THE RAILWAY EDUCATIONAL BUREAU

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STUDY CLEARS THE ROAD TO PROGRESS

INSTRUCTION PAPER

UNIT N. 21

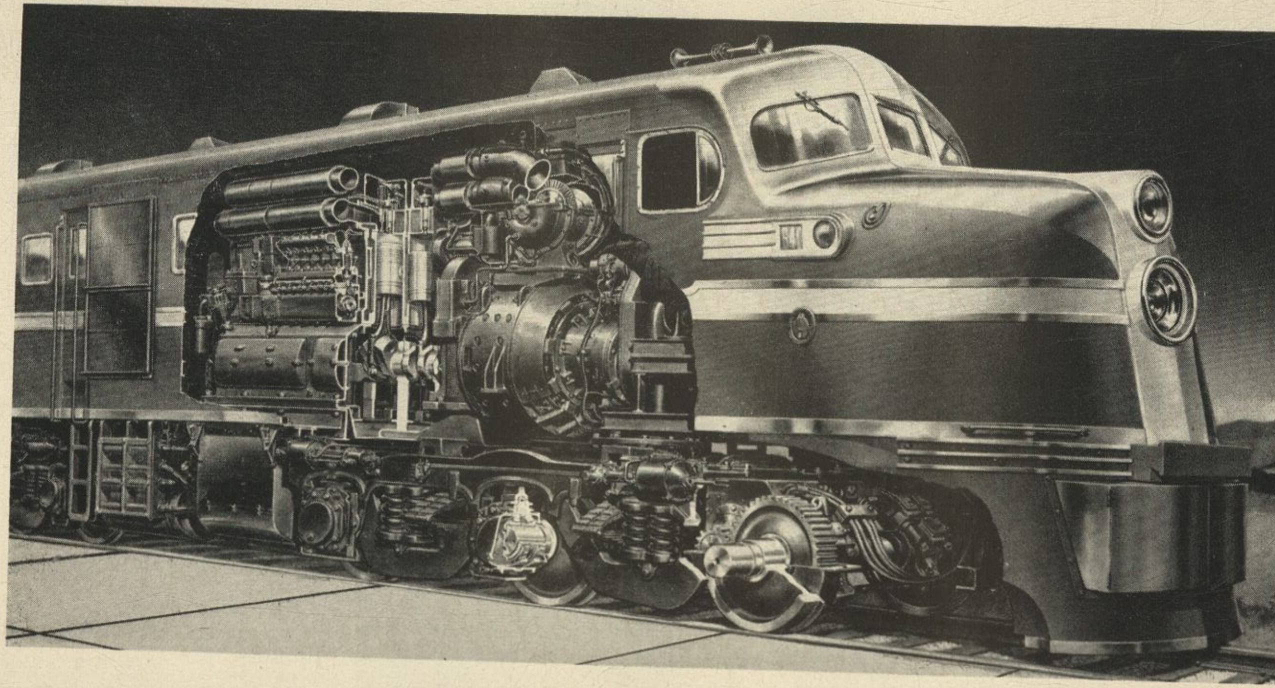
SUBJECT:

DIESEL LOCOMOTIVE OPERATION

GENERAL

OMAHA——POSTAL ZONE 2——NEBRASKA

Four-unit Diesel Freight Locomotive



Cutaway view of Diesel Locomotive
(Courtesy Socony-Vacuum Oil Co., Inc.)

DIESEL LOCOMOTIVE OPERATION

General

1. This series of texts explains the principles of Diesel locomotive construction. This is necessary information for any man who is to operate or maintain Diesel locomotives. The texts also give the necessary information about Diesel locomotive operation to enable operators or prospective operators to qualify on the examinations for Diesel locomotive service. Maintainers must understand Diesel locomotive operation in order to shoot trouble and differentiate between electrical and mechanical maintