combine naval and military forces in a landing offensive. This is a point which we think will be entitled to considerable emphasis when the history of this war is written.

It is a source of great satisfaction to us that the Diesel powered LST, the first landing craft built to cross the ocean under its own power, has proved so efficient that it is now being used by the Naval authorities as an ocean freighter as well as a tank landing ship. In truth, the Diesel powered LST has become as to ocean transportation a real counterpart of the Diesel freight locomotive in land transportation.





VARIABLE PITCH PROPELLER

This propeller was first used on the 110 ft. SC vessels. Then it was decided to use it on the LCI(L) and our folks had the unique experience of cutting large quantities of bronze at a time when it was a most critical material. Our photographer has given you an idea of what a really beautiful thing this propeller is. The operation shown is that of balancing and polishing the Propeller Hub. The machine being used was designed and built in The General Motors Research Laboratories. The only other special machine used on the propellers was a Cincinnati Hydro-Tel which was used to give the required accuracy to the propeller blades.





The First Electro-Motive Rail Motor Car. Power was supplied by the 106-A Gasoline Engine and Generator sketched below. The final drive consisted of two motors mounted on the front truck.

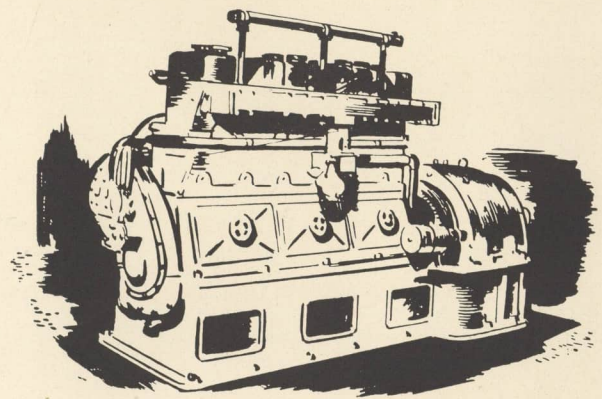
EARLY HISTORY OF ELECTRO-MOTIVE

In making Diesel engines the invaluable "know how," which is so vital in producing a new war product, didn't just appear overnight. Our organization and others associated with us put in years of patient and costly experimenting to acquire it.

The railroads of the United States were among the first to initiate the adaptation of the internal combustion engine to railroad vehicles so as to obtain a more flexible and economical motive power than steam. Starting in 1905, the McKeen Company, identified with the Union Pacific Railroad which was then under the direction of the late E. H. Harriman, built a 150 HP gasoline engine powered rail car. A few months later the General Electric Company brought out a rail car using a gasoline engine for power. But General Electric transmitted the power to the drive wheels through an electric generator and motors.

Between 1905 and the start of World War I the McKeen Company put 155 gasoline engine driven rail cars into service and General Electric sold more than 90 of their gasoline-electric cars. All of these were used on branch lines. Many are still in service.

However, both of the aforementioned companies abandoned the gasoline rail car enterprise during the first World War. Unsatisfactory engines and difficulties in transmitting gasoline engine power to rail car drive wheels seemed to be insurmountable obstacles in the path of further expansion along the lines they had initiated.



In the immediate post-war period a number of motor truck manufacturers put flanged wheels on trucks and busses in order to provide a light weight, flexible, economical rail service. But the innovation did not obtain wide acceptance commercially.

The first practical gas-electric rail car came into being in 1924 following the formation in Cleveland in 1922 of the Electro-Motive Company by Mr. H. L. Hamilton. The Chicago Great Western Railroad and the Northern Pacific Railroad bought the first two cars produced by the new company after the cars had been demonstrated on several roads. Between 1924 and 1930 more than 500 of the company's gas-electric rail cars were sold. Nearly all of them are still operating on branch railroad lines.

The work of developing and adapting the transmission of primary power, via electric generators and motors to the drive wheels—and the development of the other fundamentals which are so vital in the design of today's successful Diesel powered locomotives—was carried on during this period, the

prime mover being a gasoline engine. In this development work the company had many expensive trial and error experiences similar to those suffered by the early automobile makers.

During this development period the Electro-Motive Company did the engineering work but contracted for the manufacture of the rail passenger motor cars with various car builders, such as the St. Louis Car Company and Pullman Standard Car Manufacturing Company. Winton gasoline engines and General Electric or Westinghouse electric transmissions were used in all the rail cars sold.

Electro-Motive Company took full responsibility for the performance of its cars. The company maintained a force of service men in the field to make sure that the cars were operated to yield their maximum possibilities. The maximum power produced in the gasoline engine-electric transmission type of car at that time was 900 HP.

One of the first steps toward creation of the modern passenger train came in 1931 when a gasoline power plant was installed in an articulated unit which was purchased by the Sante Fe Railroad and operated between Kansas City and Topeka. This power and train unit was ordered in September 1931 and delivered in January 1932. The

Electro-Motive Company powered the first "streamliner," the "City of Salina," which was purchased by the Union Pacific Railroad. The engine was a 600 HP distillate engine, was ordered May 24, 1933, and delivered February 12, 1934.

To obtain the complete story of Electro-Motive's entry into the production of Diesel engine power—electrically transmitted—for railway service, it may be of interest to trace the part that General Motors played in the development.

In 1930 General Motors purchased an interest in the heavy internal combustion engine industry and in the aircraft engine industry. These acquisitions, entirely apart from their value and future possibilities, were made to enable the corporation to become familiar with the engineering developments in these fields. It was thought that their engineering developments and research might be of considerable value to all internal combustion engine activities, of which the automobile engine was a substantial part.

Electro-Motive had become one of the principal sales outlets for the gasoline engines produced by

The Sante Fe 900 Horsepower Locomotive unit, articulated with a baggage car. This was one of the forerunners of the "Streamlined Trains" of the modern era.





The GREEN DIAMOND, powered by a 16-201A GM Diesel Engine was one of the early streamlined trains.

the Winton Engine Company, and both the Winton Engine Company and the Electro-Motive Company (both then located at Cleveland) were acquired by General Motors in 1930.

The following related types of engineering and manufacturing experience were brought together in a unique way by this purchase:

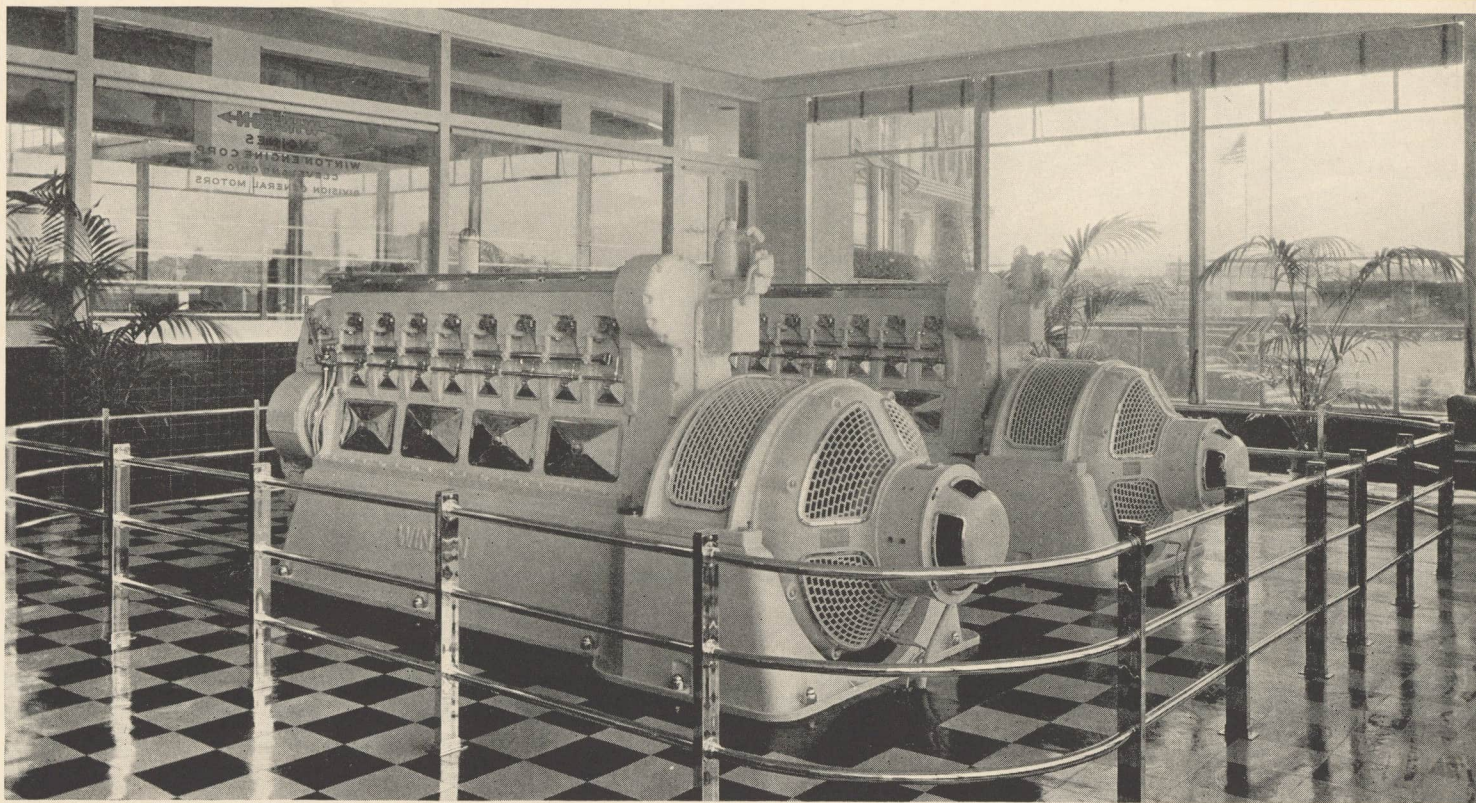
- 1. General Motors Research Laboratories, which was interested in the possibilities of the Diesel engine.*
- 2. The Winton Engine & Manufacturing Company, which had been manufacturing gasoline and Diesel engines for the Electro-Motive Company's railroad business and for the marine trade.*
- 3. The Electro-Motive Company, which was familiar with the railroad problems and had the confidence of the railroad managements.*

The first achievement of this combination of en-

gineering and production talents was the building of two 8-cylinder, 8 x 10, 2-cycle Diesel 600 HP engines. These were used to provide part of the power used in the General Motors Fair Building at the Chicago Century of Progress in 1933. The principal feature of the General Motors exhibit at the Fair was the actual assembling of the Chevrolet cars in which these Diesel engines were used to supply part of the power for the assembly line.

It was at this exhibit that Mr. Ralph Budd, president of the Chicago, Burlington & Quincy Railroad, observed the operation of these new Diesel engines and shortly thereafter selected this type of engine to power a new streamlined train which the road had previously decided to introduce, and which was on order at that time.

Our 600 HP Diesel engine was built into the three-car Burlington Route train constructed by the E. G. Budd Manufacturing Company at Philadelphia, and which was later named the "Pioneer Zephyr." The original trial run of this, the first Diesel-powered streamlined train, showed a speed of 104 miles per hour. Instantaneous public inter-



The 2 cycle Diesels which supplied power for the General Motors Building at the Century of Progress Exposition.

Below—Ten years of Progress . . . PIONEER ZEPHYR Meets 5400 HP Freight Locomotive at Birthday Party.



est was aroused by the streamlined car bodies and the unusual speed and the quick and easy starting and stopping qualities of this three-car Diesel train, as well as by the similar "City of Salina," powered by the distillate engine.

The operating economies and the passenger-getting characteristics demonstrated by these trains in the first few weeks of their operation convinced many railroad officials that a way had been found to reverse the long, downward trend of railroad passenger traffic.

The next step in Electro-Motive's engine program was the production of a higher horsepower engine unit. A demonstrator Diesel passenger locomotive was built in two units which were rated at 1800 HP each. This locomotive was designed to operate in multiple, if desired, and thus make a total of 3600 HP available through a single control. It was so simply designed that it could readily be operated by the oldest of railroad engineers who had been handling only steam locomotives.

This locomotive and the additional power units built for the new streamlined trains were designed by the Electro-Motive organization and built into power car bodies produced by various car manufacturing organizations such as Pullman and Budd.

Up to this time our operations were carried on in Cleveland, but so substantial was the demand for our new product after the new Diesel trains began to receive public approval, that it seemed highly desirable to launch a broad, long range program

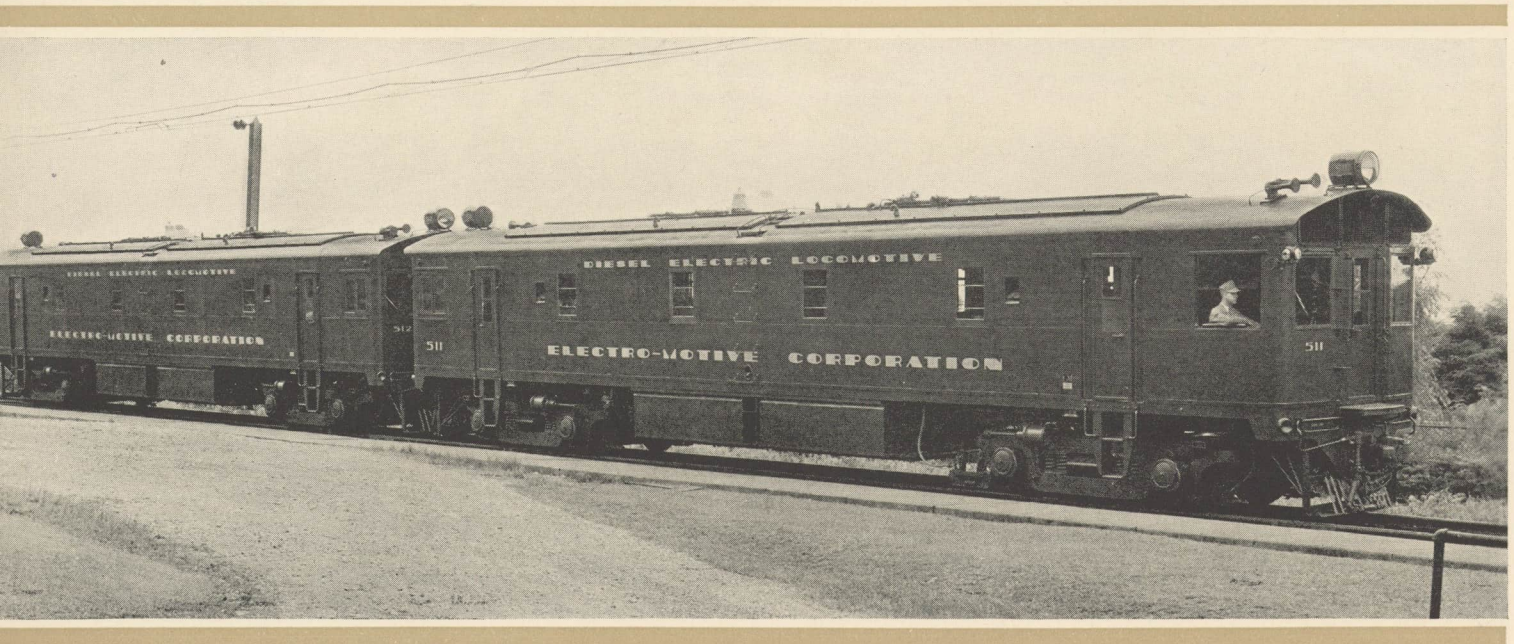
for manufacturing locomotives and their accessories.

A plant site was selected in LaGrange, Illinois, 14 miles southwest of Chicago, and ground was broken for the construction of our first plant units on March 27, 1935. A three-story office building, 40 ft. x 140 ft., a manufacturing building, 167 ft. x 500 ft., and a power plant were erected.

Though the new road locomotive was in great demand and destined to become our chief product in a very short time, two types of Diesel switching locomotives then formed the backbone of our production. These switching locomotives had been designed for sale to the railroads on the basis of efficiency and economy and have lived up to their reputations admirably.

Our first passenger locomotive was soon redesigned to incorporate improvements which had been suggested by the operation of the demonstrator locomotive and other streamlined power units which we produced during 1935 and 1936. And so persistent was the demand for the improved product that during 1937, the plant area was doubled by the lengthening of the locomotive assembly bay from 500 ft. to 1000 ft. It was evident on every hand that this new kind of motive power had made a secure place for itself in railroad transportation.

The original 3600 H.P. Passenger Locomotive consisted of two units, each carrying two 12 cylinder engines and generators, all controlled from a single station.

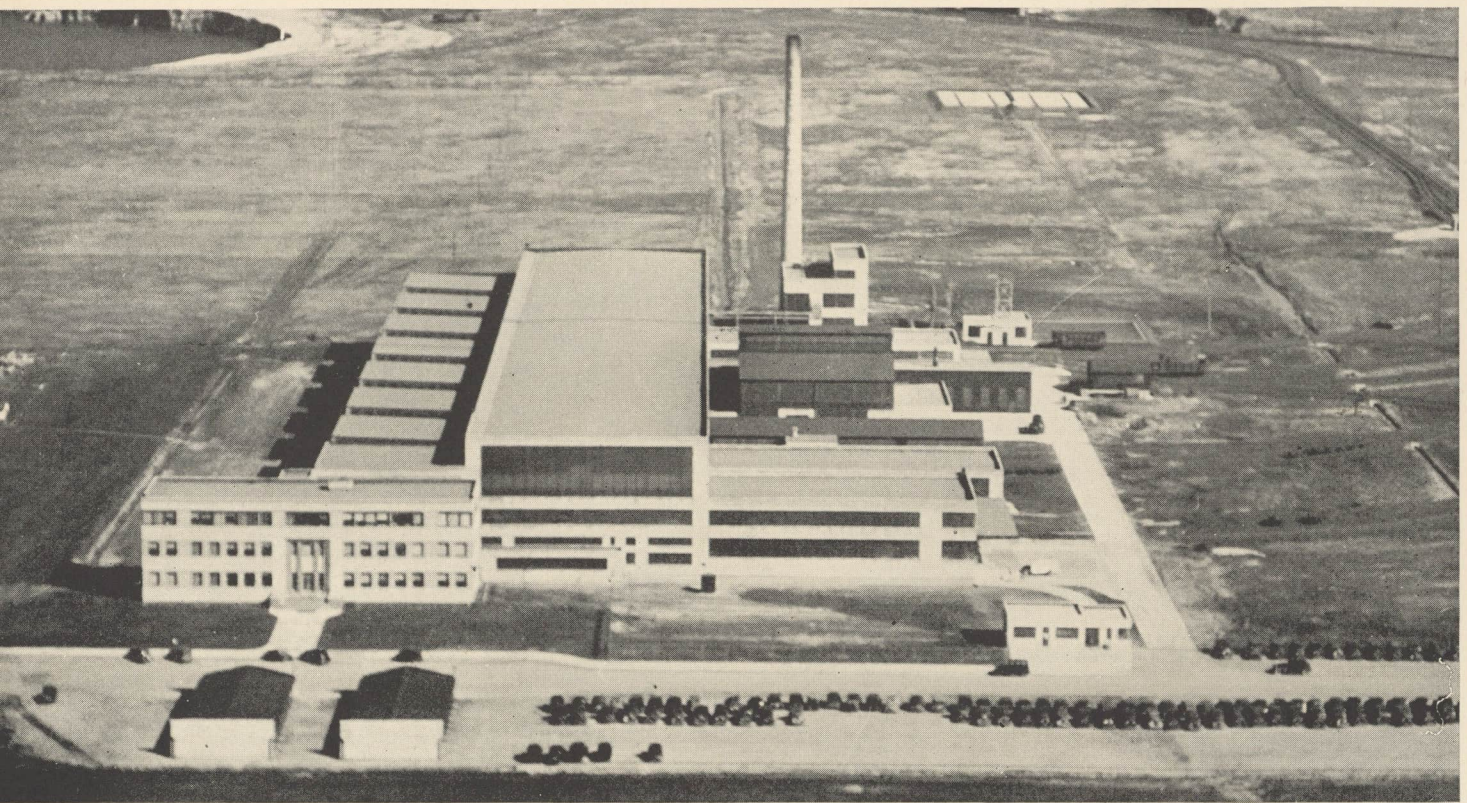




The 1000 Horsepower Switcher is typical of our Diesel switch engine production. Every factory should have a "Bread and Butter" item and the Switcher was our first.

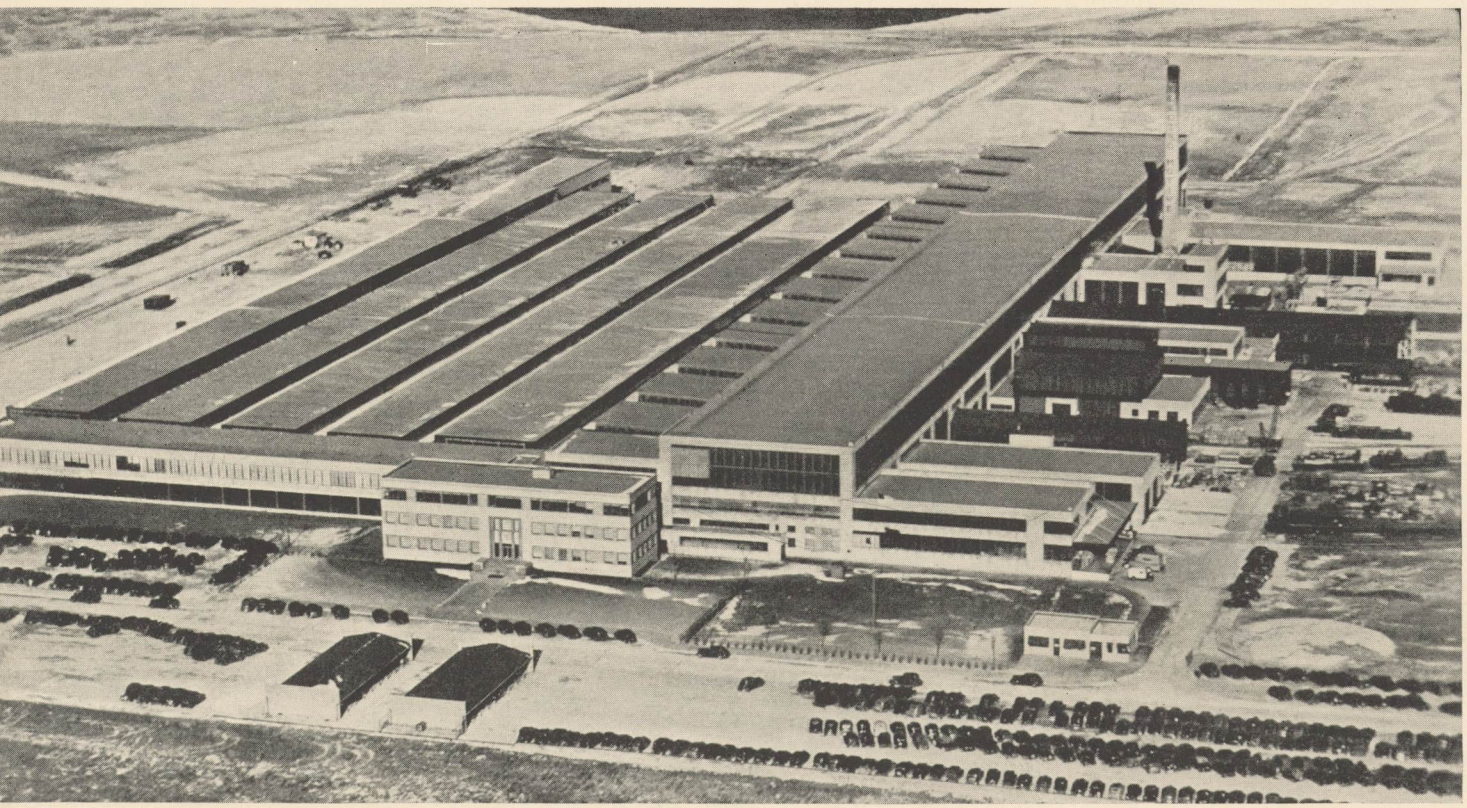
The locomotive below represented the second phase of our operation in LaGrange, and embodied the Electro-Motive built Diesel Engine and Electrical Equipment.





Above—The original Electro-Motive Plant at La Grange, built in 1935, designed for assembly operations only.

At the end of 1938 our plant had expanded to over five times its original size, covering approximately 12 acres.



THE 1938 PLANT

As early as 1937 it became apparent that a re-design of the Cleveland Diesel Model 201A General Motors Diesel engine (successor to the Winton engine), to make it more useable for railroad locomotive purposes, would be desirable. While the 201A engine had been originally designed to operate in vessels of the United States Navy, particularly submarines, as well as in locomotives, some of the features, while necessary for Navy operation, were not suitable for railroad work.

The management felt that an engine designed to supply the particular requirements of railroad motive power was justified in view of the potential volume of rail business which seemed available and also to provide the power qualities essential to most effective railroad operation. And, naturally, an engine so designed was expected to materially increase sales. Experience since its introduction has amply confirmed our expectations.

Considered also in our planning was the possibility that a reduction could be made in the cost of the engine if it was designed solely to meet the needs of railroad locomotive service. Moreover, we thought it desirable to bring about a closer coordination of the engine power and electrical transmission equipment in the power unit.

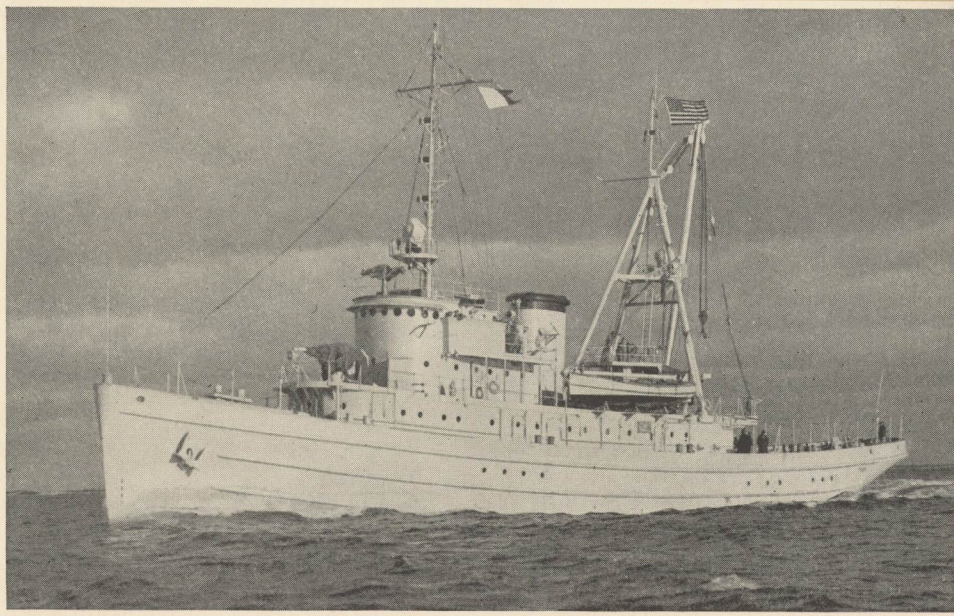
The latter consisted of a generator, driven by the engine, and four traction motors mounted on the power car's trucks, together with suitable controls. It was felt that if this transmission equipment were

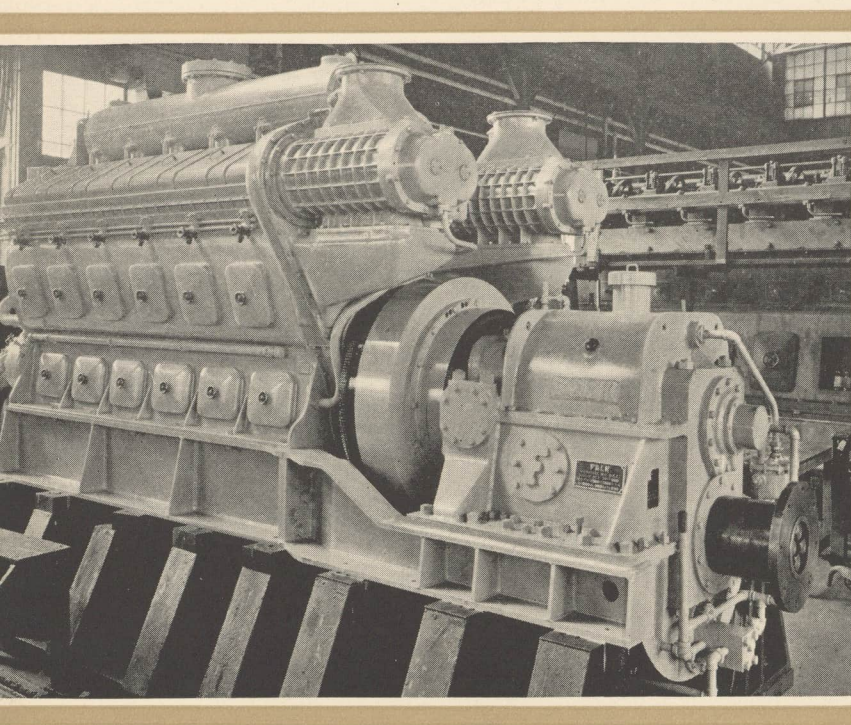
designed to operate as an integral part of an engine, (itself redesigned for use solely as a railroad locomotive) we would accomplish all of the objectives above-mentioned.

These redesign projects were completed early in 1937 and during the summer of that year construction of a plant addition for the manufacture of engines and electrical equipment was started. The addition consisted of seventeen bays, 370 ft. x 816 ft., and covered an area of approximately 300,000 square feet. About one-half of the new area was devoted to the manufacture of Diesel engines, a third to the manufacture of electrical equipment, and the remainder was devoted to service, tool room and truck assembly.

The rated output of the plant, including the new addition, was one locomotive unit per day. This output required the production of one Diesel engine, one electrical equipment set (which consisted of one generator and four motors), one car body and one pair of trucks per day. Overhead cranes were installed throughout, the largest crane in the main locomotive assembly bay having a 200-ton capacity. When the plant was completed in the spring of 1938 the first factory for manufacturing all of the component units of a Diesel-electric railroad locomotive under one roof had been brought into existence.

The USS NAVAJO, a Fleet Tug commissioned in 1940, was powered by four 12-567 engines built in the new plant, as were the sister ships, Seminole and Cherokee.





Engine, clutch and reverse gear of the "Bull Calf."

a flow of materials through the plant by arranging our machinery as logically as possible.

The Navy Department recognized the possibilities, as well as the inherent difficulties, in our endeavors to effect mass production of Diesel engines. That it did not formulate its judgment on the immediate results is to their credit and was much appreciated by us.

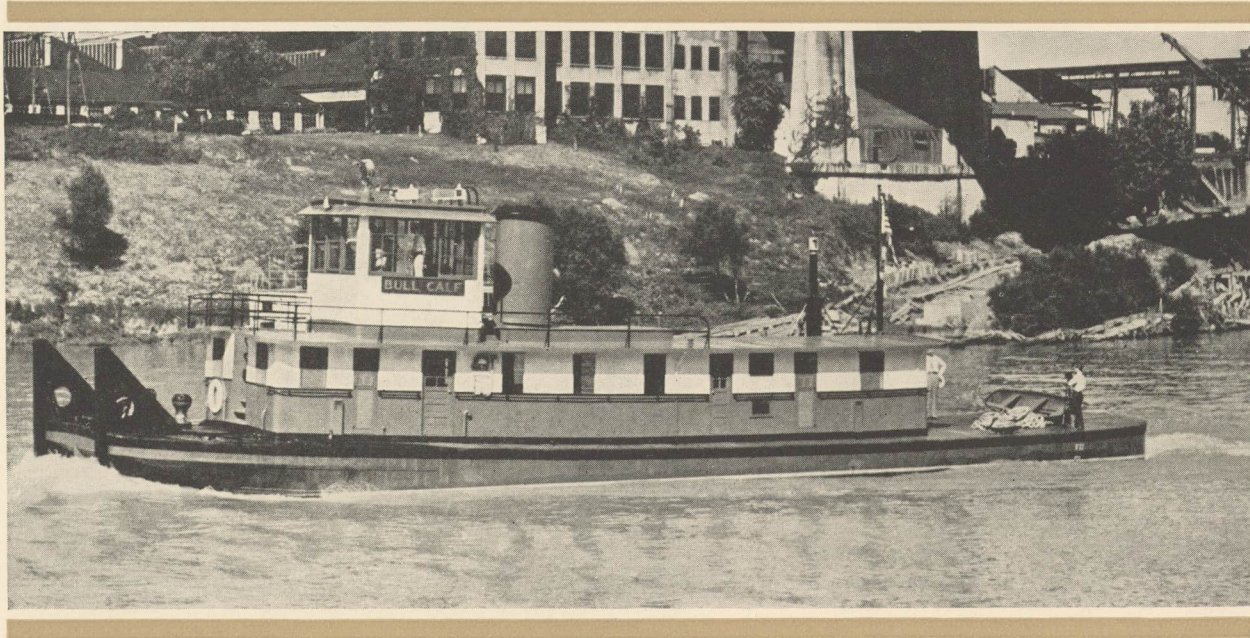
In the fall of 1938, following a visit by an officer from the Bureau of Engineering, we received an order from the Navy Department for twelve, 12-cylinder, 567 engines intended for use as the main propulsion machinery for three fleet tugs, the Navajo, the Seminole and the Cherokee. The engines, together with electrical equipment of the same general type as the electrical transmission of the Diesel railroad locomotive, were shipped in the spring of 1939 and the vessels were completed later that year.

The engineering work on these tugs was done by the Cleveland Diesel Engine Division of General Motors Corporation.

These tugs were commissioned early in 1940 and distinguished themselves from the start. By performing reliably they built up our reputation with the Navy Department. Fortunately, one of them was at Pearl Harbor at the time of the Japanese attack, and rendered valuable service. The Semi-

The Navy Department, and particularly the then Bureau of Engineering, was interested in the possibilities of mass production of Diesel engines. Obviously, production of one locomotive unit per day could hardly be called mass production. Moreover, small production runs made frequent machine set-ups necessary. For instance we had six gear cutting machines on which we were forced to produce some thirty-nine different gears. However, in spite of the handicaps some effort was made to maintain

The Mississippi river tug "Bull Calf" whose Power Plant furnished the Engineering background for the design of Propulsion Machinery for the Landing Ships, Tanks.



nole was sunk October 25, 1942 during action near Tulagi in the Solomon Islands. The Navajo was sunk September 12, 1943 in the South Pacific by an underwater explosion.

In 1938 we supplied the Moran Towing and Transportation Company with four engines for tugboats built by the Defoe Boat Works at Bay City, Michigan. These tugs used two of our 8-cylinder Diesel engines with electric drive to the propellers. At the outbreak of the war the Navy, recognizing the usefulness of these boats, commandeered them. They have since seen service in many parts of the world.

Also in 1938 we produced four 8-567 Diesel engines for the United States Coast Guard. The gears of these engines were changed so that the blowers could be put inboard. This reduced the width of the engine and made it easier to fit into the ship. In 1942 we effected similar space-conserving modifications in the 567 engine used in the LST vessels.

The performance of the engines installed in the vessels mentioned above provided the background of experience which enabled the Navy and ourselves to make the proper engineering and manufacturing decisions when the present war started.

Furthermore, the year 1938 stands out because in that year the first Diesel railroad locomotive power car unit using the 567 engine and Electro-Motive transmission was produced. During the two years preceding we had built car bodies, installing General Motors Diesel engines built by Cleveland Diesel Engine Division, and electrical equipment purchased from leading manufacturers. But in this 1938 job we built, for the first time, the engine and the electric transmission as well as the power car.

The events in 1938 in our railroad Diesel power program provided a sound foundation for today's war output at Electro-Motive.

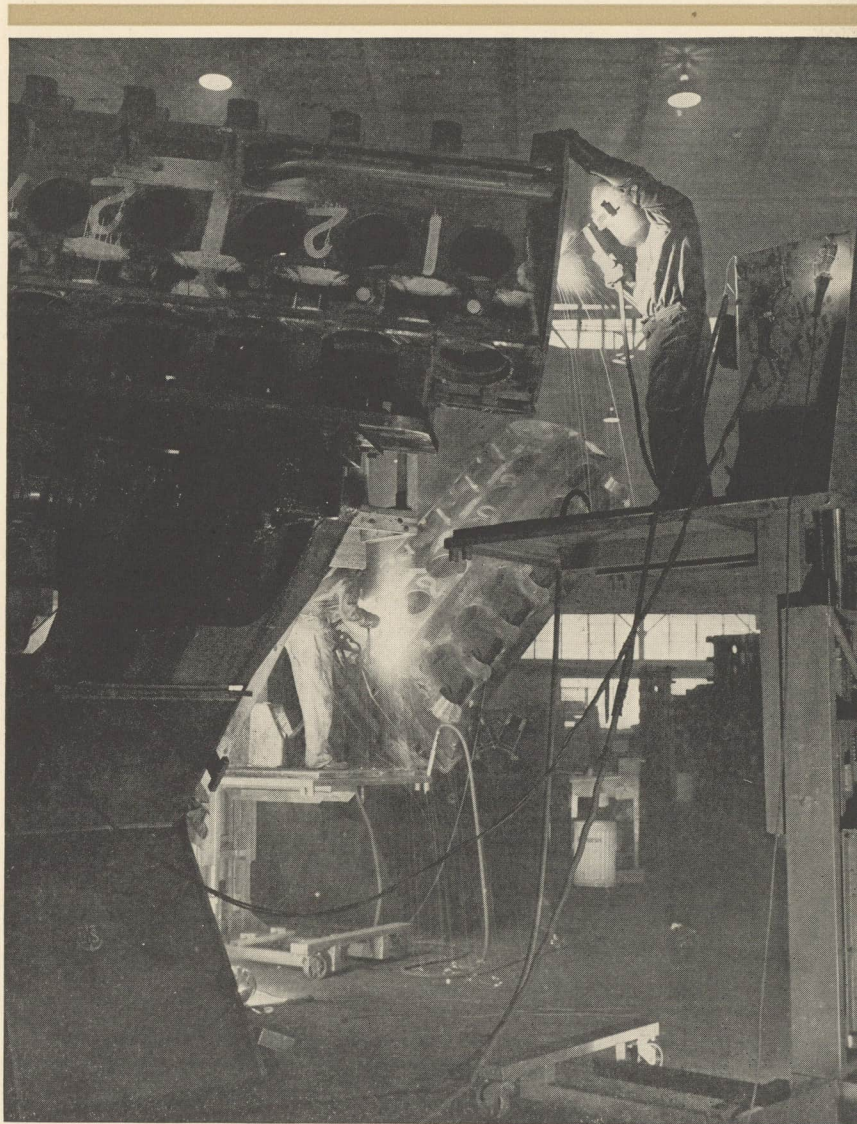
The first Diesel-electric passenger locomotive using the 567 engine was shipped on October 25, 1938 to the Seaboard Railway which put it into service immediately on its Orange Blossom Special between Washington, D. C. and Miami, Florida. Being the first locomotive to use engines and electrical equipment made in our LaGrange plant, the success of the operation was of great importance to us. Three 6000 HP locomotives were delivered on the Seaboard's order and to the great satisfaction of all they carried out their 1938-39 winter assignment without missing a run.

On January 1, 1939, we had approximately 2,000 employees at LaGrange. We had been able to bring workers into the plant from the Chicago area who had special skills in the trades required in the build-

ing of power car bodies. We also recruited a considerable number of tool makers and machinists. Our welding technique was developing under the supervision of our Metallurgical Department.

The Engineering Department and the manufacturing departments of the plant both inaugurated apprentice courses. With two years' training already accomplished, we had reason to be proud of the Electro-Motive trained apprentices. Naturally, many of these apprentices were just out of high school when the classes started and most of them became members of the armed forces, where the skills they acquired at Electro-Motive proved of value. In a little over three years a sound and efficient manufacturing organization was created and became closely knit for producing a new product.

Positioning Machines make Crankcase welding easier.





TRUCKING THE LOCOMOTIVE

Placing the locomotive body on the trucks is the most dramatic operation of any performed in the plant. When the body is assembled on the trucks the unit "comes to life." From that instant it functions as an individual and develops its own peculiarities and habits, both good and bad. This unit is recognizable as destined to work out its career on the Great Northern Railway and when joined to its three companion units will be known as Number 414. The crane being used for this "trucking" operation has a capacity of 200 tons and carries the body complete with engine, generator, radiator and other accessories with ease. At the front end of the first truck may be seen the cables from the first motor. When these are connected to the corresponding cables on the body, the unit is ready to run.





THE FREIGHT LOCOMOTIVE DEVELOPED IN 1939

It was only logical that Electro-Motive should turn its attention to building railroad freight locomotives as soon as its railroad passenger locomotive program was well under way.

At the end of 1938 after the company's first complete passenger locomotive, using the 567 engine, had been delivered to the Seaboard Railway, our Engineering Department set to work designing a railroad freight locomotive. The developing and designing work was carried on for several months and the first 5400 HP locomotive was completed in November 1939.

This Locomotive traveled 83000 miles on runs such as this, developing facts about Diesel Power for Freight.

Because a freight locomotive works at full capacity for a much higher percentage of the time it is in use than any other form of railroad motive power we decided that the testing of the newly designed equipment must be unusually complete and comprehensive. To this end we conducted a series of test runs which covered 83,764 miles and included almost every difficult operating condition which confronts the railroads.

It was also desirable that as many officials of as many different railroads as possible be given an opportunity to see what the new locomotive could do in actual operation. We deemed this important because, while the locomotive's rating of 5400 HP

and 220,000 pounds of tractive effort was accurate, the rating did not adequately portray all of the unusual power and road service qualities that the unit could deliver.

The first orders for freight locomotives came from the Atchison, Topeka and Santa Fe Railroad. Soon after delivery was made in December of 1940 and early 1941, orders began to come from several other roads. From the time the freight locomotive was introduced to December 1941, orders were received for fifty-seven 5400 HP locomotives. This gave us a record volume of business for 1942. When the orders for switcher and passenger locomotives received during the same period were added to the freight locomotive orders the aggregate of business on hand at the end of 1941 was quite substantial.

Plantwise, at the end of 1941 Electro-Motive had about 700,000 square feet of floor space devoted to building Diesel locomotives. (The term "locomotive"

means the Diesel engine, the direct current electrical transmission, the incidental accessories and the car bodies.) Everything about the plant, including the product, was new.

Some idea of the scope of railroad motive power which was produced by Electro-Motive as a result of the 1937-41 expansion period can be seen in the following tabulation. The products listed therein were regarded as covering the principal motive power requirements of the American railroads.

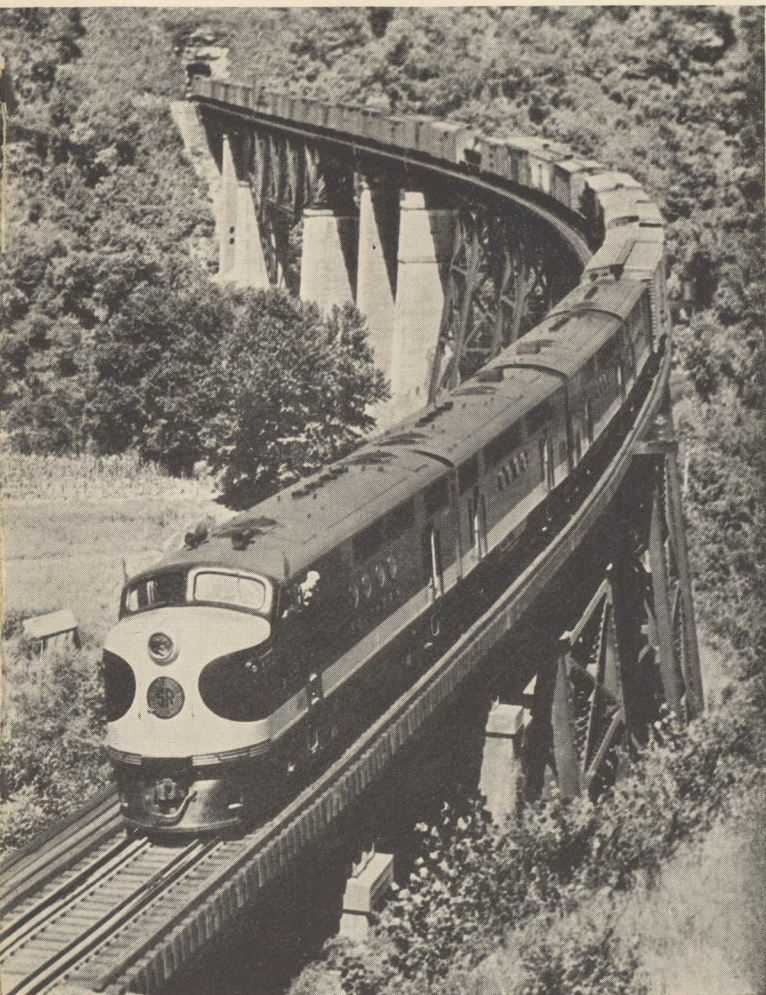
- (1) a 600 HP, 100 ton Switcher
- (2) a 1000 HP, 125 ton Switcher
- (3) a 2000 HP Main Line Passenger Locomotive
(which could be operated in multiple to make a 4000 or 6000 HP locomotive)
- (4) a 5400 HP Freight Locomotive
(which could be built in multiple to make a 1350, 2700, 4050 or 5400 HP locomotive)

We felt we had accomplished our basic objective of supplying complete new design types of railroad motive power in the form of efficient and economical, lighter-weight Diesel engines and coordinated transmission equipment. This equipment was built into sturdy, welded car bodies and mounted on especially designed, flexible trucks.

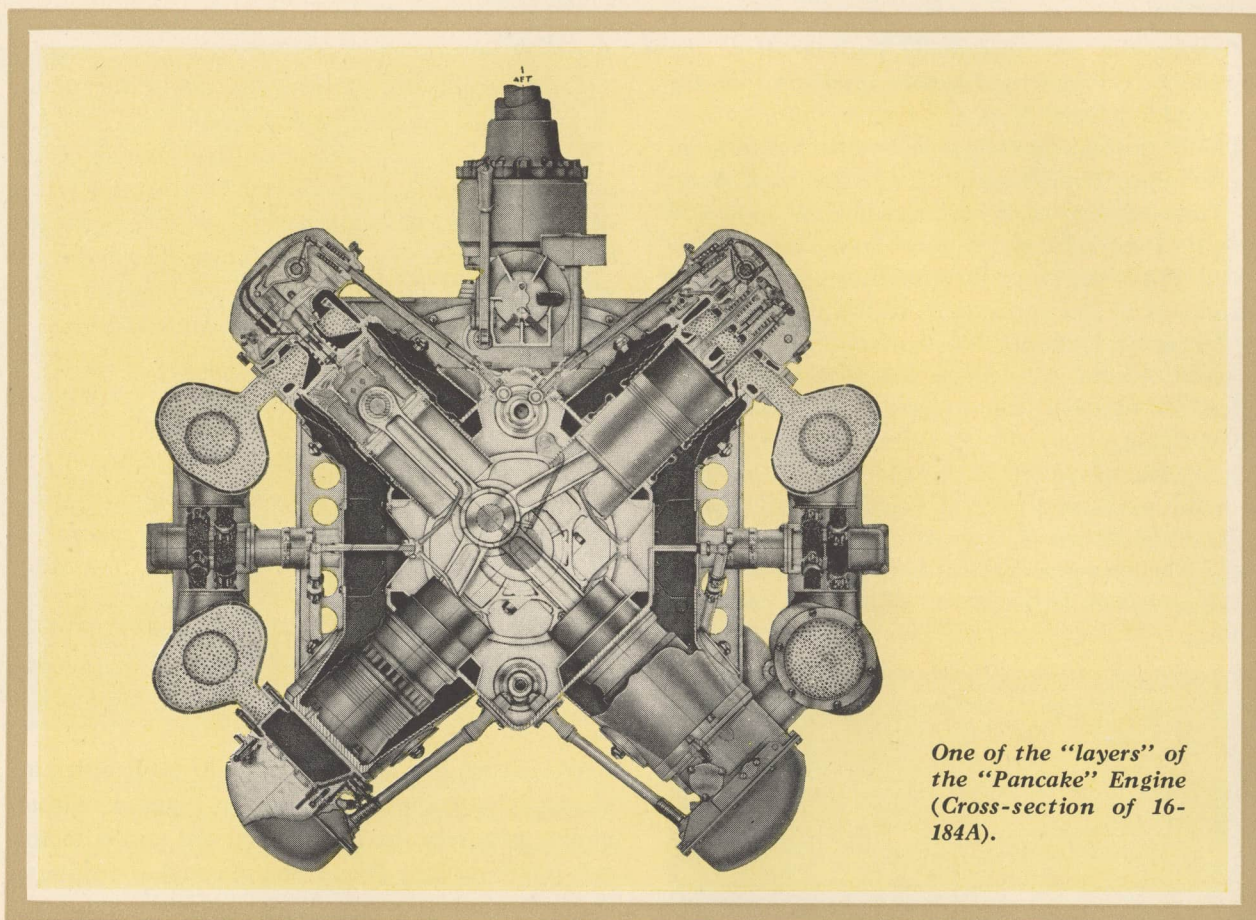
To sum up: the new locomotive plant had been built since 1935, the product had been redesigned during 1938, 1939 and 1940, and we had a full order book toward the end of 1941. All of the personnel, except some eighty members mainly in the Engineering and Service Departments, had been recruited since 1935. A large number of our employees were entering their fourth or fifth year of experience in the production of the new Diesel locomotives.

The only cloud on the horizon was the war in Europe, then entering its second year, and the war in China, then in its fourth year. It seemed at that time that the most important contribution we could make to the defense effort would be to produce as many locomotives as possible and thus increase the aggregate hauling power of the nation's railroads.

It was self-evident that the scheduled increase in productive activity all over the nation would require additional railroad motive power. It was also obvious that the withdrawal of shipping from the Panama Canal routes, because of the submarine menace, would increase the load on the Western railroads especially.



5400 H.P. Freight Locomotive on the Southern Railway.



One of the "layers" of the "Pancake" Engine (Cross-section of 16-184A).

OUR FIRST WAR JOB

It is a characteristic of good research organizations never to be satisfied. The General Motors Research Laboratories in Detroit completed its part of the design and experimental work on the original Model 201A Diesel engine in 1934 and immediately began studying a still lighter engine. While the original objective was to design an engine light enough to be used as an airplane motor the work led to the design of a light marine engine.

For three years experimental work on a single cylinder engine was carried on. Navy officials, after a visit to the Research Laboratories in 1937, became definitely interested in the development of a light-weight Diesel engine for Navy purposes. A series of contracts for producing experimental engines resulted.

These contracts provided the means by which the design of the 16-cylinder, Model 184 engine, which soon became known as the "Pancake," was evolved. The sixteen cylinders of the 184 engine were arranged in four horizontal "layers," of four cylinders each, and that suggested the nickname.

In the course of the development of this engine the Research Laboratories interested the Navy in the possibilities of making a variable pitch propeller which would eliminate a reverse gear. Such a propeller offered several additional advantages in fuel economy, weight saving and in effecting bridge control of a ship's power.

Eventually a contract was made between the Laboratories and the Navy for the construction of the main propulsion machinery for an experimental 110-foot vessel, the contract including shafting and variable pitch propellers as well as the two engines and engine equipment mentioned above.

The Navy's 110-foot submarine chaser required a light-weight engine which would occupy a very small space. Our Model 184 engine filled those requirements and was deemed necessary to the successful performance of the 110-foot vessel. General Motors Research Laboratories conducted many tests during which the weak spots of the engine were discovered and the first successful Navy acceptance test of the engine and equipment was finally completed on October 31, 1940. A period of three years

elapsed after the combined program of the Navy and the Research Laboratories was inaugurated.

Following the successful acceptance test the Navy immediately issued a letter of intent, which was followed by a contract, to build 100 Model 184 engines, engine equipment, propellers, shafting, etc. The first phase of the new engine's development was thus completed.

At this point the engineering phase of the program was divided into two parts. Electro-Motive undertook the task of making complete production drawings of all parts of the engine then available, submitting them to the Navy for approval. And, in order to expedite this work at LaGrange, a majority of the Model 184 engineering staff of the Research Laboratories was transferred from Detroit to La Grange. The Navy, in turn, established at our LaGrange plant its own office of Inspector of Naval Machinery to supervise the Navy work.

The Research Laboratories, as the other part of the program, carried out its final task, which was to develop the complete installation of the new engine in a 110-foot wooden submarine chaser then being built by Fisher Boat Works in Detroit. This new vessel was designed by Captain A. Loring Swasey, U. S. Navy, who had designed its predecessors, the 110-foot, World War I, wooden subchasers, which were powered by gasoline motors of about 600 HP. The new vessel was to have, in contrast, two 1200 HP engines, weighing about 4,800 pounds each, and occupying a relatively small amount of ship space.

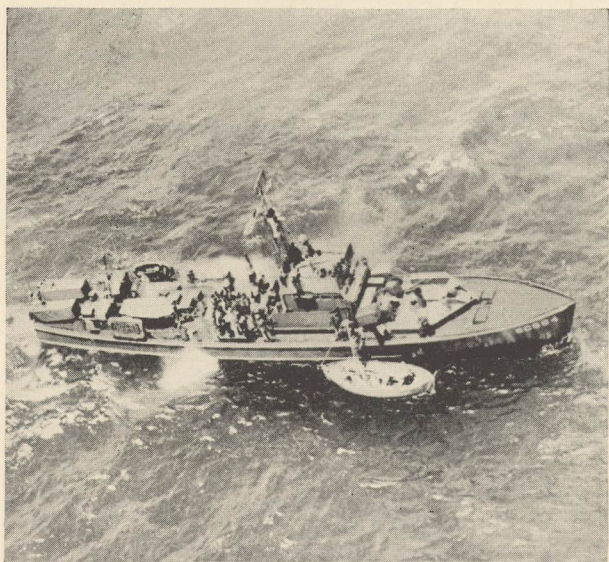
As finally accepted by the Navy this new engine developed 1200 HP at 1800 RPM. It was a 2-cycle engine and weighed about one-fifth as much as our 12-cylinder, Model 567 Diesel locomotive engine. The larger horsepower per vessel was necessary to provide the higher speed required to successfully combat the latest design, high speed enemy submarines. The use of Diesel fuel oil eliminated the fire hazard always present in the use of gasoline and substantially increased the cruising radius.

In order to hasten the beginning of actual service of this engine, modification of its design and the design of its apparatus was prosecuted as rapidly as possible. The first pilot vessel ran its preliminary acceptance trial on July 28, 1941.

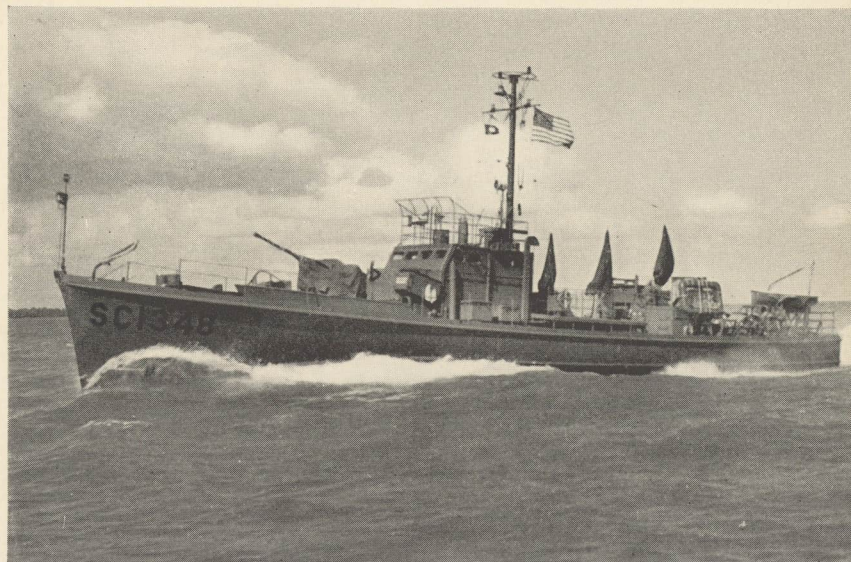
During the time the first pilot vessel of the program, the SC-453 was undergoing her initial trials and sea trips the engineering staff at LaGrange was producing approximately 2,500 separate drawings of the engine's various parts. While these drawings followed the design as laid out by the Research Laboratories, the information required by our own production departments, such as limits and material specifications, was also required by the Navy. Hence, this time-consuming work had to be done before the drawings were acceptable to the Navy and before actual production could be started.

The last of these drawings were received from the Research Laboratories in May of 1941 and were submitted to and approved by the Navy in July

SC664 completes an ocean rescue mission.



Identification Photograph 110 foot Sub-Chaser.



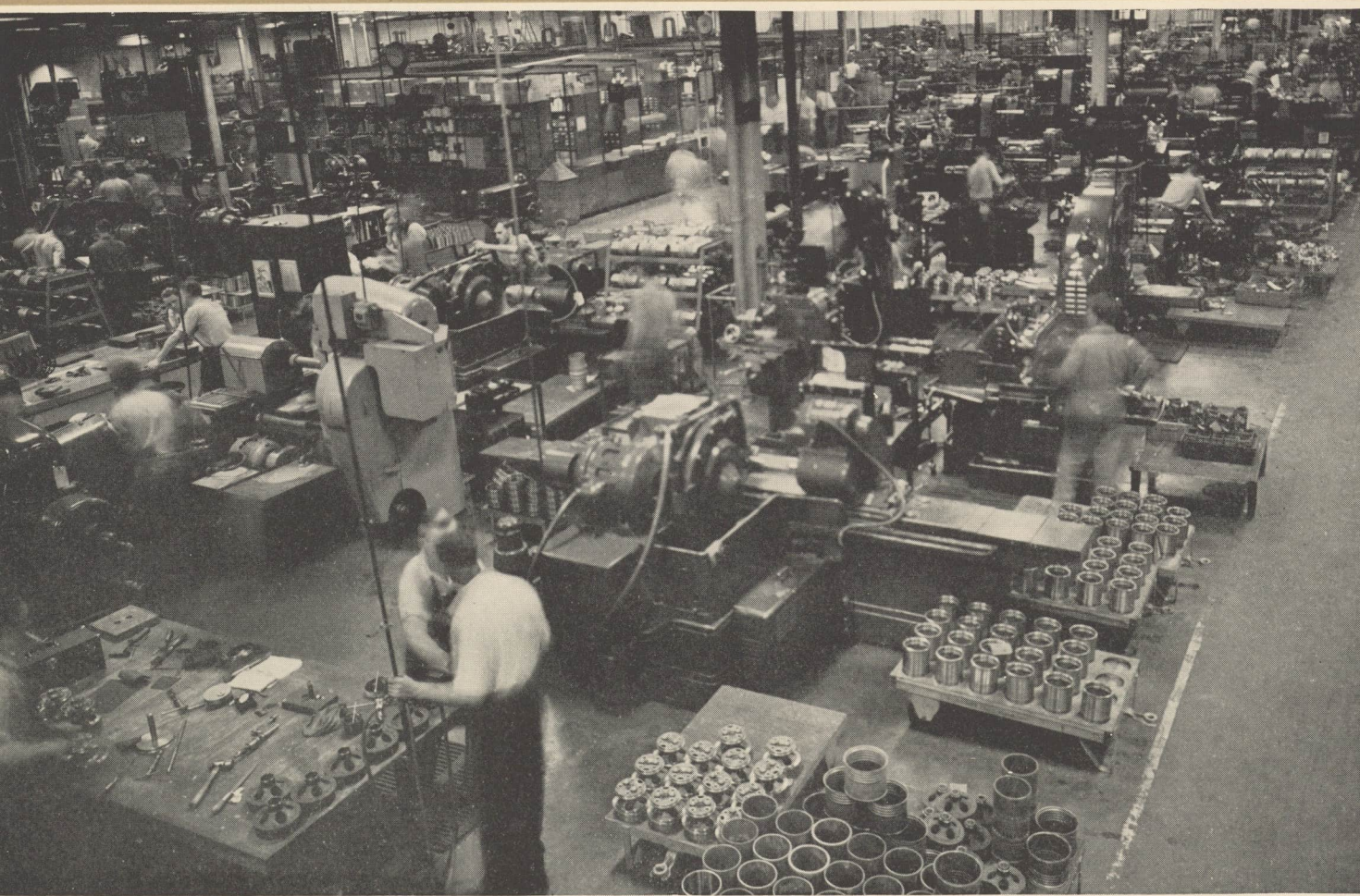


Rear Admiral Bowen (on right) was responsible for the Navy contracts which resulted in the "Pancake" Engine. "Boss" Kettering points out the grid, a feature of the connecting rod, to C. R. Osborn and the Admiral.

1941. However, there were still several important changes to be made as a result of the various tests made in our plant and on the SC-453. These changes were made and production soon followed.

The first pilot engine of our 184 model was completed in October of 1941. It had been built by using production drawings and, as far as possible, production tools, and was run on test on October 11, 1941. A variety of other tests followed.

The first production engine was accepted by the Inspector of Machinery on February 5, 1942 and shortly thereafter two production jobs of the Model 184 engine were installed in the ship PC-499 under the supervision of our service men and the Engineering Department. This vessel was then given its various trials and was commissioned on March 18, 1942. While our engineering troubles were not over on that date, it was a great relief to know that the first equipment had been satisfactorily installed and had left Chicago for New Orleans.



View of cylinder liner and piston operations in Navy Building

THE NAVY BUILDING AND 184 ENGINE PRODUCTION

World events were shaping up so rapidly that steps were taken in December 1940, while the development of the 184 engine was in progress, to build at Electro-Motive the kind of plant necessary to produce the new engine and all of the parts and accessories needed for the 110-foot vessel. A one-story, "black-out" type of brick, concrete and steel building, windowless and air-conditioned, to provide 121,300 square feet of floor space, was constructed. The contracts were let during December 1940 and, with the contractors working three full shifts part of the time, the plant was substantially completed in May of 1941.

The machine tools, however, were not available and, though ordered early in 1941, were not received in substantial volume until the fall of the year. To equip the plant meant the purchase of some 255 machine tools for machining approximately 600 different production parts.

An idea of the size of the job can be seen in the fact that a total of over 5,000 jigs, fixtures, templates and cutting tools were involved in the operation. It was necessary to prepare and use tool drawings before the finished production drawings were available to the production departments. As this was the period in which it was especially difficult to obtain tools, we were very grateful to the Research Laboratories for giving us the use of a large part of their model shop to assist us in carrying out the tooling program.

However, the manufacturing facilities for the 184 engine were substantially completed during January, 1942. This was approximately fourteen months after the receipt of the Bureau of Ship's letter of intent.

At the time of the awarding of the original contract for one hundred Model 184 engines the production schedule was established at 10 engines per month. But before any substantial amount of work had been done this schedule was raised to 20 engines per month.

Training of personnel was started simultaneously with production and by the end of September 1941, some 875 of our people were working directly in the Navy Building. The number of employees was finally increased to 1,400, a majority of whom had been upgraded or trained for the particular type of work to which they were assigned.

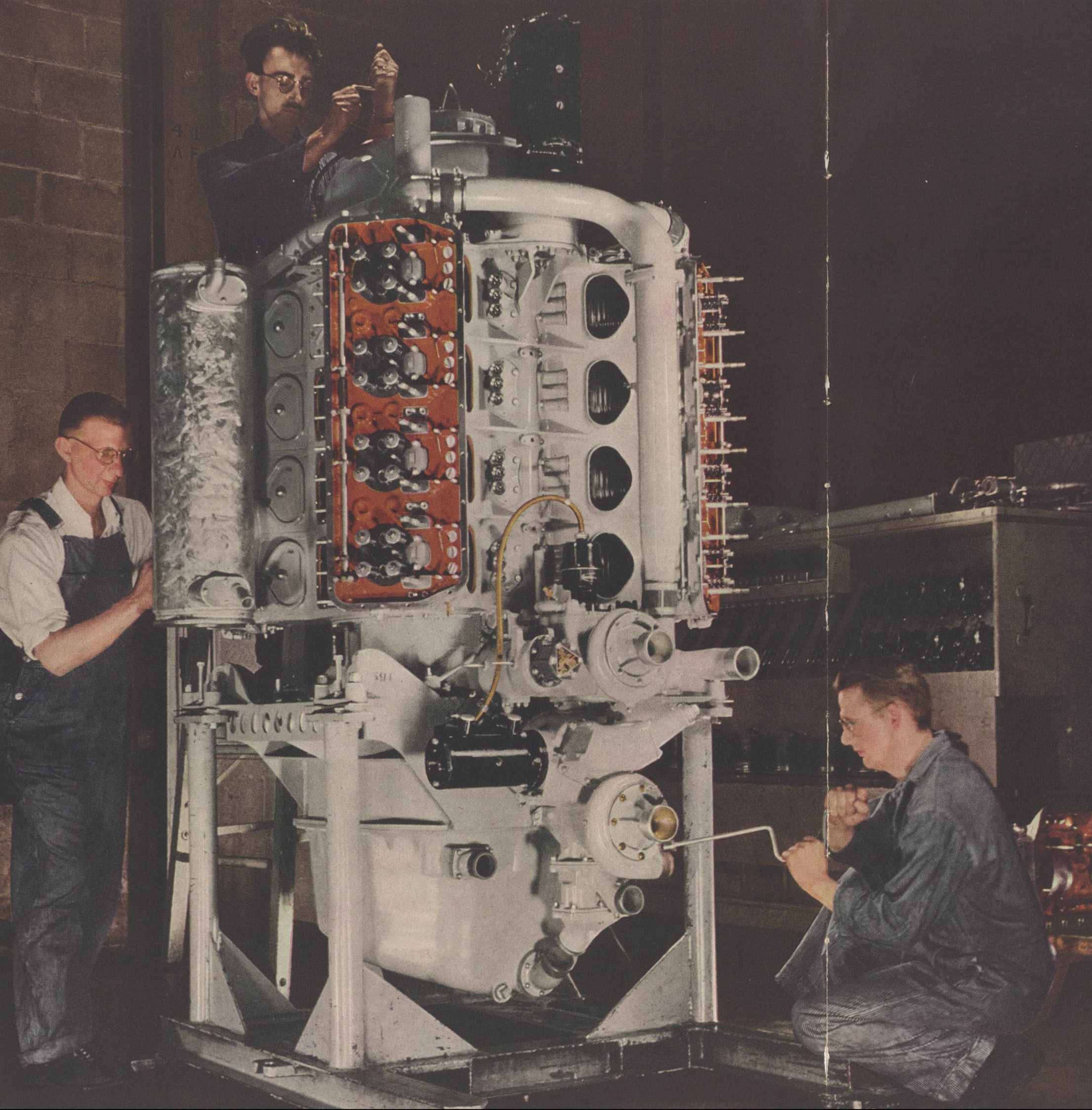
We think it is worthy of note that of the fifty-five persons in the engine testing department of the 184 engine only five had had previous experience. The work of the department nevertheless went ahead satisfactorily.

Once production had started, or in February 1942 when six engines were shipped, it increased steadily. Twenty engines were shipped during the month of May and production averaged slightly more than 20 engines per month during the two-year period between May 1942 and the completion of the contracts in May 1944.

In the meantime the remainder of the vessel's machinery, which included the variable pitch propellers, shafting, exhaust manifolds, lube oil tanks, propeller pitch control and bridge control, became known as the "A" shipment of the subchaser program. These products were shipped prior to the shipment of the engines, for installation in the boats at the shipbuilder's yards.

Since the shipbuilders were totally unfamiliar with the equipment, an Electro-Motive installation engineer was stationed at each of the thirty-two shipyards. These men were responsible for installation of all equipment in accordance with the plans. The scope of this job can be appreciated in noting that the shipyards were located all the way from Rockland, Maine to Los Angeles, California, and from Duluth, Minnesota to Corpus Christi, Texas.

When the engine had been received and installations were completed, dock trials were held. After necessary corrections and adjustments, a preliminary acceptance trial, which called for a full power run of four hours' duration, together with various crash stops and rudder tests, was conducted under the supervision of a Trial Board composed of Navy officers. It is to the credit of our installation personnel and our workmanship that practically all of the vessels were accepted without any repetition of the acceptance trials.



PANCAKE ENGINE PERFORMANCE IN THE 110 FOOT SUBCHASER

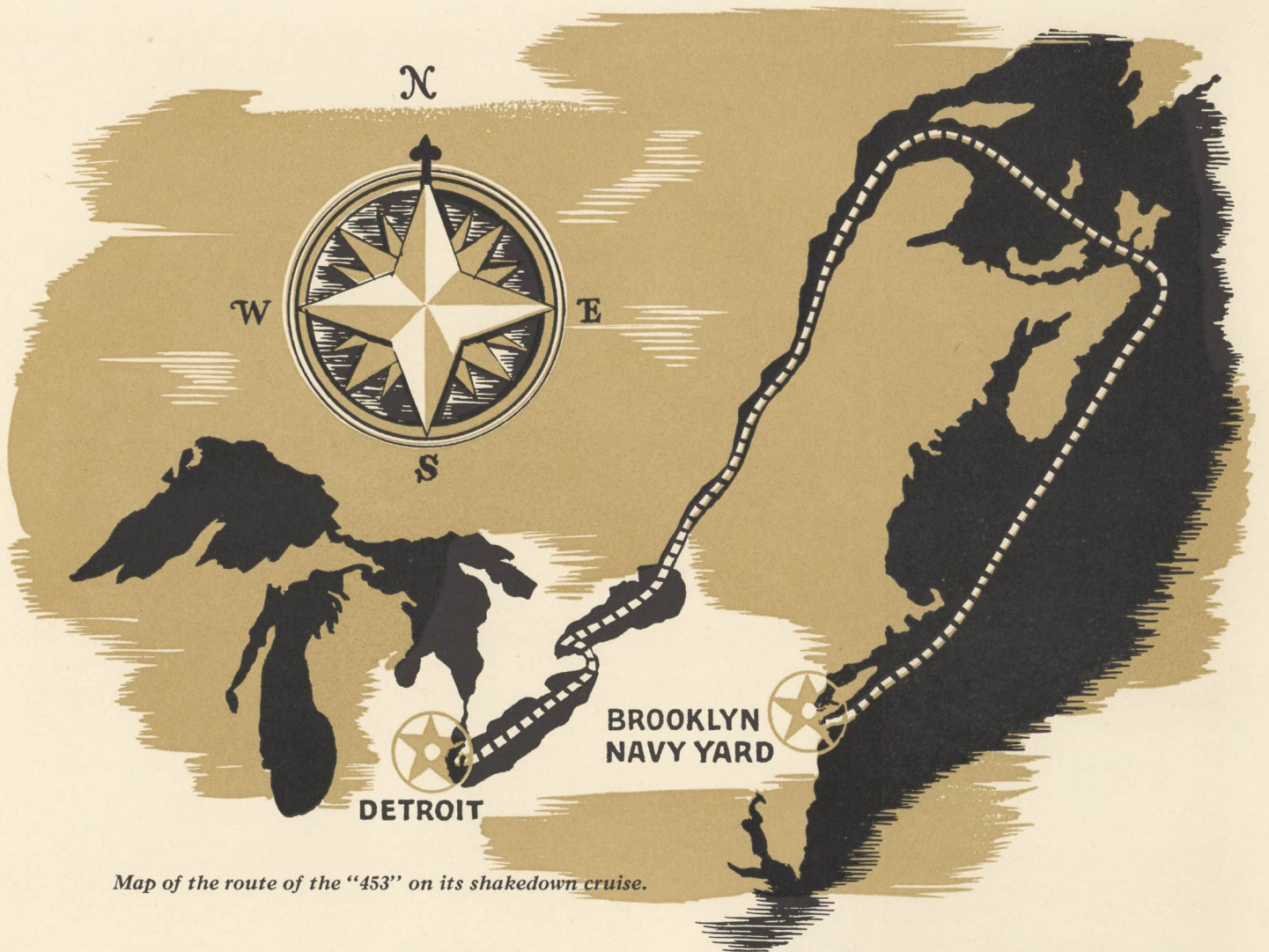
The main propulsion machinery of the subchaser, which includes the Model 16-184A engine, was so novel it was necessary for us first to study the operating characteristics of the engine in the vessel before attempting to instruct the Navy personnel. In our final assembly and test, and under actual operating conditions on the SC-453, we learned how the engine should be operated.

Starting in June 1941 and continuing until July 1942, some 97 enlisted ratings of the Navy were given an operating instruction course at our La Grange plant. While this schooling was going on our own people completed an instruction book. During the summer of 1942, after instruction was sufficiently advanced, the school was moved to the Submarine Chaser Training Center at Miami, Florida, where a much more comprehensive school covering all phases of the operation of an SC vessel had been set up.

Due to the fact that enemy submarines were operating just off the coast of Florida at that time, these courses provided intensive and realistic training for the students and their instructors. We supplied the instruction material, which had been built up at LaGrange during the previous year, and the services of an especially experienced instructor. During the fall of 1942, approximately 700 students went through this part of the Miami school.

The base at Miami became the center, "or shake-down" base to which each vessel proceeded from its delivery yard and where the crews were given their final training preparatory to actual combat duty.

The 16-184A Engine also known as the "Pancake." Contrary to original thinking it did NOT take a "Philadelphia lawyer with a license in steam" to assemble.

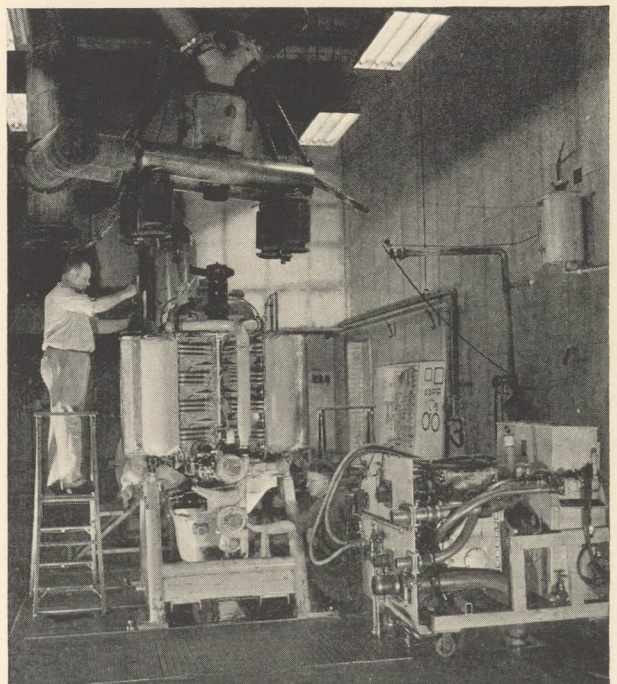


Map of the route of the "453" on its shakedown cruise.

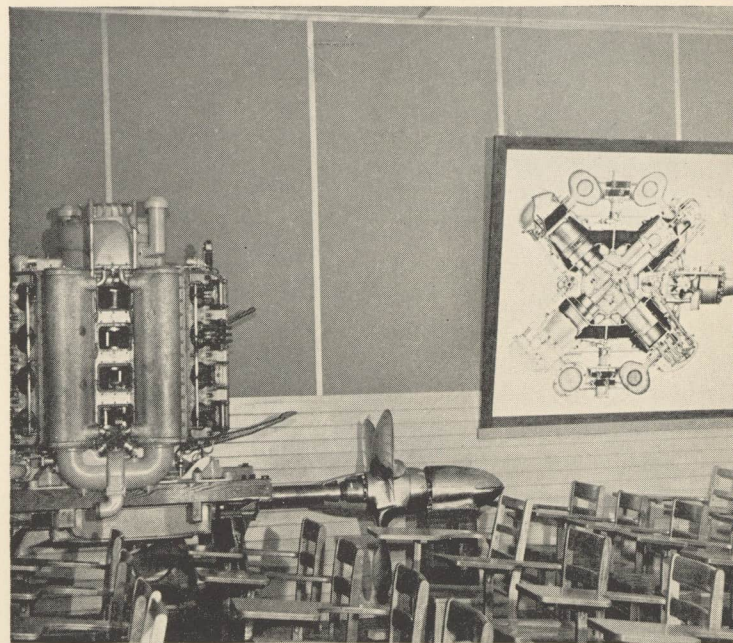
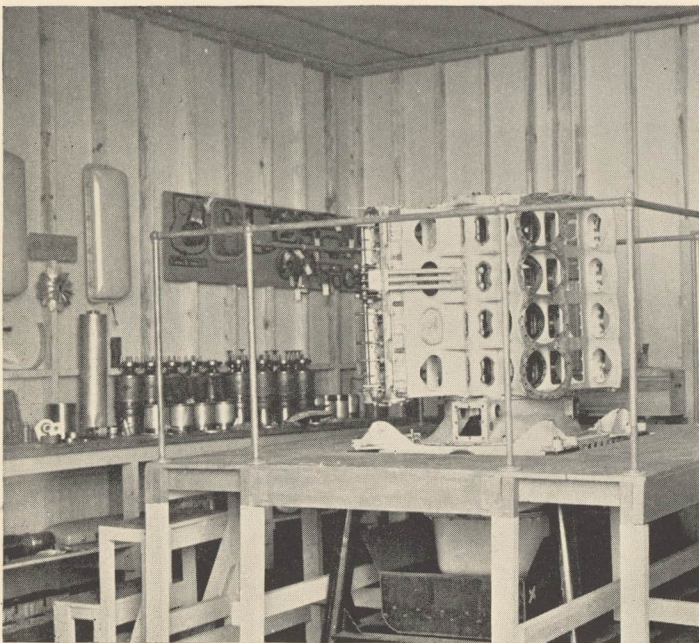
TESTS OF THE 453

At four o'clock on the morning of September 12, 1941, after completing a month of testing on the Great Lakes, the SC-453 (formerly the PC-453) left Detroit, bound for the Brooklyn Navy Yard where it arrived in the afternoon of September 22. The trip was made via the Great Lakes and the St. Lawrence River. Total distance traveled was 2,300 sea miles.

After making this trip, the SC-453 made a circuit of practically all the ports on the Atlantic and Gulf coasts. It was available for subchaser duty in the early part of 1942. It is now at Miami, Florida, serving as a school ship.



One of the four test cells built to test the 16-184 Engine.



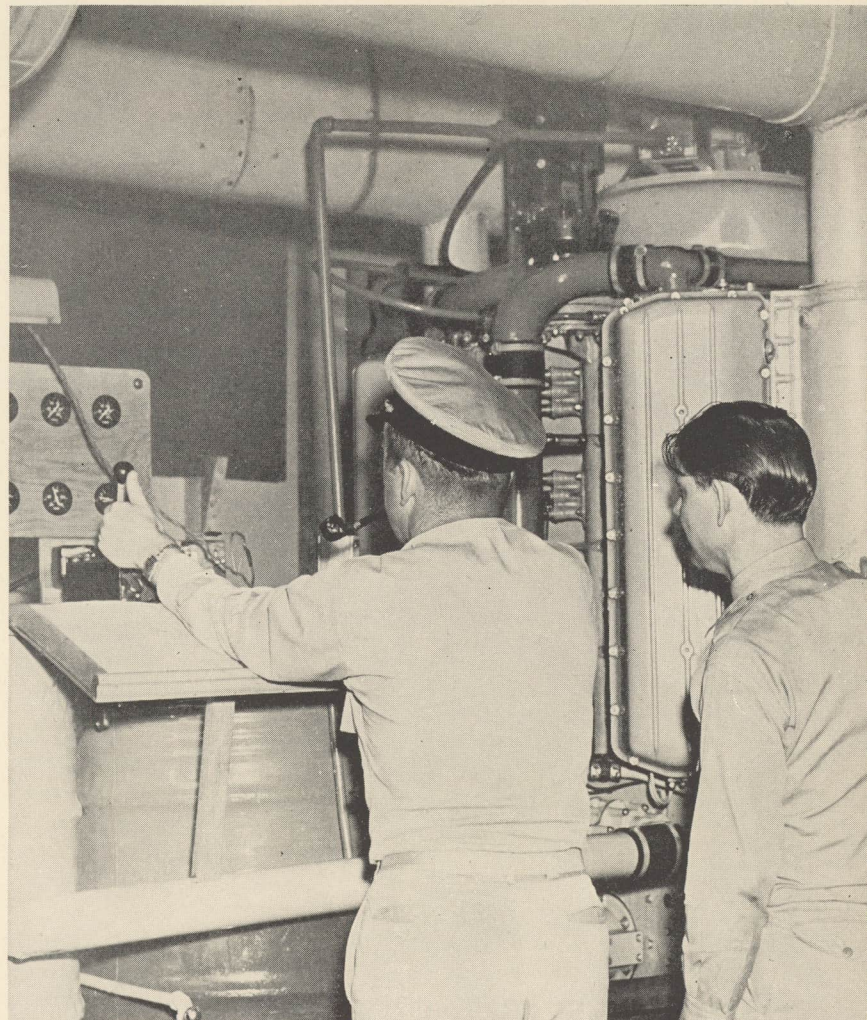
School for 16-184 engine at S.C.T.C. Miami. At top left the platform simulates the deck of the engine room. Top right is a complete engine and propeller assembly, to demonstrate the Variable Pitch Propeller.

The "Zero" or original 184 engine is used for instruction.

OPERATIONS OF THE SC

The SC is 110-feet long with a displacement of 100 tons. Its function in the fleet scheme is inshore patrol and escort duty in the supposedly calmer ocean waters, such as the Caribbean. These vessels, however, have operated out of all the principal ocean ports of the United States, including Dutch Harbor and Pearl Harbor. While their primary function is to drive submarines away they are armed sufficiently to sink them.

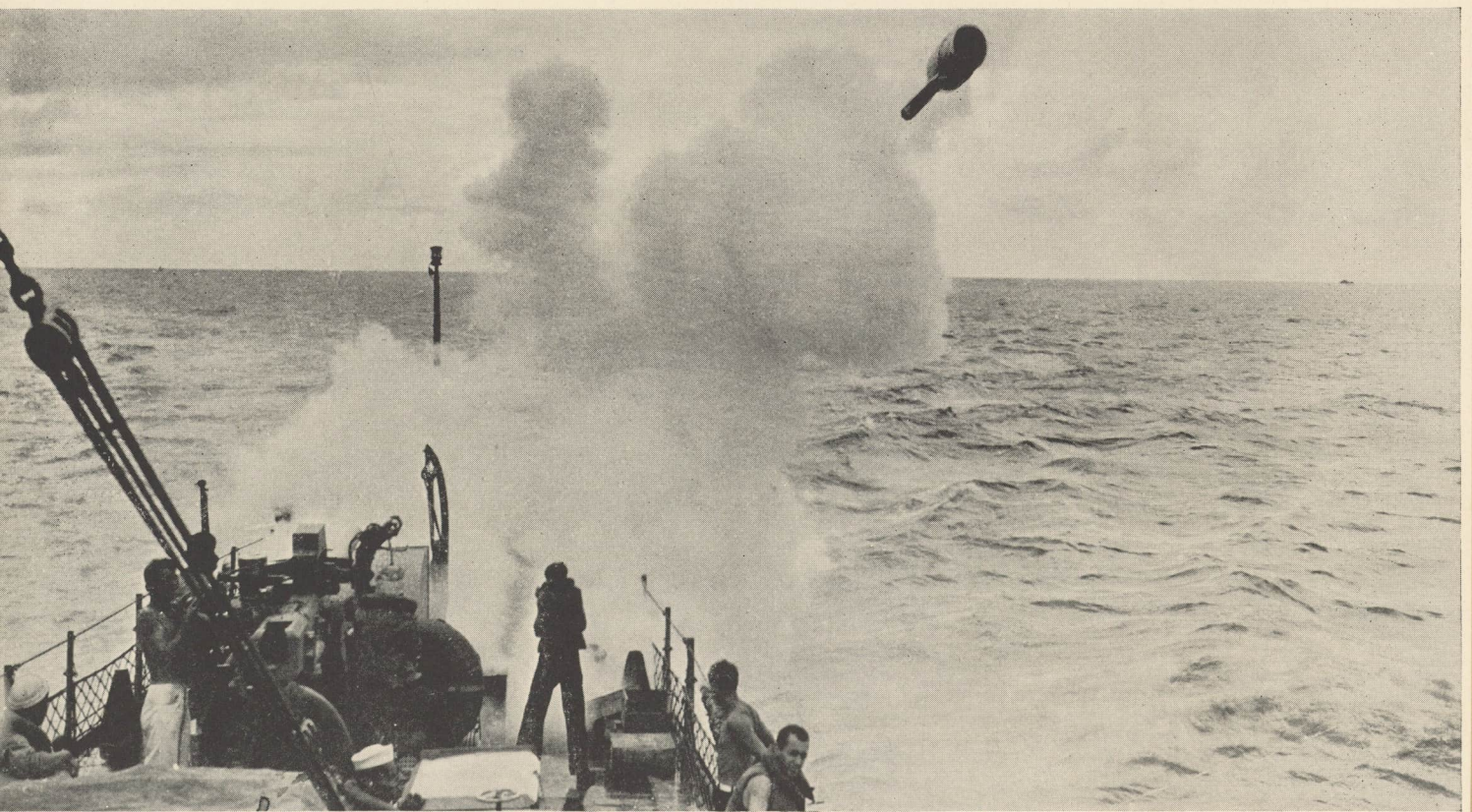
Because of the fact that the principal service of an SC involves staying at sea continuously and for long periods, uninterrupted power availability is the criterion of superior engine performance. It is a source of satisfaction that over a hundred of these extremely light-weight engines have passed the 3000-hour mark of continuous sea duty. Engine performance has been such that the vessels have been able to proceed under their own power at all times.





Above—Protection of Convoys such as this is one of the jobs of the 110 foot Sub-Chaser. Below—Scene at TANAMERAH BAY.

Principal weapon of the Sub-Chaser is the "Ashcan" or Depth Charge shown just as it leaves the "Y" gun.



SOUTH AMERICAN CONVOY

Coincident with the declaration of war by the United States the German submarine fleet invaded the Western Atlantic Ocean and the Caribbean Sea, and, in its attacks on American coastal shipping, sunk half of the coastal oil tanker fleet. This made it necessary for shippers to divert to rail transport practically all material which had moved along the Atlantic Seaboard by water.

Then the German submarine fleet moved down into the Caribbean and even shelled the island of Aruba, off the coast of Venezuela. This was carrying the war close to the Panama Canal and, what was more important, the sinkings were so numerous that a stoppage of shipments of bauxite to the United States was forecast. Bauxite is aluminum ore and a continued decrease in the supply of prime aluminum would have interfered with the scheduled increase in airplane production. Bringing the situation home to many of us personally was the rationing of coffee, which similarly was brought about by the sinking of freighters in the same area.

But the submarine menace began to be overcome in June 1942 when a protected convoy route was established between South America and Southern United States ports. This route was 1900 miles long and over it traveled northward, among other important things, the aforementioned bauxite and coffee for the United States while supplies for West Indies air fields, machinery and other goods for our South American allies moved southward.

Among the escorting vessels for these convoys were 170-foot PC and the 110-foot SC vessels. One Naval

Operating Base was enlarged and an almost new base was constructed at another location. When the whole operation was fully functioning, which was in August or September of 1942, the submarines left the area. The removal of coffee rationing in the summer of 1943 was the result of the protection offered by these escort vessels and by the air patrols set up from our West Indian bases.

The travel time of a convoy between the United States and South America was about ten days. Most of the operating was under very light load conditions. For this kind of work the variable pitch propellers were especially useful. They permitted the use of the desired higher engine speeds with lower propeller pitch and kept the otherwise fast escort vessel speed down to convoy speed.

One engine operation of these escort vessels was tried out on these runs. Experience showed that the second engine could be started in less than a minute and its power made instantly available. All in all these SC vessels gave an impressive demonstration of the economy, the flexibility and the quick availability when needed, of the abundant power found in the Pancake engine.

PATROL IN THE ALEUTIANS

An entirely different type of operation was carried out in the Aleutian Islands which stretch into the Pacific from Alaska and reach within 750 miles of Japanese territory, the Kurile Islands. The Aleutians are on a great circle course from Japan to Seattle and an anti-submarine patrol operating in these waters was necessary to keep Jap submarines from menacing the west coast of the United States and Canada. Likewise, escort vessels for convoys are necessary for ships supplying our forces on the Western end of the Aleutian chain of islands.

Fog veils the Aleutians almost constantly for it is in this area that the moisture carried by the warm Japan current strikes the cold waters of the Bering Sea and condenses. The winds are very erratic and the seas are heavy and choppy. We have lost one SC ship on the rocky shores of these islands.

This general area is not far from the Arctic Circle, and it is a real achievement for a vessel to survive a year in these waters. Yet, many SC boats have been in this area over a year. The Alaskan waters are now a separate command—the 17th Naval District. Originally this was part of the 13th Naval District at Seattle.



REPORTS OF FIELD MEN

The full story of the conditions under which the Pancake engine worked and how it performed in the SC vessels will not be available until the war is over, but the following excerpts from reports of our field service men give a faint idea of some of them.

* * * * *

"This ship is in Seattle after nine rugged months in the Aleutians. They have compiled an enviable record of engine performance.

"The starboard engine was supposed to have been damaged by a depth charge shortly after the ship was put in commission (Bulletin 173, paragraphs 6 and 9). That this fear was unfounded, is proved by the fact that this engine has given very little trouble, i.e., one starter and two Cuno filters failed, and still has ten of her original injectors.

"The port engine's record is almost as good, at 2600 hours an after section of the propeller shaft broke at the sleeve, and at 2643 hours A-3 cylinder was removed because of a coolant leak at the gasket. This engine still has seven of her original injectors. It has had five Cuno and two starter motor failures."

* * * * *

"Never had any trouble starting their engines, other ships using the same fuel had considerable trouble in starting.

"Their engine room is as clean, and the engines sound as good as when the ship left Mathis.

"We are planning on removing these engines for the 3000-hour overhaul, as the ship will probably go back to Alaska after a month's refresher in Seattle.

* * * * *

"It is always a pleasure to check the propelling machinery in this SC as everything is kept as spotless as the day it left our factory. The crew had a perfect score on their first set of engines and are well on their way with the second set of engines. To date the only repair on engines 360 and 367 has been a leaky liner in engine No. 360."

* * * * *

"This pair of engines, though well taken care of, have been subjected to a terrific beating. The ship was on convoy duty from Ketchikan to Attu for nine months. The port engine was used alone to escort a 17 knot transport, at 1700-39" pitch for several days. The starboard engine at various times was used at speeds and loads above normal.

"The two engines, No. 169 and No. 166, removed

from SC 1014 after 3000 hours of service were in better condition than any engines ever disassembled here regardless of their length of service. We found no parts in a condition that would not warrant at least 2000 hours more service. The greatest gap on any compression ring was 0.059". The valves were all in perfect condition. No springs were broken in the blower coupling. No liners or pistons were scored. Below is an item for item comment on the repair report. The numbers correspond to the numbers on the inspection report."

* * * * *

"In the past nine days I have had the opportunity of visiting almost all of the ships working out of this base (Key West).

"It has been a pleasure to go aboard one after the other, meet the crews and listen to their enthusiastic reports on the performances of our engines. Our troubles, so far, have only been minor ones, and if we could have our engines in a hull that would eliminate shaft troubles and could clear up our injector trouble, due, I believe, to overhaul and bad fuel, I feel that most all of our troubles would be over.

"New ships and new crews seem to have the most difficulties but I'm sure that the larger majority of them will be converts and will be just as enthusiastic in their praise of our engines as some of these crews which now have close to 3000 hours on their engines and those who are already running on their second set of modernized engines.

"I feel that the engines in the ships here are piling up hours we can well be proud of."



MISCELLANEOUS WAR JOBS

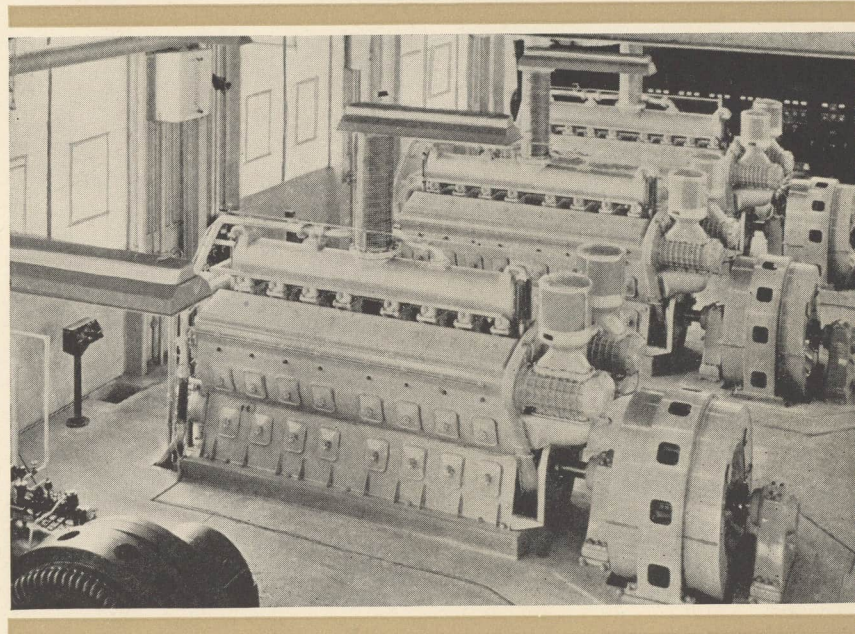
During the fall of 1940 our Metallurgical and our Fabrication departments undertook the job of welding a cast steel tank hull. We welded the job and it was later sent to the Aberdeen Proving Ground in Maryland for testing. Mr. John H. Hruska, then our Chief Metallurgist, was later appointed to the Metallurgical Advisory Committee of the Watertown (Massachusetts) Arsenal. In this capacity he directed several experimental projects which helped to introduce new alloy steels into use as armor plate. The actual welding was done in our LaGrange plant, the material being sent to various proving grounds as directed by the Ordnance Department.

Then, in 1941, presumably as a result of the bombings in Great Britain, a number of organizations began buying our 567 engine for use as emergency, stationary power plants. Among the stationary applications of our engines were, notably: the Key West Electric Company in Key West, Florida; the Allison Division of General Motors in Indianapolis; and the North American Aviation plants in Dallas and Kansas City.

The Bell Telephone Company likewise adopted a policy of putting in independent sources of stand-by power for its large switchboard operations. Electro-Motive supplied the engines and were responsible for the telephone company's installations at Pittsburgh, Akron, Cleveland, Detroit, Chicago and Lawrenceville, New Jersey.

At the end of 1942, when our electrical production department was nearly shut down as a result of the concentration of the plant's facilities on Navy Diesel engines, we were called upon and were glad to take over the manufacture of 100 KW generators for the Navy. These were for use with the power units in the new landing boats and were built by us in accordance with the design of Delco Products Division of General Motors. We made 967 of these generators in the first six months of 1943 and, presumably, they are all being used in the Landing Craft program.

At about the same time we also agreed to make one hundred Model 8-567 engines for tugs for the Army. This engine installation included the use of a Falk Airflex clutch and reduction gear, as were being used in installations for the Navy. These power plants and their equipment were installed under the supervision of Army engineers. The tugs were known as the DPC tugboats.



Top—Experimental Tank Body welded by EM in Fall of 1940.

Bottom—Battery of 16-567s in industrial Power Plant.

The same power plant purchased by the Navy for the LST vessels, which is described elsewhere in this book, was also supplied for the 180-foot submarine chasers (known as the PCE), which were built for use in British waters. These vessels were under construction during the last half of 1943.



ORIGIN OF THE LANDING CRAFT PROGRAM

Back in the winter of 1935-6 the Bureau of Construction and Repair of the Navy (which later became part of the Bureau of Ships), initiated the designing of various types of small craft intended for landing soldiers at invasion points. These small landing craft were to be carried in boat davits on troop transports and auxiliary vessels and to be used for landing troops and cargo where pier facilities were unavailable. A number of these craft were tested in the fall of 1936.

The testing, developing and improving of these first landing craft types led ultimately to the adoption of standardized models LCV (Landing Craft, Vehicle); LCP (Landing Craft, Personnel); and LCR (Landing Craft, Rubber). Large numbers of these boats were later ordered by the Navy.

At about the time the foregoing events took place, the Navy undertook the development of a "tank lighter." This was to be a boat designed to carry one light Marine Corps tank and have facilities which would permit the tank to run ashore over a ramp. Detailed plans were completed in 1937. One lighter was tested in landing exercises a year later.

But as war clouds gathered and the feats of mechanized warfare in Europe became better understood the role of the tank in warfare assumed increasing proportions. The tank became a vital part in the nation's preliminary war production program.

By the latter half of 1941 it seemed certain that a new provision would have to be made for transporting great numbers of heavy tanks to invasion areas. It seemed necessary to build a tank lighter capable of crossing oceans under its own power. It was obviously impossible to launch a lighter capable of carrying multi-ton tanks from the decks of any transports or freighters then in existence.

A 155 millimeter gun is landed on Rendova Island. The Solomon Island camouflage gave the LST the nickname "GREEN DRAGON" in the Southwest Pacific Theatre.

The British, who had an extensive landing craft program of their own, had come to similar conclusions. Though their early plans were built around Commando raid experiences the new technique of invasion called for a landing craft large enough to carry many men, machines, guns and supplies.

A new type of vessel was in the minds of most naval men. In November 1941 a small delegation from the British Admiralty arrived in the United States to work with our Navy Department on a preliminary design of the desired larger landing craft. This delegation was also to arrange, under the then recently enacted Lend-Lease Act, for construction of the ships in the United States.

As a result of these conferences it was agreed that the Bureau of Ships should develop the LST (Landing Ship, Tanks), which was to be a giant vessel capable of transporting and landing a number of tanks and accessories weighing hundreds of tons.

One of the unexpected uses of the LST. They have served as hospital ships in many theatres of operation.

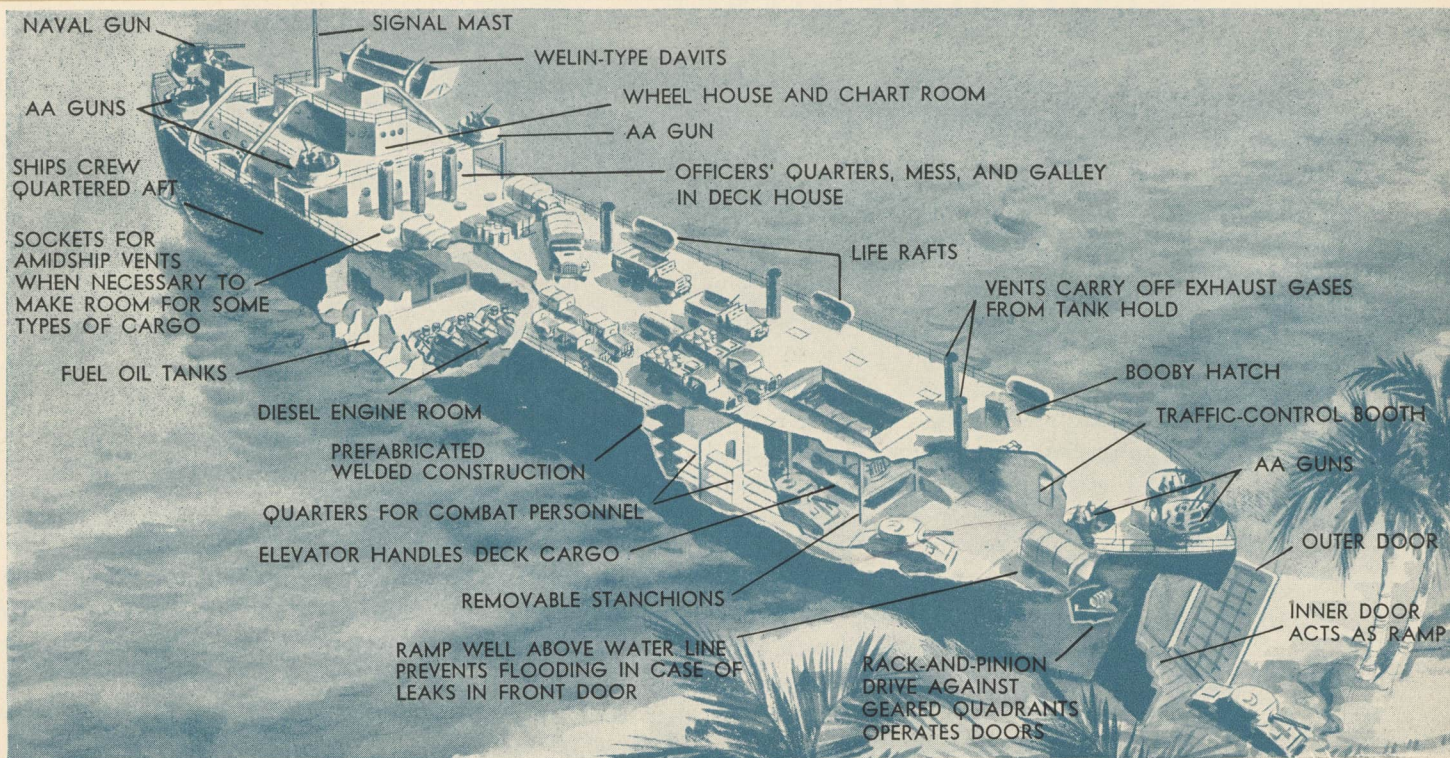
Also concluded during these meetings were plans for a smaller lighter, the LCT (Landing Craft, Tanks). The latter was conceived as an intermediate landing craft which could be carried (in sections) on cargo ships or on LST's. Afterward a number of related other craft were suggested by the logic of the situation.

In all, at the time of the attack on Pearl Harbor, the following were under construction or in the design stage:

- LST* —Landing Ship, Tanks
- LCVP* —Landing Craft, Vehicle, Personnel
- LCM (3)*—Landing Craft, Mechanized (Mark III)
- LCT (5)*—Landing Craft, Tanks (Mark VI)
- LCC* —Landing Craft, Control
- LCR* —Landing Craft, Rubber
- LVT* —Landing Vehicle, Tracked
- DUKW* —Amphibious Vehicle (Army)

After the Japanese attack on Pearl Harbor, and while the LST was in the design stage, realization of the need for ocean-going, tank-carrying craft became widespread. In fact, the demand for all





kinds of landing craft skyrocketed. Strenuous efforts on the part of all power unit and vessel builders, both those in the business at the time and many potential builders, were needed to get the program into quick production.

But let us dwell a moment on the LST which can well be called a paradox. While its draft is light enough to permit nosing up to a shallow beach, it is nevertheless sufficient for ocean-going freight service. The ship is large enough to carry soldiers and their fighting and supply equipment, including tanks and small barges, and it can be unloaded quickly without using docks or piers.

Approximately 316 feet long and 50 feet wide, the inner deck space of the LST is large enough to carry a number of tanks or their equivalent as to weight and space of other modern war vehicles. This carrying space is in addition to a large upper deck cargo space.

Quarters for the ship's personnel are built around the inner tank deck. The power plant, stores, etc., are in the hull which is lined with water-filled compartments which can be used as controllable ballast. When filled these compartments give the ship greater draft, and vice versa. Also this controllable

The above cross section of the LST gives a good idea of the inside story of these ships which have played such an important part in our successful landings. Their tremendous capacity and ability to land close up on shore make the LST as one of the great developments of the war.

water ballast can be operated to make the boat ride high forward or aft as may be desired in particular operations. By emptying the tanks on one side and filling them on the other the ship can be made to list sufficiently to facilitate side launching of small, deck-carried craft or even sidewise unloading of deck cargoes.

A feature of the LST is the winch-operated stern anchor which is dropped when the ship is approaching shore to make a landing and is then used to pull the ship off the shore when its landing operation has been completed.

Incidentally, the economic effects of the likely introduction of these ships into peacetime freight-carrying are interesting to contemplate. Many an area over the world has remained remote because of an inaccessibility which the LST now overcomes.

PROVIDING DIESEL POWER FOR LAND- ING CRAFT

Adaptation of the 567 Engine to the LST

While the designing of the LST ships had been making good progress a supply of applicable ship engines was not in sight. In fact, so great was the need for coordinated action which would make engines available when the ships were ready for their power installations that, even before the design of the LST was completed, the Bureau of Ships began looking over possible new sources of ship power.

During December, 1941, a representative of the Bureau of Ships visited Electro-Motive. He described the size of the program and explained some of its details. The power situation in this new program was such that it seemed necessary to make use of our Model 567 engine, which we were using in our railroad locomotives.

Our position was set forth in the following excerpts which are from letters written by our Mr. F. H. Prescott during January 1942 to the Bureau of Ships:

"We have supplied a number of 567 engines to the Navy which have been modified somewhat by the Cleveland Diesel Engine Division. We have no

hesitancy in rating the 567 engine at 100 HP per cylinder at 800 RPM, and would be glad to undertake whatever tests seem desirable to the Bureau of Ships to establish such a rating.

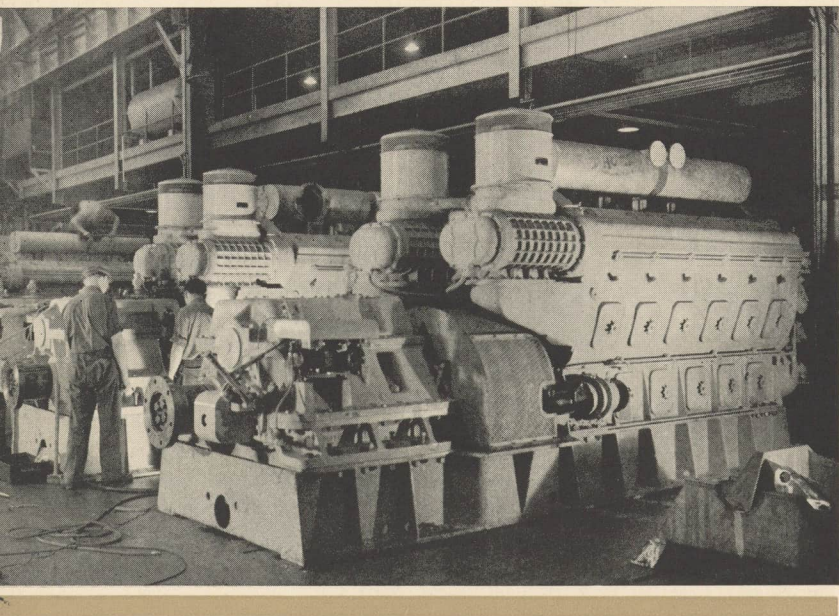
"It should be pointed out that this engine is not reversible and up to date in marine service it has always been used in connection with electric drive. It is necessary to add electric starting, and it has been customary to provide liquid cooled exhaust housings.

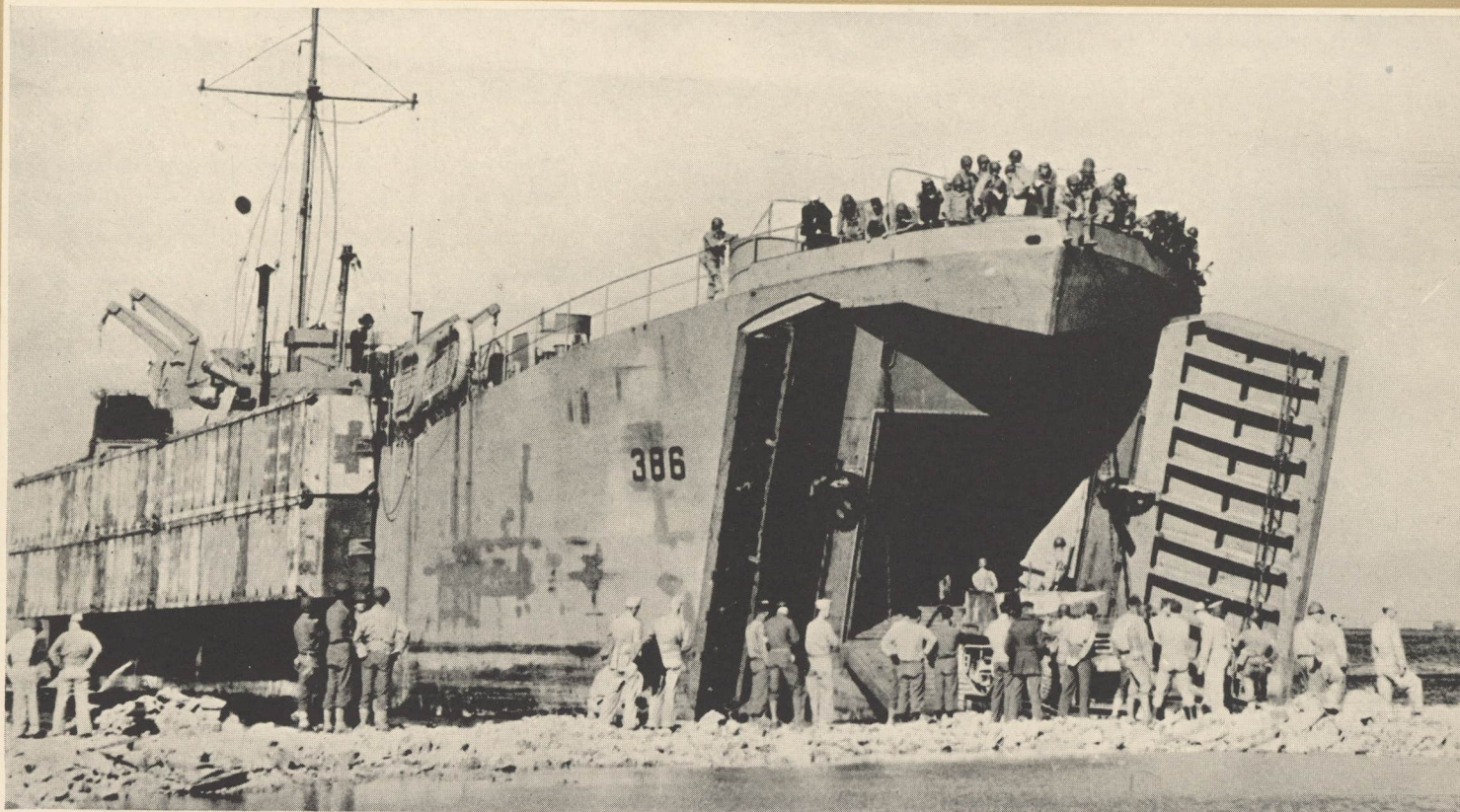
"We supplied some 8-567 engines to the United States Coast Guard on which the blower was moved inboard, reducing the overall width of the engine considerably.

"The original drawings for this engine were completed in 1937 and the buildings, machinery and equipment were completed in 1938. The first engines were completed in July, 1938 and were installed in a tug built by the Defoe Shipbuilding Company for the Moran Towing and Transportation Company. A number of other marine applications were made at this time by the Cleveland Diesel Engine Division, notably twelve 12-567 engines for fleet tugs, the Navajo, the Seminole and the Cherokee.

"The first Model 567 engines sold for locomotive work were delivered in October 1938 to the Seaboard Railway and have been in continuous service for the past three years, covering approximately one million locomotive miles, or 20,000 hours of operation. We have supplied the following engines to various railroads in locomotives:

Assembly of Engine and Reverse Gear on the Sub-base.





From this position on the side of the ship the LST can drop pontoon gear to establish a "road bed" for landing

heavy vehicles. The gear was not necessary here. Below—The pontoon bridge is used at Nettuno, Italy.



270— 6-cylinder engines

487—12-cylinder engines

49—16-cylinder engines

In addition to the above, fifteen 16-cylinder engines have been made for stationary work.

“During this three year period a continuous effort has been made to improve the engine from a production and maintenance standpoint. Orders on hand at the present time require the building of 46 six-cylinder engines, 161 twelve-cylinder engines and 196 sixteen-cylinder engines.

“We are also attaching a sketch showing the proposed arrangement of the blowers to reduce the overall width and some test data covering the torsional study of the 12- and 16-cylinder engines.”

To demonstrate to the Navy what our engine could do a 12-567 was taken from locomotive production and put on a test stand and run for fifteen days. It produced 960 HP at 720 RPM; and then, without stopping the test run, the load and speed were stepped up and the engine was run two more days, producing 1200 HP at 800 RPM.

This test was conducted at our LaGrange plant under the supervision of the Inspector of Naval Machinery. It followed the exact procedure prescribed by the Navy for testing Diesel engines for submarine use. Examination of the engine after completion of the test showed it to be entirely satisfactory at the stated rating.

By the time the test had been completed, Gibbs & Cox, Inc., of New York, had been appointed design agents for the LST, and the problem of designing the installation of the 567 engine was undertaken.

The arrangement of the final drive was almost identical with that used in the tug “Bull Calf,” built in 1939, i.e., the main propulsion consisted of a 12-567 engine driving a reduction gear through an air operated clutch supplied by the Falk Corporation (See picture of Bull Calf engine, page 18).

It is an interesting fact that the Falk Corporation, Cleveland Diesel and Electro-Motive, in cooperating to produce the river tug “Bull Calf” in 1939, had produced a mechanism which embodied almost all of the principles adapted for the propulsion machinery of the LST, which was not projected until more than two years afterward.

The propeller speed for the LST was set at 300

RPM with the engine running at 745 RPM. The push of the two propellers of the LST, with the engines at full power, is about equal to the pull of one unit of the four power units which make up an Electro-Motive freight locomotive of 5400 HP.

Because the LST was designed to have two propellers rotating in opposite directions it was necessary to build reduction gears and engines for both directions of rotation. By using the air operated clutch mechanism and reduction gear the electrical equipment for the drive was eliminated. This was important because it would have been difficult to manufacture the electrical drive in the quantities required.

The further fact that one unit of reduction gears and air clutch had been in satisfactory operation over a three-year period in the tug “Bull Calf” undoubtedly helped to give this design sufficient background to permit its adoption.

The principal changes found to be necessary in the engine itself were dictated by the requirement that it be made shock-proof, that is, made to withstand the shock of bombs which might fall on or near the vessel. This meant the elimination of all cast iron except for the cylinder liner, cylinder head and the pistons, which were surrounded by steel. The blowers were moved inboard to decrease the width of the engine and a new exhaust housing was designed to provide for water cooling the exhaust passages. A sample engine was built according to our drawings and specifications and the final test stand run was completed July 20, 1942.

On October 31, 1942 the first LST sea trial and beaching operation was made. The principal difficulty encountered was that the sea suction was lost due to sand, dirt and pebbles getting into the sea chest during the beaching operation. However, these difficulties were overcome, the trials completed and the vessel was formally accepted on November 4, 1942.

The test vessel had been built by the Newport News Shipbuilding Company. While the actual building of this first ship had taken only ninety days, a whole year had elapsed since the original plan for building such a vessel had been adopted. We were, nevertheless, elated that our 567 engine had been found to aid so effectively in the attainment of the Navy's objectives.

DEVELOPMENT OF THE QUAD ENGINE FOR THE LCI(L)

Like the LST, the LCI (L) was expected to cross oceans under its own power. The "Quad" power plant developed by The Detroit Diesel and Electro-motive Divisions of General Motors was selected for the propulsion of the LCI(L) vessel.

Detroit Diesel during the summer of 1941, had supplied twin Model 6-71 engines for medium tanks and this had suggested the possibility of using four of such engines, assembled around a single reduction gear unit, to obtain power for marine propulsion which would be equal to the combined power of four engines operating on a single propeller shaft.

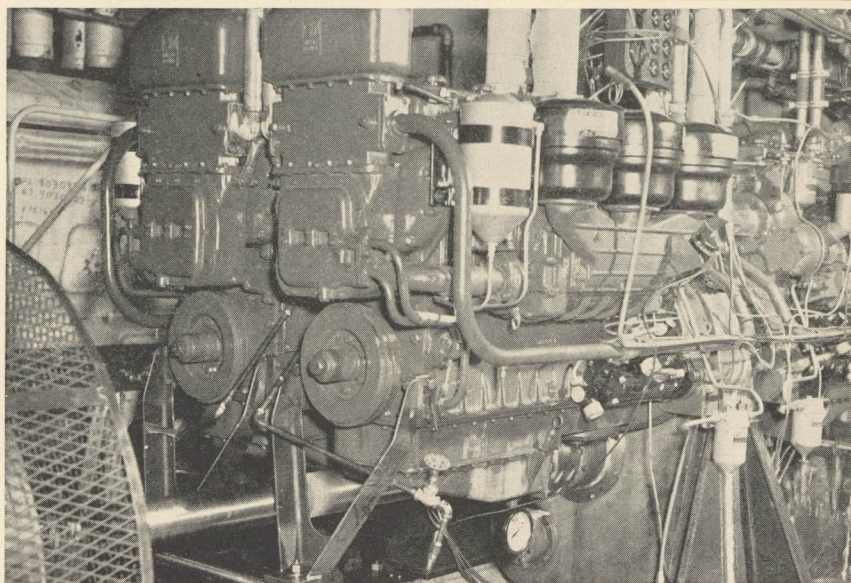
This power plant was to drive a propeller shaft equipped with variable pitch propellers and thus enable the vessel to back up without using a reverse gear mechanism. The propeller thrust was absorbed in the gear box by a double row ball bearing.

An experimental model of this power unit was completed in February 1942, and put on test in our plant under the supervision of Inspector of Naval Machinery at LaGrange.

When the LCI program was started in the Bureau of Ships on April 28, 1942 by a dispatch from the European Theater, two of these Quad power plants of 900 HP each, capable of producing a maximum of 1800 shaft horsepower for the boat's propulsion, were decided upon as the power plant. A contract was negotiated with the Navy, calling on Detroit Diesel to build the engines and Electro-Motive to supply the reduction gears, the propellers, shafting, and the control units for the variable pitch propellers. Details of the installation were worked out between Electro-Motive, Detroit Diesel and the New York Shipbuilding Corporation as the latter had been made responsible for the craft's design by the Bureau of Ships.

The first LCI vessel was completed in exactly five months after it had been projected. It passed its preliminary acceptance trial on September 28, 1942 and further trials were immediately conducted by the Navy. No extensive modifications of the equipment were required.

The fact that the LCI vessel has proven satisfac-



This is the original QUAD Engine. Tests on this assembly were run in February 1942. The numerous wires and tubes are for engineering test purposes.

tory in spite of the extremely short development period makes the engineering of this project a remarkable achievement.

In addition to the New York Shipbuilding Corporation whose normal operations centered on building battleships, cruisers, and aircraft carriers, the following yards were assigned the task of building LCI(L) vessels:

George Lawley & Sons, Neponset, Mass.

Bethlehem Steel Co., Hingham Plant, Hingham, Mass.

New Jersey Shipbuilding Corp., Barber, N. J.

Consolidated Steel Corp., Ltd., Orange, Texas

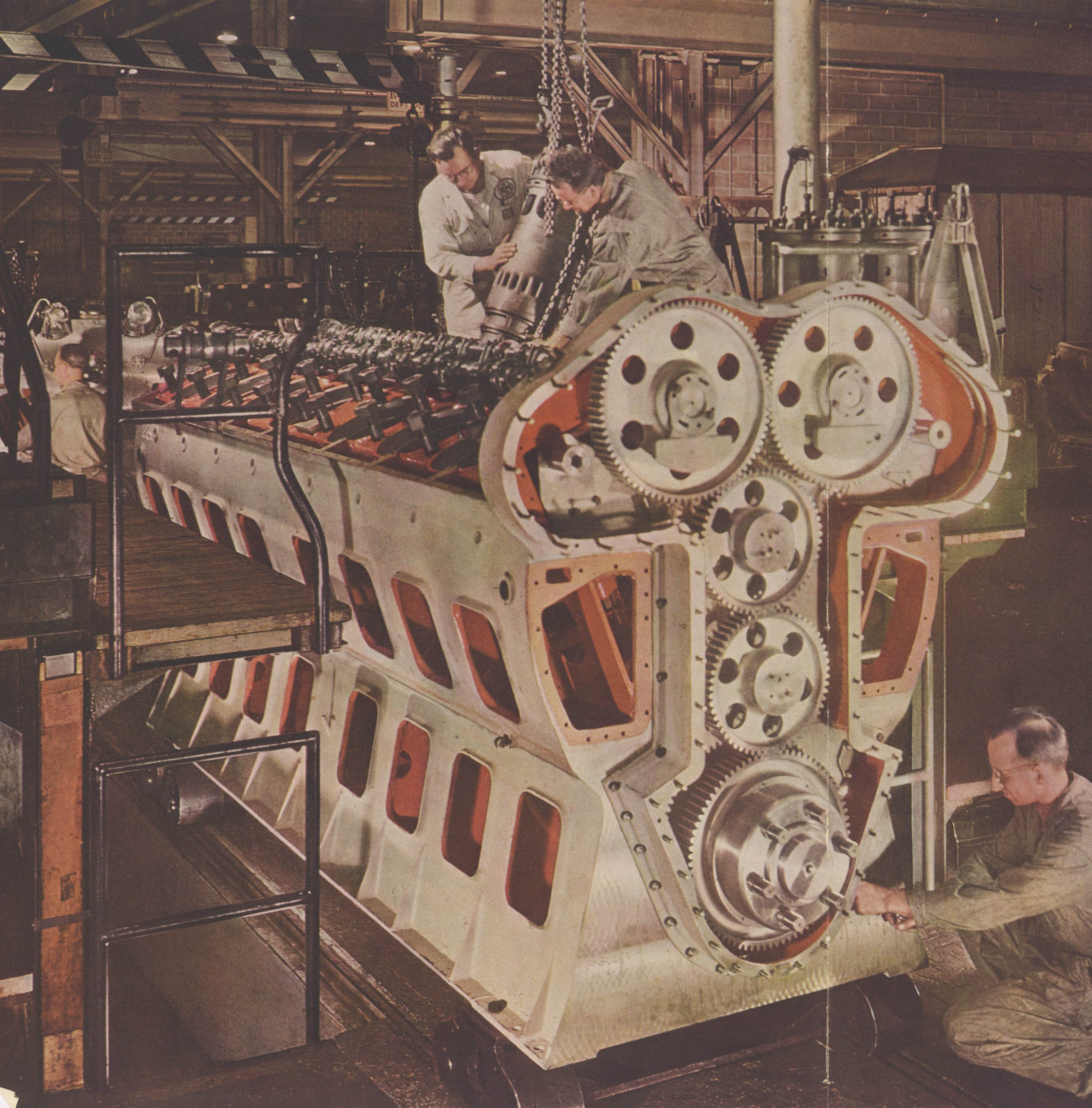
Brown Shipbuilding Co., Houston, Texas

Federal Shipbuilding & Dry Dock Co.,

Newark, N. J.

Todd Erie Co., Erie Basin, Brooklyn, N. Y.

The building of LCI propellers, shafts, reduction gears and controls, which was our part of the LCI program, was carried forward and completed during 1942. At that time no further orders were in evidence and it seemed as if a sufficient quantity of these vessels had been produced. However, in the spring of 1943, new orders came from the Navy. An ever increasing demand had been created by the performance of these vessels in the combat areas.



FACILITIES FOR BUILDING THE 567 ENGINE

Our business was expanding rapidly during the fall of 1941 and it was becoming increasingly evident that additional manufacturing space and machinery would have to be acquired in order to maintain our locomotive production program. The 120,000 square feet of new plant capacity, known as the Navy Building, was in process of completion.

It was planned to add five bays, 240 ft. x 370 ft., having a total area of approximately 89,000 square feet, to be used for the purpose of manufacturing the electrical equipment used in the locomotive.

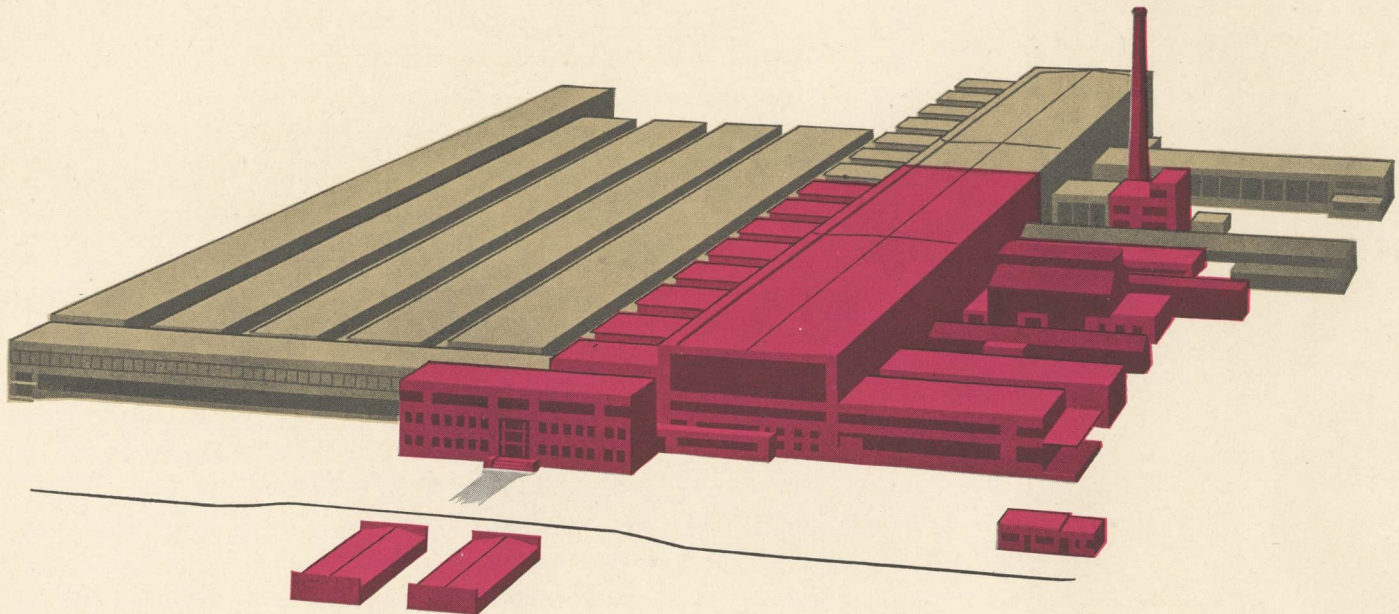
However, even before building operations on this newest addition were well under way or during December 1941, we changed the plant layout to meet the Navy's 567 engine requirements. In January 1942 we submitted plans to the Navy for using the 89,000 square feet then under construction, plus a still further addition of four bays and a test building, for Diesel engine production. These changes increased the floor space for making the 567 engine by approximately 189,000 square feet.

When the expanded project was being first negotiated, the machinery requirements for the projected plant capacity were outlined to the Navy and an agreement was reached whereby the Navy would provide the machinery and we would provide the land and buildings necessary to house the machines. Authority for the machinery was given (in a letter of intent on February 12, 1942), and purchase of the machinery was started immediately. This purchase and lease contract, NObs 594, is familiar to all who see the machinery. The words "U. S. Navy Property—Contract NObs 594" appear on some 664 separate machine tools in our plant.

Naturally, this project was only one of the many being started by the government at that time. Hence, the actual receipt of required machinery

ASSEMBLY OF THE 567 ENGINE

A subassembly of the cylinder head and liner is being lowered into its position in the engine crankcase.



Isometric projection of Electro-Motive Plant in 1938 before gathering war clouds made expansion necessary.

was very much delayed and this interfered seriously with the engine building program. During the month of August, 1942, the following list of super-critical or "bottle-neck" machine tools was submitted to the Bureau of Ships as being the most urgently needed:

<i>Horizontal Boring Machines</i>	4
<i>Drill Presses</i>	13
<i>Grinding Machines</i>	10
<i>Lathes</i>	25
<i>Milling Machines</i>	6
<i>3-head Milling Machine for Crankcases</i>	1
<i>Gear Cutting Machines</i>	5
<i>Miscellaneous</i>	5

By February 1, 1943, however, we had received a total of 599 or 90% of the 664 machine tools which were on order and which were required to complete the job. Due to delays occasioned in obtaining steel, the new building and test building were not completed until October 1942.

Due to the late start which the LCI program experienced, manufacturing was carried on by using facilities of the 184 engine in the Navy Building

together with the old and new machinery for making the 567 engine. Also, due to the big LCI schedule, it was possible to assign one bay for LCI propellers and shafting production.



BUILDING OF THE LST SHIPS

When the program for building the LST ships was originally launched the shipbuilding yards in the United States were fully occupied building other Navy and Maritime vessels. Hence, rather than disturb these activities, and especially since the LST was an entirely new ship, the government deemed it logical to set up new yards to build the LST's.

The following companies were selected by the Navy to build the LST's:

*Dravo Corporation, Neville Island,
Pittsburgh, Pa.*

Chicago Bridge & Iron Co., Seneca, Illinois

*Missouri Valley Bridge & Iron Co.,
Evansville, Ind.*

American Bridge Company, Ambridge, Pa.

*Jeffersonville Boat & Machine Co.,
Jeffersonville, Ind.*

All were experienced bridge builders and, with the exception of the Chicago Bridge and Iron Works, which built a new shipbuilding plant at Seneca, Illinois on the Illinois River, they constructed their LST yards along the Ohio River. It

being apparent that this LST shipbuilding program would take considerable time, the original schedule was set up with the expectation that the shipbuilding companies would start deliveries of the vessels coincident with the expected production of 567 engines in our new plant.

We had prepared an engine production schedule in April 1942 which could have been met with the existing machinery and without interfering with the locomotive program. However, during May the necessities of the war situation required speeding up of the LST program, reducing the time allowed for delivery of the first lot of ships by six months.

The navy therefore added the following yards to the LST shipbuilding program:

Navy Yard, Boston, Boston, Mass.

Navy Yard, New York, New York, N. Y.

Navy Yard, Philadelphia, Philadelphia, Pa.

Navy Yard, Norfolk, Norfolk, Va.

Navy Yard, Charleston, Charleston, S. C.

*Bethlehem Steel Co., Fore River Plant,
Quincy, Mass.*

*Bethlehem Steel Co., Fairfield Plant,
Baltimore, Md.*

Preparing to load LSTs for an amphibious operation.



*Newport News Shipbuilding & Dry Dock Co.,
Newport News, Va.*

Kaiser Company, Inc., Richmond, Calif.

Kaiser Company, Inc., Vancouver, Wash.

Among other effects of the change was an increase in output of reduction gears by having companies other than the Falk Corporation, the original manufacturers of the gears, undertake the work.

It proved difficult to find additional sources for the production of Diesel engines and so it was decided to build all the LST engines possible in the existing Electro-Motive plant at LaGrange. The consequent interruption of our locomotive building program had not been contemplated originally, and only the extreme urgency of the situation made this sacrifice necessary.

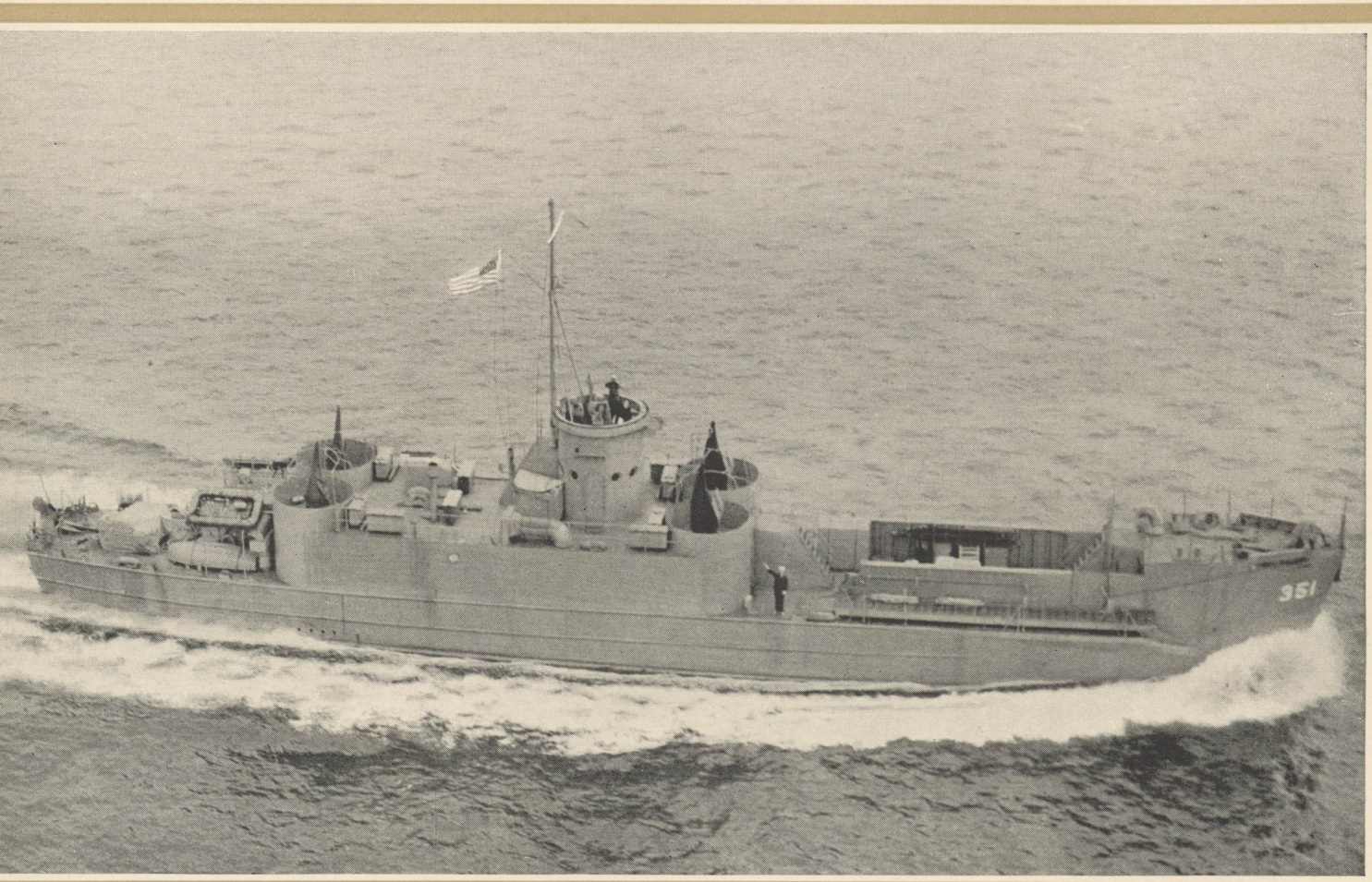
However, the flow of LST engines to the shipyards started with the shipment of four sets in July 1942 and we were able thereafter to keep our deliveries ahead of the shipyards' actual needs. With the 100 engines shipped in November 1942 we undoubtedly supplied more engines than the Bureau

of Ships had hoped for, although the quantity of our engines shipped was according to the Navy's schedule.

With the completion of the first rush order of LST vessels in the early spring of 1943 the demand for these ships slackened. But after the landing at Sicily and Salerno a really urgent need for increasing ship production was made known. In other words, the demonstration of what the ship could do in practical combat service brought a big increase in orders for engines.

Month after month these engines have been and are being shipped to the Navy in quantities far in excess of any horsepower previously delivered to the railroads in a similar period. In fact, the aggregate horsepower delivered to the Navy over the past twenty months equals the aggregate horsepower delivered to the railroads in the past ten years.

The LCI(L) 351 is the first of the second design of Infantry Landing Craft, hundreds of which are in service.





LST AND LCI ENGINE AND EQUIPMENT INSTALLATION

This scene is on the Ohio River at the Dravo Corporation Shipyard. The 567 Engine complete with Clutch and Reverse Gear is being lowered into the hull of an LST. In the background may be seen the ways down which this ship will slide in a sidewise launching.

The problem of installing machinery in the LST and the LCI(L) vessels was somewhat different from that of installing engines in the 140-foot submarine chaser in which we had the full responsibility for the propulsion machinery. In the case of the LST vessels we had representatives at all of the shipyards but their responsibilities were limited to seeing that the engine was installed properly and to give such instructions required in regard to the engine.

The same procedure was followed in the case of the LCI except that our responsibility was limited to the propeller, shafting and reduction gears.

Cleveland Diesel had prime contractor responsibility on LST, while Detroit Diesel had prime contractor responsibility on the LCI(L).



SCHOOLS OF AMPHIBIOUS CRAFT

The first LST engines completed in our plant were taken by the Navy Department for school purposes. Schools were established at the Navy Pier, Chicago; at the Cleveland Diesel Engine Division in Cleveland and at South Richmond, Virginia. The course of instruction was prepared at General Motors Institute at Flint, Michigan, and instructors, who were Chief Petty Officers of the Navy, were trained there.

Electro-Motive's contribution to this school program consisted of revising the standard locomotive Diesel instruction manual to fit the changes in engine design found in the LST engine and to harmonize with marine operation requirements. We also supplied service engineers to give on-the-spot information in the Navy schools.

Since the aggregate personnel required to operate all the ships in the LST program alone was expected to be over 50,000 men, or six times the total number of people employed in our plant, the Navy obviously faced a tremendous task in getting the crews trained for these vessels.

Isometric projection of Electro-Motive Plant in 1944 after expansion to meet Engine Requirements of Navy.

Whenever possible our service men contacted the crews, who had just been assigned their new ship, giving last minute information and instruction before the vessel set out on her maiden voyage.

SPARE PARTS

As more and more ships were commissioned the problem of spare parts supply became increasingly important. This was and continues to be particularly so because most of the spares are used in foreign ports. For the last named reason the problem of inspection and packing has also become increasingly important.

Fifty-five thousand square feet of floor space was added to our plant in April 1944 to enable us to take care of the packaging, boxing for export, and shipment of Navy spares.

Some idea of the spare part supply job can be had by noting that the work involved in meeting the Navy's requirements for spare parts in 1944 is about the equivalent of the total production activity of Electro-Motive for the year 1938. It might be added that the spare parts are absolutely necessary to keep the vessels in operation, especially since ocean-going craft like the LST and the LCI(L) are serving as freighters as well as landing craft, involving thousands of hours of operation per year.

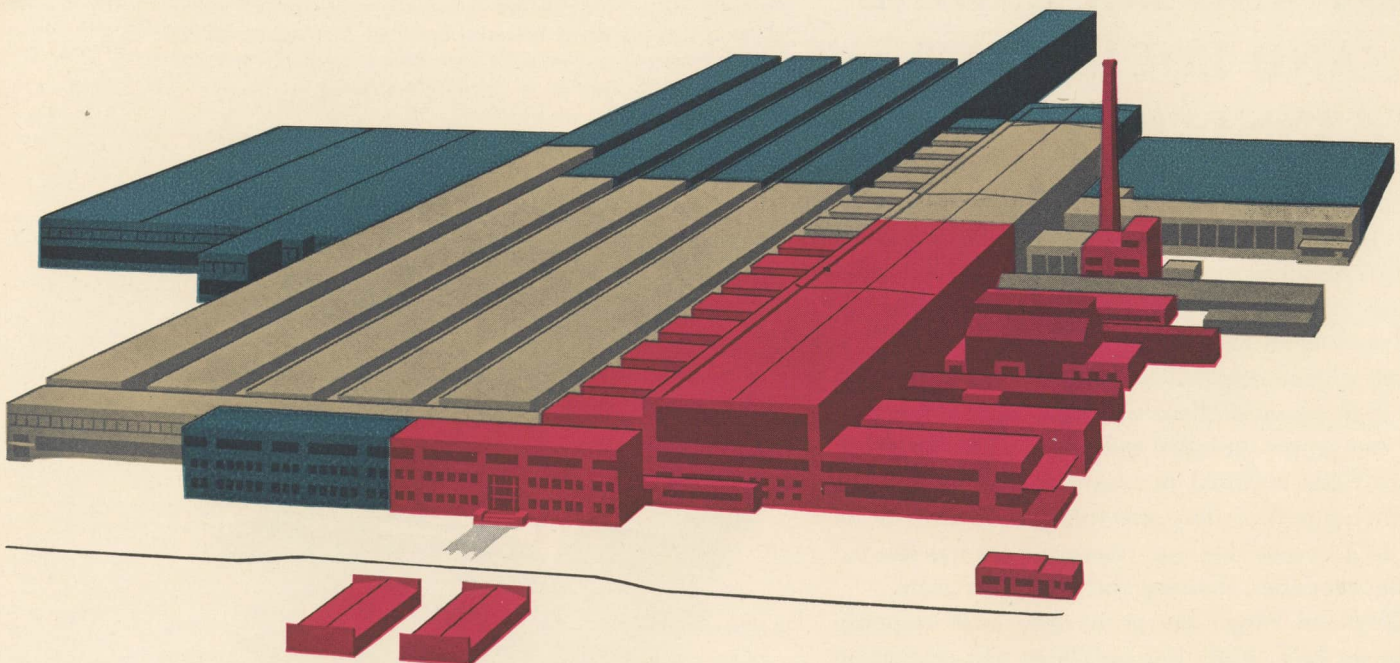
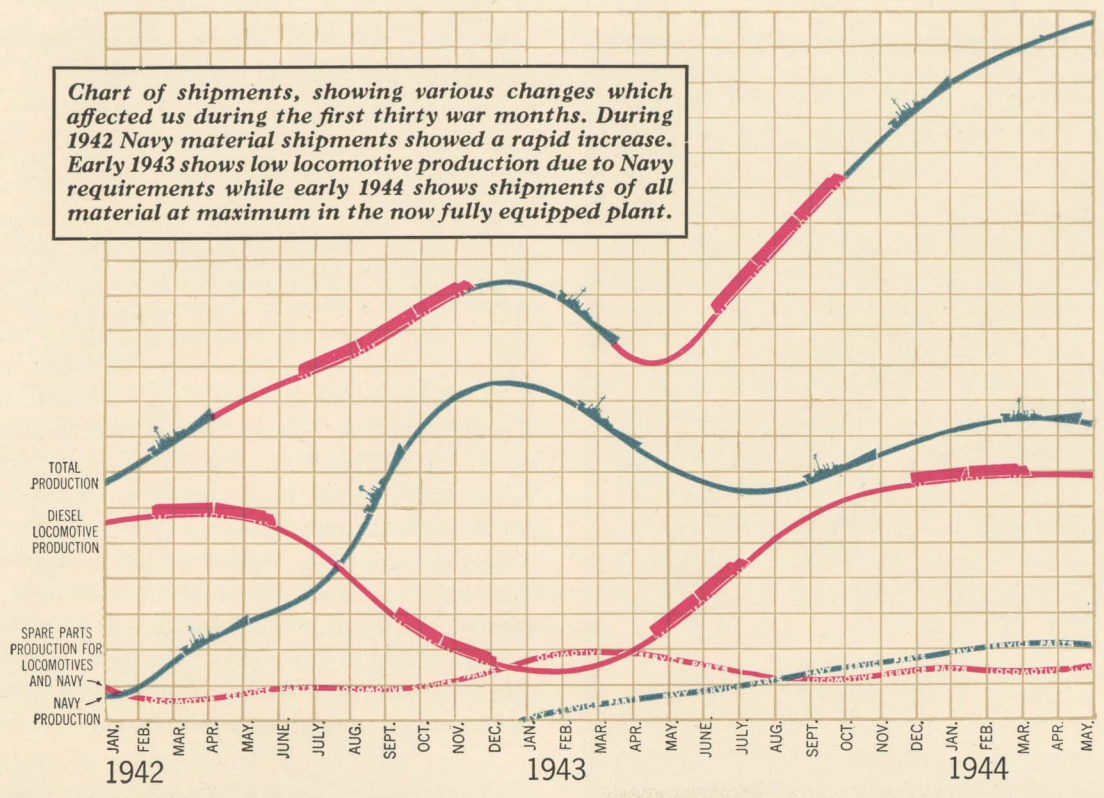
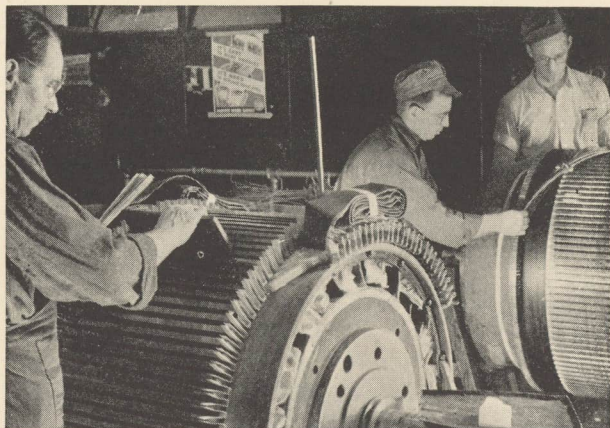


Chart of shipments, showing various changes which affected us during the first thirty war months. During 1942 Navy material shipments showed a rapid increase. Early 1943 shows low locomotive production due to Navy requirements while early 1944 shows shipments of all material at maximum in the now fully equipped plant.



RESUMPTION OF LOCOMOTIVE PRODUCTION

In February 1943 we had received a supply of machine tools sufficient to carry on the manufacture of the 567 engines required by the Navy as well as for our scheduled locomotive production. While the locomotive material had been on order for sufficient time, delivery was tardy and the activities



Winding freight locomotive armature.

of the Locomotive Division were almost at a standstill during February and March 1943.

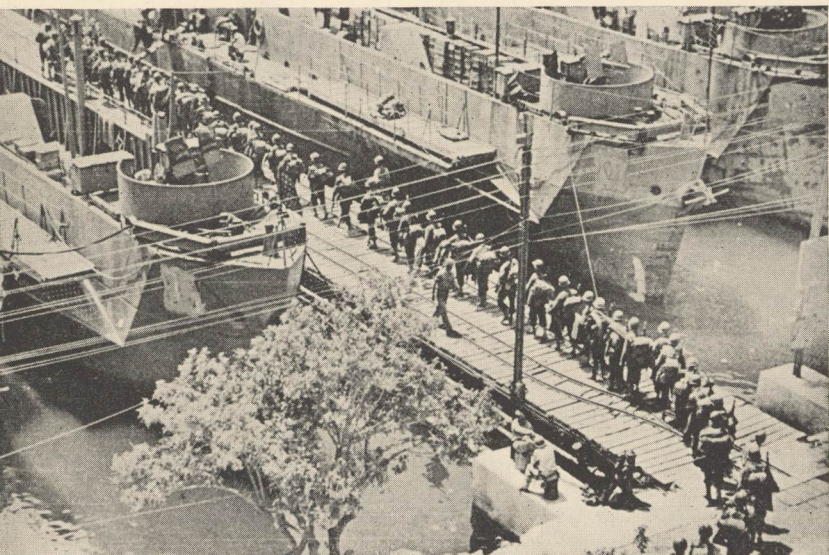
However, during the month of May the first locomotives of the new program were shipped and throughout the remainder of the year, pressure was exerted to increase the production of locomotives so badly needed by the hard-pressed railroad industry. The resumption of locomotive production has required further increases in personnel.

Our present force of 9,000 employees reflects the fact that we have been producing the following products during the spring of 1944: (1) freight locomotives, which includes locomotive bodies and electric transmission as well as the engines; (2) 567 engines for the LST vessels, (3) reduction gears, propellers and shafting for the LCI(L), and (4) complete propulsion equipment for the SC's. All of these products, as this is written, are being produced in greater quantities than at any previous time.

The above graphs show the trends of (1) total production and (2) production for the Navy and (3) production of Diesel locomotive units in the LaGrange Electro-Motive plant during 1942 and up to May, 1944.

Production of locomotive service parts and Navy service parts are also shown on the chart.

LANDING CRAFT IN ACTION . . .



Long lines of infantry are shown here, boarding Landing Craft for the great invasion of Sicily, in 1943.



In February 1944 this formidable group of LCI(L) vessels headed for the Green Islands. Another demonstration of the great efficiency of these ships.

We have followed with particular interest the reports of the landing assault operations of the recent past because we knew that a number of the largest landing vessels, the LST and the LCI(L), were crossing oceans under their own power to participate therein.

The first major landing involving vessels using our equipment occurred while U. S. troops were making their attack on Sicily July 10, 1943. But almost simultaneously with the landing of an American and British army in Sicily American marines were being landed by vessels of the same type at Rendova in the Solomons half way around the world. Landing craft and ships were enabling Uncle Sam's forces slowly and relentlessly to push the Nips back toward Japan.

In the succeeding pages we have thought to provide an eye-witness portrayal of, and some of the combat vicissitudes incident to, a landing assault. We are proud to have had a part in the engineering and construction of the main propulsion machinery of the vessels which are pictured here.

THE LANDING IN SICILY

as described by Lt. John Mason Brown

As the troops of the 45th Division, U. S. Army, moved toward their landing at Scoglitti in Sicily, Lt. John Mason Brown stood on the bridge of one of the supporting cruisers and described for the men of his ship the Armada extending along most of Sicily's southern shore, in part in these words:

"The smallness of man the individual, with all



our inner tyrannies and humiliating frailties, is worth considering today because of what we saw this morning. Did this North African harbor teem this morning with British and American LCT's, LST's, LCI's, tankers, freighters, destroyers, transports, and cruisers, until it resembled an anthill into which hot water has just been poured? It did. It most assuredly did. The war canoes, big and little, were all around us. Even when seen from the peak of that crow's nest which is the upper signal bridge, the procession stretched fore and aft to the horizon, beyond human sight. * * * * * Think of the titan's effort represented by these vessels having been made, manned and moved. Think of the conferences for which they stand; the dark mines from which they were scooped; the dinner pails, the sweat, the bent backs, the heat as of blast furnaces, the working hours, the fatigue, the sciences mastered, which they symbolize. Think of the huge plans, originating behind closed doors with a few men gathered from afar at the top. Think of how these plans have not only taken from but have seeped into all of our forty-eight states and into almost every home in each town and county in these forty-eight states. * * * * *

"Think of how breathlessly the news of this expedition's movements will be awaited in China, in Berchtesgaden, in Turkey, in Russia, Sweden, conquered Europe, Mexico, Italy, Australia, Tokyo and in plain Kalamazoo. * * * * *

"If you are not too tired thinking of the obvious, allow that huge armada, seen this morning, to conjure a few more images. Think of how different history would have been had Hitler after Dunkirk been able to amass such a fleet; had Xerxes been so equipped; had Hannibal had these ships and our tanks instead of rafts to support his elephants; or

had Napoleon at Toulon been capable of assembling and launching such a floating force.

"Above all, think of how paralyzing to all we hold dear it would be if, at this very moment, such an armada as is now luckily ours, were moving on Long Island, Vineyard Haven or Bermuda under Axis command—even as we of the Allied Forces are now converging upon Sicily. * * * * *

"On a beach about two miles west of Scoglitti I saw jeeps, trucks, DUKW's, and reconnaissance cars scurrying busily back and forth through acres of ammunition, provision, etc. * * * * * The beach, a shallow and most treacherous one because of its double-chin of reefs, was fringed with a number of landing craft—stranded, flooded, and abandoned—while countless LST's were nosing bravely shoreward to unload. Two of the LST's near Lt. Burton and me had been hit and slightly damaged by enemy bombs this morning."

THE ATTACK ON THE LST 340

A Bureau of Ships Report

Passing to the Pacific scene, this is a report of the Bureau of Ships, U. S. Navy, and it refers to what was perhaps the first baptism of fire for an LST in the southwest Pacific.

"On June 16, 1943 the USS LST-340 was proceeding toward Khukum Beach, Guadalcanal, with a cargo of vehicles and troops. At 1345 (1:45 pm) on that date the "Condition Red" signal was received from a shore radio; 9 dive bombers were observed approaching at an altitude of 20,000 feet. The planes peeled off and began a bombing and strafing attack which lasted for approximately twenty minutes. One direct hit and several near misses were scored. A 300 lb. bomb landed just forward of the after hatch, pierced the main deck, and detonated upon striking an Army truck.

"The explosion fractured the fire-main, and started a fire on the tank deck. The fire spread rapidly, and virtually swept the entire ship. In spite of the terrific heat and minor explosions the gun crews and all other personnel continued the action against the attacking planes. The plane that scored the hit and three others were shot down.

"A fragment of bomb penetrated the tank deck, entered the auxiliary engine room, and knocked out the generators. This was followed by burning gaso-



LST outside some of the obstacles on the Normandy Beachhead.



These 40MM guns, part of the deck load of an LST, are ready for action if Japanese raiders appear overhead.

THE LST AS A WAR FREIGHTER

When landing craft, the "ugly ducklings" of the Fleet, began to roll out off the ways, they had to prove themselves not only in action against the enemy but first of all to the men of the Navy who were to man them. Here is a story of how the LST's demonstrated their worth in the Pacific and won the admiration of a veteran of the Fleet.

When Lieutenant George Baker, commanding one of a dozen LST's, crossed the Pacific in February, 1943, most of the other officers and men were as new to the Navy as the ships themselves. But Baker was a "mustang," an officer who had come up from the ranks, with seventeen years of Navy experience behind him. The Navy Cross and the Purple Heart are among the four rows of ribbons on his chest. There are seven stars on his Pacific Theater ribbon, each signifying a major action.

On seeing his first LST on the ways, Baker was frankly skeptical. As he puts it, "I was sure I'd bought a one way ticket. In fact, I made my will."

The first assignment of the new flotilla was to take men, guns and ammunition from Guadalcanal to the Munda beach. The parting message of Admiral R. K. Turner, Commander of a U. S. Task Force, South Pacific Area, was, "The eyes of the Amphibious Forces are upon you. It's up to you to prove those ships. Take 'em through and deliver the guns."

The ships got through. The guns were delivered. During the next month Lieutenant Baker's ship ran a shuttle service between Guadalcanal and Munda, bringing supplies to the front lines and taking out wounded. It was at anchor for only six hours in 30 days. And there was no smooth sailing in those round trips. The LST's ran the gauntlet of submarine attacks, dive bombing from the air, and shelling from surface vessels and shore batteries.

Not a ship in the unit escaped at least one scar from a direct hit or a near miss. But none was sunk until the fifth trip when three ships, the LST's 342, 396 and 399—the latter commanded by Baker—entered a stretch of water known as Torpedo Junction. The dangerous area lived up to its name. Suddenly the sea was boiling with torpedoes.

The 342 was hit squarely. She had a capacity load

line from the tank deck, making it necessary to abandon this compartment. Before leaving, the personnel opened the CO₂ fire fighting system which later proved to have been very effective. The other damage in this compartment was caused by flooding. This damage was not very great, however, because one week later the crew had one of the Diesel generator sets in operation.

"The destruction of one generator cut off the power from an air compressor. This caused the pneumatic clutch on the port engine to fail; immediately after, the engine stopped. It is believed that upon the sudden release of the load, the overspeed trip came into play and stopped the engine.

"After the heat in the main engine room became unbearable, all men other than the gun crews were ordered to abandon ship. On receiving this order the starboard engine was set at flank speed. Later when the ship was about 500 yards from the beach the clutch on this engine failed. Evidently the failure occurred when the flooding and CO₂ in auxiliary engine room stopped the other two generators. However, the starboard engine continued to operate, and four hours later after the fire had been brought under control, the Chief Engineer entered the main engineroom and secured the engine.

"Although the LST-340 will not see action again for some time, it is no doubt well represented in the fight, for all serviceable machinery parts were stripped for use as spares on other ships."

of land mines and ammunition and blew up in an awesome explosion.

When the smoke died away, shouts of amazement rose from the other ships. The torpedo had torn the 342 in two parts, but the bow section still floated securely. Two days later the bow was towed into port and its share of the ammunition cargo was safely unloaded.

Said Lieutenant Baker later, back in the United States, "It's unbelievable what punishment those LST's can take. The 340 took a tremendously heavy bomb hit and is still afloat. Another LST while on the beach took a 500-pound bomb that sent its charts and gyro repeater flying onto my ship 100 yards away, yet she was later able to proceed to Tulagi under her own power.

"I can't say too much about the way the LST 399 was built. She was seaworthy all the way. In addition to combat with the enemy, she survived a full gale and a tropical storm so intense we had to lay to for two days. I had a fine engineering plant, and my gyro compasses were never over 1/2 degree in error in eight months of action, and gave me no trouble whatsoever. Since I've been back I've inspected large ships and small, including over 100 LST's, and I know from first hand experience there isn't a better job of shipbuilding being done in the country than that of the millions of men and women engaged in building and fitting LST's," Baker concluded.

ACTION IN THE HUON GULF

by Hal O'Flaherty

The following articles were written by Mr. Hal O'Flaherty, former managing editor of the Chicago Daily News, who was then stationed in New Guinea. These are eye-witness accounts of landing operations at Lae and elsewhere in the Huon Gulf.

The landing of a combat team composed of infantry, artillery and tanks on a New Guinea beachhead is one of the greatest dramatic pictures of all warfare. Since the days of the Vikings, the Greeks, and the Romans, the landing of armed forces has been the subject of epic verse and monumental painting, but over here the drama has been given a new setting, new color and costumes.

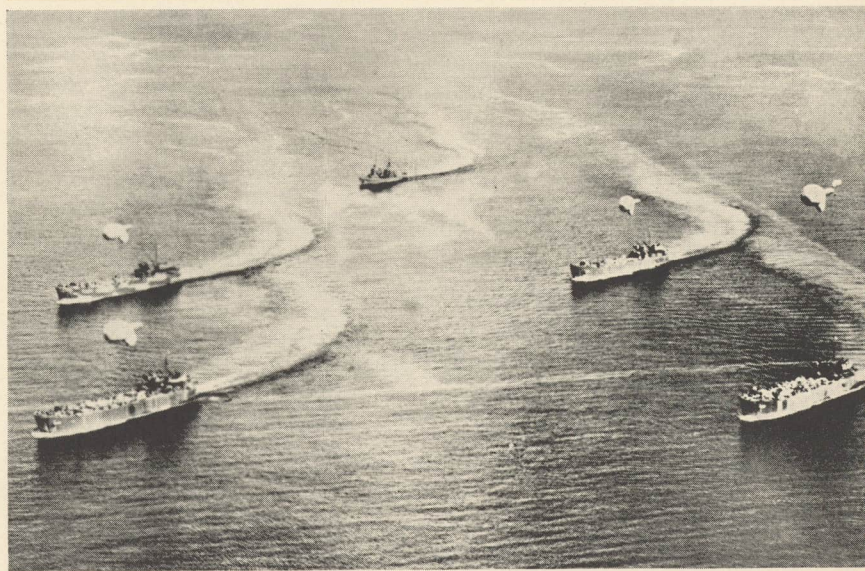
When the final moment arrives for the first wave of landing craft to move onto the beach, the spectator sees spread out before him the combined

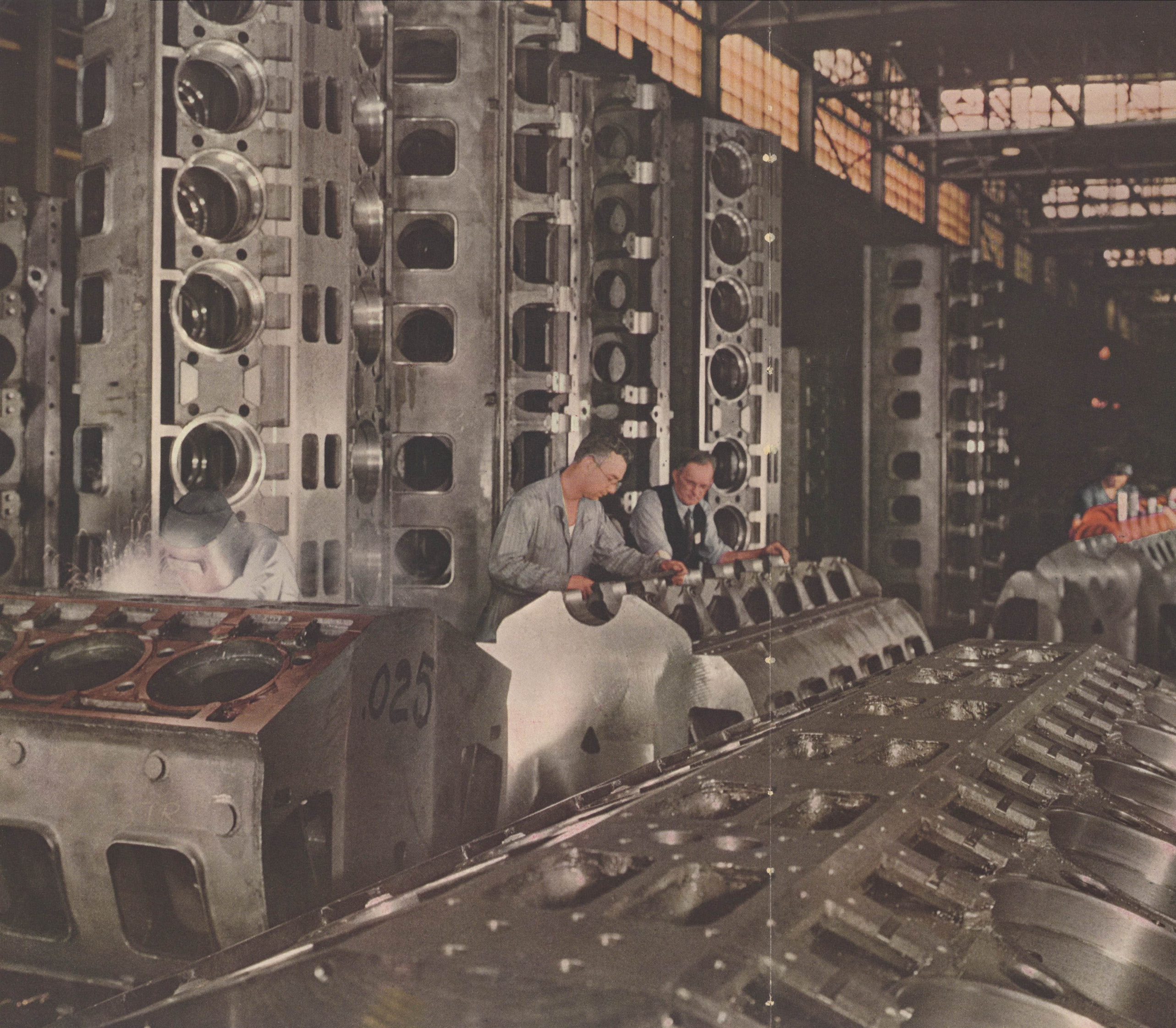
might of Navy, Army, Air Force and Amphibious Engineering. Hundreds of craft dot the Pacific waters as far back as the eye can reach. Lines of warcraft parade before the beach with guns flashing orange fire through clouds of yellow-brown smoke. Pursuit planes dart ceaselessly over the beach and its surrounding palm groves. Bombers drive deliberately like aerial express trains over the purple peaks of mountains towering to the serrated skylines.

Then follows the bedlam of landing. Men, materials and weapons, vehicles that required days to load upon the landing craft, are disgorged upon the sand just beyond the edge of the surf in a matter of minutes. Wave follows wave. Men work like mad, possessed by the urge to get the job done quickly, to make this place an impregnable fortress before the enemy can organize an attack or prepare his defenses. The modern character of these landings assumes nightmare shapes. The landing craft themselves are new, formidable, outlandish appearing vessels. Their lines look fantastic to the eye of the ancient mariner. They do not conform to age-old conceptions of sea carriers. The vehicles they carry evoke pictures of the fantastic war of the future so long portrayed in imaginative writing and in the penny dreadfuls of yesterday.

Where the Viking leaped to the beach behind his great shield, holding poised his double-edged sword, the amphibious engineer of today wields a blade twelve feet long across the nose of a Diesel driven

Tank Landing ships maneuver off the Solomons.





tractor. He comes roaring from the maw of a landing craft that towers above the beach in monstrous silhouette, terrifying in its weight and in the mass of lethal weapons spewed from its vast insides.

Viewing these dramas, I have often wondered at the genius of organization, the monumental proportions of the directing force required to bring them into being. Far back in the bases, American men of extraordinary ability, conceived the instruments and by the force of creative imagination brought them together, coordinated man with machine, conquering the elements of air, land and sea.

It's like the production of a great moving picture drama. The theme of the action is the product of a master dramatist, from whose brain flows the play's broad outlines. This brain child is given the technicians, the Army officers, the Navy officers, the airmen, whose experience and knowledge of their own fields qualifies them to work out the action, arrange it in perfectly timed episodes and bring it to its climax on the stage chosen for presentation.

Here in the southwest Pacific area, the creative part of the drama, the dreaming in terms of the art and science of war is done by the Commanding General, Douglas MacArthur, and by his colleagues of the sea, Admiral Chester Nimitz and Admiral W. F. Halsey, Jr. They devise the plot, write the script and turn over the production of the drama of war to their directors.

On a base ship along the Guinea coast, Admiral Kinkaid receives a copy of the script. It goes also to General George C. Kenney of the Air Forces, and to Brigadier General William F. Heavy, commander of the amphibious engineers. They must procure the ships, planes, armament of all kinds for their directors to use in developing the final picture. And the directors, those who whip all the elements into coherent, fast action, are the men whose names appear incidentally on the screen. But their part is of overwhelming import to the audience, the publics of our allied nations, and the enemy.

567 CRANKCASES

The cast, forged and rolled steel parts of which this structure is composed have been welded into a massive unit. Huge machines have completed the many operations required on these engine foundations. They will soon be ready for assembly operations.



The Mighty Bulldozer comes out of the nose of an LST.

Back in the rear echelons, are the technicians, schooled in the years of peace, but now practicing in deadly, uncompromising war. They must see that the millions of tons of fuel oil are placed where they can be poured instantly into the tanks of the small boats, the planes, the landing craft, and the infinite variety of wheeled vehicles that make up the elements of a successful beach head operation.

Under Admiral Kinkaid a staff of skilled technicians does this organizing work. They must see that troops are first trained in the work of moving

from land to sea and back to shore and must stage a dress rehearsal that has all of the tension of a final take of the big scene of a spectacular movie. In this show, the costs are far beyond the dreams of the most affluent movie producer, the price of failure a national calamity.

At various points along the coast, American and Australian infantrymen, artillerymen, engineers, signalmen, and airmen are gathered together for these periods of training. The infantrymen frequently must be taught to aid in loading and unloading a ship. He must learn how to get aboard with his gear, where to go on board, where and

when to get onto the beach and what he must, and that speedily, do after he is ashore.

Airmen, the commanding officers of bomber groups, must work with the command of the sea forces to be sure that the landing will be protected and that nearby enemy airfields will come in for such blasting that their planes cannot interfere with our operation.

Amphibious engineers go over and over with their men the technique of loading a landing craft. If properly executed, the landing craft or the bigger ship, can deposit its load and leave the beach exactly on scheduled time. If improperly loaded, it might easily cause the deaths of many men, through the holding up of the following waves.

Each landing craft, in fact every type of vessel afloat in the amphibious war, must be routed much like a train dispatcher keeps the tracks open for moving trains. There are literally thousands of boats and ships plying the waters of the southwest Pacific under command of the Seventh Amphibious Force. Under this direction, they move from rear base to the combat zone and carry to the front lines mountains of material consumed by the Armies.

Before every major landing, a dress rehearsal is held. Every last man, every gun, every truck or jeep that is to be thrown into action, is on the landing craft. The convoy leaves the beach, proceeds to another beach and there demonstrates the dangerous process of landing under fire and seizing a section of coastline from the Japs. The first rehearsals, held months ago, I've been told were departments of utter confusion. Today, they are orderly, managed by such officers as Captain Burton G. Lake and Captain John W. Jamison, both U. S. Navy.



The Ships That Make the Landings

Along New Guinea's palm-groved coast sails a fleet of strange looking craft, with square forward sloping bows, straight rectangular lines, square sterns low in the water. They are landing craft, conceived in England for war purposes of cross-channel landings but perfected in the United States and placed there on a production basis. They are the work horses of the sea.

Those of us who have led the migratory life of war along the beaches join in praise of these carriers and the outstanding courage of the young Americans who operate them. As the Jeep is a prime mover on land, and the transport plane is the truck of the airborne traffic, so the landing craft takes its place as the dependable sea freighter for the beachheads.

Landing craft range in size from the Higgins boat, which is barely large enough to carry a Jeep and a few men, to the ponderous LST's, whose initials mean Landing Ship, Tanks. The LST is a giant capable of carrying a thousand tons of cargo and four to five hundred troops. In between the smallest and largest craft are three others.

Next in size to the Higgins boat is the LCM, Landing Craft, Mechanized, built of steel instead of plywood and offering greater carrying capacity for all types of cargo. The LCI, Landing Craft, Infantry, is especially designed to carry troops and is provided with long ramps on each side which extend forward and may be lowered to the beach to facilitate the disembarkation of troops from ship to shore.

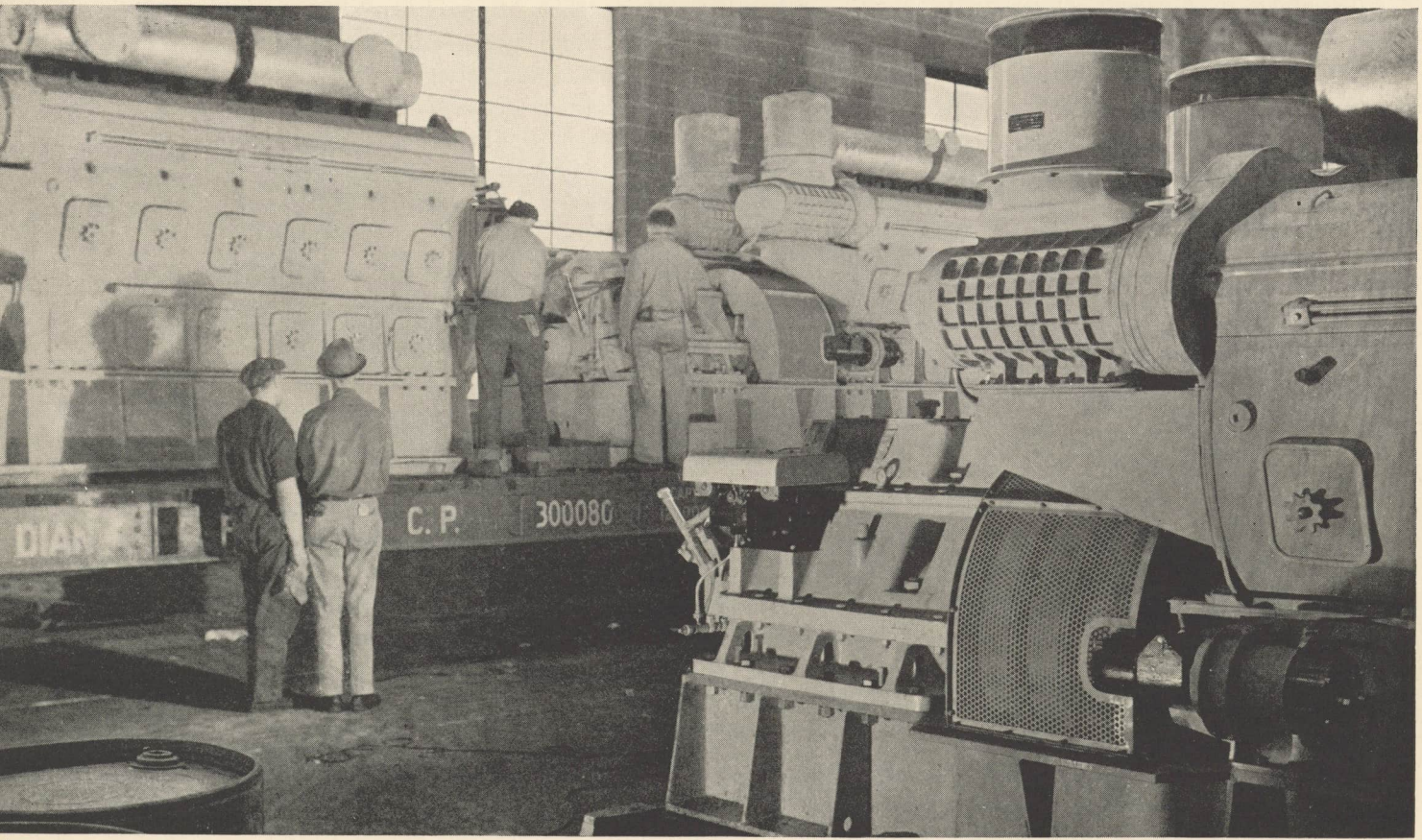
Finally, come the LCT, Landing Craft, Tanks, more mobile than the LST, more capacious than the LCM and an all-around utility boat. It can carry anything and go any place.

LCT's are open, that is, they have no deck over the cargo space as have the LST's. The bow actually is a great door or ramp raised and lowered by a power winch and when the ramp slaps its heavy weight on a beach, it provides a roadway from ship to shore over which heavy vehicles or men carrying material can pass safely. It carries any of the myriad things required in the prosecution of amphibious war. All landing craft are Diesel motored, the engines coming from the plants of General Motors in the United States, and in their husky, tireless cylinders the Allies have a means of driving the Jap out of his evilly acquired empire. With enormous power made available in compact form, they drive our



Debarking from LSTs in Hollandia area of Dutch New Guinea.

Engines are loaded on flat cars for convenience in loading and unloading when they reach the shipyards.



landing craft far up on shelving beaches of New Guinea and when the cargo is discharged, the Diesels roar into reverse and haul them off into deep water.

The noise of the Diesel's exhaust pipes can be muffled under water so completely that the enemy cannot hear them though they creep along a few yards off shore. Engines such as these frequently operate both day and night, hundreds of hours, with little repairs and infrequent overhauls.

Aboard the landing craft are some of the most picturesque crew that ever sailed the south seas. They look like pirates. They wear shorts, frequently stained with oil, and that is all they have on above their floppy green jungle boots or their soiled tennis shoes. All are tanned to a deep mahogany, a husky, high-spirited group of sea rovers and adventurers in dangerous waters. And the dangers are not all from Jap guns. The waters they ply are filled with reefs. Dotted over every coastal area are great knobs of coral, known as "nigger heads" on which ships have crashed and sunk through many generations.

It is a startling fact that the bulk of the crews on the landing craft had never seen an ocean until they went aboard their present homes and many had never set foot on a sea-going craft of any kind. * * * * *

Our use of the landing craft in large numbers began at Nassau Bay on June 30, 1943 when a combat team from the 41st Division was carried north in Diesel powered Higgins boats through one of the worst storms ever known in that area. * * * * *

Following the confusion of this start, our heavier equipment arrived and the crews were trained in the art of getting on and off a beach during the fighting south of Salamaua. The LCM's and LCT's did great work in maintaining a steady supply of ammunition for the guns and rations for the men who eventually took Salamaua.

Meanwhile, our fleet of LST's, the great granddaddy of landing ships, were put into service in the South Pacific and the Southwest. What they accomplished in the extension of beachhead war was about what steamships did to sails. These monsters have in their capacious interiors a lot of new ideas that the Jap would like to steal but couldn't duplicate for this war if he had the whole thing in blue print. American engineers have applied Diesel power to a ship that looks like an aircraft carrier from a distance.

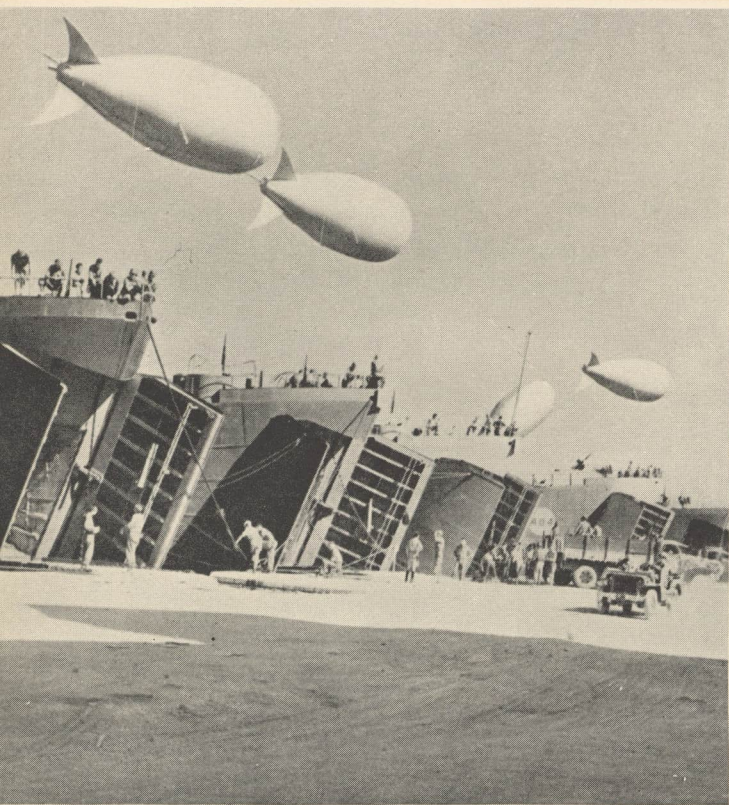
When an LST rams its big square bow on a beach and drops its ramp with a thud that shakes the earth, it is much as if the spectator on the beach were watching the front of a three story building fall forward, revealing a space between the hull and the deck as big as a factory warehouse. At the first big amphibious assault on the Red Beach east of Lae, I watched the LST's come in and stood in awe as they disgorged their cargoes.

Here was the solution of an old problem of combining Military and Naval action. We now can and do land a large, completely equipped armed force and get our ships away before the enemy can prepare his defenses or organize a counter attack. The



The surf is powerful and dangerous and many practice landings must be made before crews become expert.

Japs have shelled our landing craft from the shore, bombed and strafed from the air, but they haven't halted the progress of our courageous officers and men who man them. The lessons of the past six months have been bitter at times, ships have been damaged or sunk, but each landing is more successful than the last. The Jap knows he is licked on any beach we choose to take.



*Above—LST Ships ready to load at Palermo, Sicily.
Loading up for the Green Islands at an advanced base.*



*Unloading at Cape Gloucester, New Britain Island.
Below—Wreckage on Roi Island spreads before LSTs.*



A Landing In The Treasury Islands

A story came down the Solomon Islands from the Treasuries recently following the seizure of the Treasury Islands by a New Zealand combat force. It is a tribute to the adaptability of the New Zealand soldier and the effectiveness of our heavy landing ships, the LST's.

The New Zealanders landed on a strip of beach at the south end of the largest island, Mono, and immediately ran into hot fire from strong Jap positions. American landing craft succeeded in getting off the first wave at one end of the beach but when an LST came in at the other side, it let down its ramp only a few yards from a deeply covered machine gun position. At least six were firing through a long slit and the line of fire allowed them to traverse the ramp of the LST.

One hardy group of New Zealand infantry made the dash ashore and tried vainly to wipe out the Japs with hand grenades. They could easily determine the line of fire and tried to keep to one side

of it but several who tried to cross for a better throw were killed.

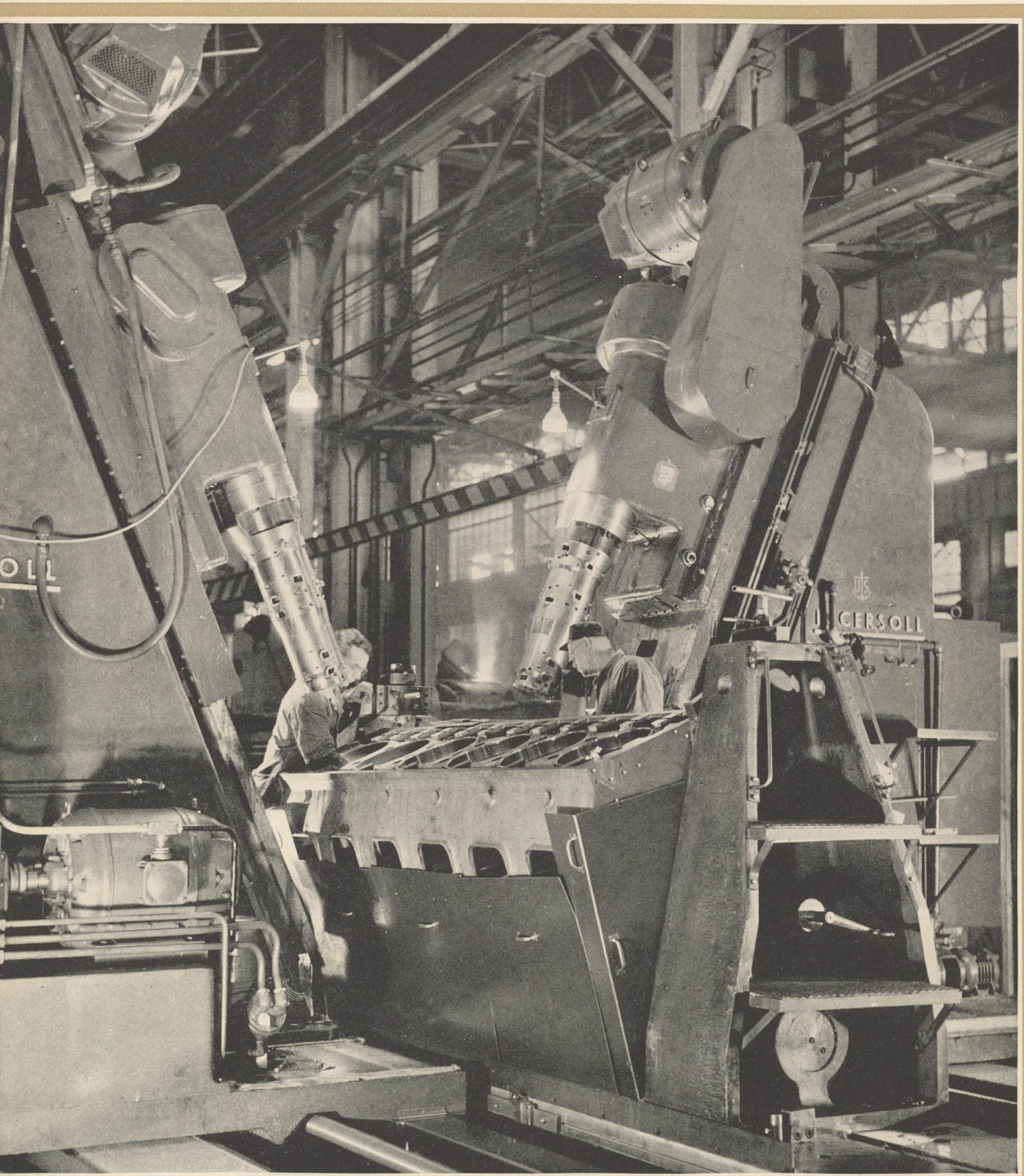
A New Zealand officer ran the gauntlet and was badly wounded. Several others tried to dash out of the great door of the LST and met a similar fate. Meantime, the Japs raked the section of the LST open to their fire and maintained a steady stream of lead.

It looked like a stalemate. The LST could not be unloaded until the infantry got ashore and the Japs could not be reached with anything less than a big tank. There was a feeling of desperation both on the part of the New Zealand forces and the officers and men aboard the LST. A few Jap planes had already made a pass at the beach. They might return any minute.

At this juncture, a New Zealand infantryman climbed up on a bulldozer stowed forward in the hold of the LST. It carried on its nose a great, sharp-edged plow. He started the motor, warmed it

Sweating New Zealanders unload an LCI at Green Island.





up and raised the plow up high enough to protect himself. It was a perfect shield.

Without any pause, he drove the dozer out over the ramp, turned sharply to the left and guided the dozer outside the line of fire directly up to the dirt covered palm logs that shielded the machine gun nest.

There, he lowered the plow. The Diesel's voice rose to a threatening howl as he bore down on the accelerator pedal. The tractor lugs bit deep into the earth and the blade plowed ever more deeply. Down into the dugout the blade cut its way, piling up logs, sand and earth before it.

The action took only a minute or two but when the New Zealander had driven the dozer across the strong point, he had buried the Japs and their guns under four or five feet of debris. Their resistance was ended, their guns effectively silenced.

The crankcase, being the largest single piece in the Engine requires very heavy machinery. This machine bores the holes for the cylinder liners, two at a time.

Pulling Off The Beach

At ten thirty on the morning of September fourth, I stood on the navigation bridge of an LST watching the skipper, Grant William Prue of Green Bay, Wisconsin, give the orders for raising the ramp and closing up the nose of the big craft. The first part of the operation on the Red Beach had been successfully ended and it was time for the landing craft to get off the beach and hurry southward.

Over to the East great clouds of smoke billowed up from Lae, then still occupied by the Japs. On the beach, what had been utter confusion became

an orderly procession of men and vehicles dispersing over a new road cut through the jungle.

The LST's, unloaded in record time, were ready to pull off the beach and their commander, R. M. Scruggs, U. S. N., shouted hoarse orders from a nearby craft. With the propellers in reverse the Diesels went to full throttle to pull the great weight of the LST's off the shelving sand into deep water. This requires good seamanship. The skippers sometimes find the fore part of the ship so heavily seated in sand that even the great power of the Diesels is insufficient to dislodge her.

Looking astern, they watch the oncoming surf and if a wave bigger than others will provide just enough water beneath the bow to give a little buoyancy, then the engines are put to their greatest speed. The noise becomes deafening and the LST trembles from stem to stern. Occasionally a passing ship will put out a wake big enough to help float off the LST's and in case of necessity a nearby destroyer can be impressed to make a pass before the beach and send in a monster wave that will help the LST to slide backward to navigable depth.

Some time was taken on September 4 in this tricky operation but by eleven all of the outfit had pulled safely away and began the tedious voyage south to the staging area, there to load again with the munitions of war. Their job had been well done that day. The Australian unit, or rather a portion of it, had been put down with what was considered a relatively small loss of life.

I set up my typewriter in the wardroom of Skipper Prue's LST and had begun writing the story of the Red Beach, when the buzzer called general quarters. Keeping pace with a part of the crew running at top speed to the upper deck, I





Above—The equipment which jams the deck of this LST is typical of the loads which these vessels carry.

Below—LSTs unload at Bougainville. This view of the stern shows almost as unique construction as the bow.



emerged into brilliant sunlight, and through half-closed lids made out the accompanying warcraft, great plumes of white at their bows, circling our flotilla. There were no planes in sight. The answer came from Captain Prue. A Jap submarine was in the neighborhood and the Navy was out to get it. Nothing happened. Nor were there any depth charges dropped. It got out of the dangerous zone patrolled by ships that could deliver a death blow to a submarine seen or unseen.

I went back to the wardroom, settled down to writing but again the tromping feet, the buzzer with its din and general quarters. This time, it was obvious that an air attack was on. We could not see it but off to the East the heavy thud of Ack Ack and the heavier low growl of larger guns was audible.

Two of our LST's, maneuvering as always under the threat of air attack, veered off eastward and gradually faded over the horizon. We continued our course and reached harbor without further alarm, but upon arrival I got the story of what happened off to the east.

A unit of LST's, the second echelon headed for Red Beach, was passing us as we sailed southward. At midafternoon, six Jap dive bombers and a group of land-based torpedo planes hove in from the direction of Rabaul. The dive bombers were at five thousand feet while the torpedo planes were almost on the water.

The dive bombers hit first. While the crews and the junior officers of the LST's went calmly about their job of putting up a wall of fire, the destroyers circled, ripping white paths in the blue Pacific, their guns blazing. The sky was filled with the black puffs of exploding shells. The heavy guns on the warcraft fired at the oncoming torpedo planes, sending fountains of water and for half a minute every gun on the ship that could get on a target, fired continuously.

The captain of one LST, Lieut. George L. Cory, caught sight of a torpedo launched from a low flying plane. He tried desperately to get his ship out of range but as she swung around in a great curve, the torpedo went home. It raised the stern of the LST out of the water but when it settled, the Diesels were still throbbing. The craft did not sink.

Simultaneously, another LST, under the command of Lt. R. W. Dillard, U. S. N., came in for trouble. A dive bomber landed a big one on his

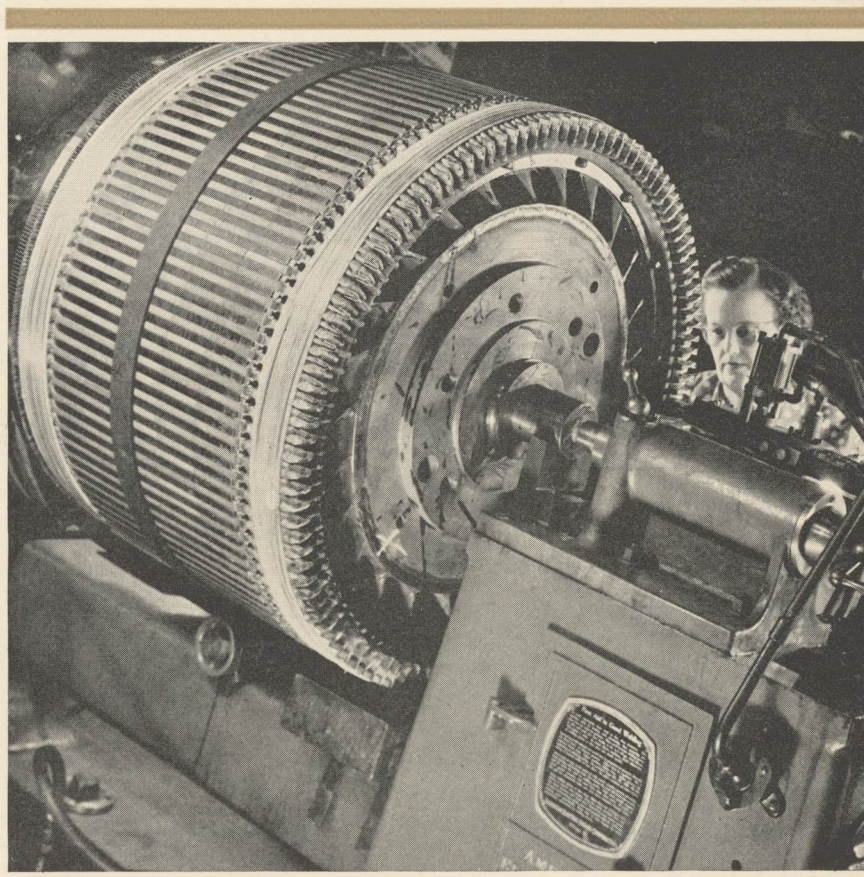
deck, causing fires. Too much cannot be said of the steadfast courage of both enlisted men and junior officers during this attack. They pursued their duties throughout with complete devotion.

The dive bombers completed their pass. The torpedo bombers coming low, dropped altogether twelve torpedoes. The sea seemed to be full for a time of thin wakes from the sleek polished steel bodies of the "fish."

Watching these wakes, both Cory and Dillard out-manuevered them. At least twelve came slithering through the water but in each case the skippers saved their ships by most skillful tactics. Both ships were hit hard, and steering became almost impossible, but the Diesels were still functioning.

That is the point at which two of the LST's in the unit going southward came into the picture. They had been diverted by the commander to go to the aid of the two that were damaged. By the time they arrived on the scene of the conflict, the crews had mopped up the debris, and the two great ships were rolling in a mild sea.

As the two rescue ships came alongside their damaged comrades, lines were thrown aboard and each



Electrically produced heat completes the silver soldering operation on Locomotive Generator Armature Coils.

rescue ship took one of the helpless sister ships in tow. It was a long way to base, but they made the voyage without further attack and by nightfall both were high on the beach with repair men still at work. Both could be repaired. The dive bombers and the torpedo planes had done their best but that best was not good enough to put an LST out of action or destroy the power of her motors.

The fact that these two badly hit ships could be beached, then towed a long way southward to a repair base where they were made seaworthy, is a tribute to maintenance engineers and the skill of the men who brought them back. They are today continuing to do their part with the amphibious fleet.

The conquest of this island in the Marshalls is complete and the LST now brings in supplies for the next attack.

An Attack By Jap Mitchies

No matter how peaceful the waters of Huon Gulf may be nor how secure our landing craft may feel themselves as they push their blunt prows through the blue and emerald waters, death may still strike at any moment. It was a perfect afternoon in September as the Skipper of an LST leaned at the rail of his navigation bridge, considering with pride his record of unloading at Lae in less than the usual time taken to discharge the heavy cargoes of the big carrier he commanded.

Now he could relax and enjoy the view of dark green mountains, yellow strips of sand and the gentle roll of his ship as she made her majestic way southward. Some of the crew were sloshing off the deck, not only to rid the ship of the refuse of freight



but to cool down the plates heated to a high temperature by the equatorial sun.

On the shady side of the ship, men who had worked the whole night through at the Lae jetty, cajoling the stevedores and keeping traffic in and out of the huge hold running smoothly, slept with the usual cool breeze bringing comfort and rest. The Diesel engines below maintained their steady but rhythmic throb. All was serene.

A few specks appeared on the background of white cumulus clouds to the north. At a distance, it is extremely difficult to spot enemy planes. Our own bombers and transports fly frequently over the Huon Gulf. Our "pea shooters" dart swiftly from one area to another and their very presence instills a false sense of security.

But this day, the Skipper had a premonition and called his crew to their battle stations. The raucous buzzer aroused the sleepers. Men came up from below putting on blue life jackets and steel helmets, looking skyward, knowing that Jap bombers can strike in a matter of seconds and be gone.

The cluster of four specks rapidly took shape. They were Mitchie type bombers and they were headed straight for the LST. In a matter of minutes, they were in close enough for the order to fire. The anti-aircrafts began their heavy beat and were soon joined by the sharper, ear-splitting racket of the machine guns.

Men who handle guns on our landing craft have little time to know fear. A sort of rage takes hold of them. When a Jap plane comes into their sights, a mounting anger keeps them at a high pitch of tension. They frequently hold down on the firing lever, muttering to themselves, burning with the desire to bring down the enemy and the belt of cartridges and tracers grinds across the breech. Not until the barrel of the piece is glowing red with heat do the men cease fire.

Before the Mitchies had made their pass, the gunners had found their targets. Two of the oncoming planes spouted smoke from their engines. Their noses inclined downward and with hardly any decrease in speed, they smashed into the smooth sea. A plume of white spray, a cloud of smoke, the quick flash of sunlight on a broken wing standing for an instant after the crash. That was the end of half of the attacking force.

Yells of mingled rage and elation broke from the men on the LST but they were smothered in the horrifying explosion of a bomb hurled from one of the remaining Mitchies as it passed swiftly over their ship. Steel plates buckled and sprang upward

in fantastic jagged patterns. Red hot fragments of the bomb cut like knives in every direction. Some men fell moaning or collapsed silently when hit.

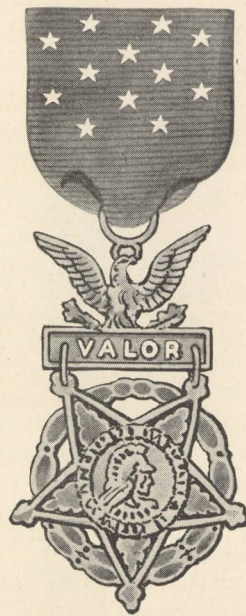


The effects of one bomb hit. This LCI was operating in the Lae area when it was struck by Japanese bombs.

From the side came billows of black smoke. Portions of a compartment containing ammunition and aviation gasoline had been set afire and the bright orange flames followed in the wake of the smoke.

In the wheel-house, a lad, white-faced but steady at his job, heard the skipper's shouted order, "Right full rudder." At that instant a second bomb hit the pilot house. Johnnie David Hutchins, seaman first class, lee helmsman, heard the order for full right rudder at the instant the bomb hit. He staggered under the shock of the explosion, several fragments ripped through his flesh but true to his training, his shaking hands grasped the wheel, pulled it to hard right, and as the ponderous bulk of the LST swung away, the third bomb, dropped by the last of the Jap planes, threw up a spout of water just off the port bow. It was a miss.

But Johnnie David Hutchins didn't live to know that by his steadfast devotion to duty and his courage in that instant he had saved his ship and most of his mates. Standing at the wheel with glazing



eyes, he leaned forward. His fingers clung to the spokes of the wheel and there he was found as the Jap bombers wheeled skyward and disappeared.

Members of the crew rushing into the pilot house to report on damage found Johnnie dead but with his hands fixed on the wheel, their duty ended.

For saving his LST from destruction, Johnnie David Hutchins was awarded the Congressional Medal of Honor. A new destroyer escort vessel has been named the U. S. S. Johnnie Hutchins in his honor.



This is the background picture of amphibious war, by far the most fascinating from the spectator's point of view of all types of combat action. Here is an operation in which you see the culmination of war's science and art, the triumph of army and navy engineering, the fighting between planes, the stately progress of the bomber formations, and the heroism of every day men, meeting at long last the test of fire. Death and pain are incidents. We are only in the initial stages of amphibious war.

THE END



Graceful and flowerlike plumes from a depth charge.



Pictures of equipment in action printed herein were supplied by the United States Navy, Acme Newspictures, Inc., and Press Association, Inc.



Pacific Ocean

Attu
Kiska

Saipan

Eniwetok
Kwajalein
Makin
Tarawa
Abemama

Admiralty Is.
Biak
Green Islands
Hollandia
Bougainville (EMPEROR AUGUSTA BAY)
Lae
Arawa
Vella La Vella
Salamaua
Rendova

Never before in the history of warfare has a nation carried on war from bases so far distant from the battle grounds. To make landings on enemy held shores has required specially constructed vessels, some of them capable of crossing oceans and yet able to land on hostile beaches. The stars indicate locations of United Nations amphibious assault operations in the Pacific Theatre.

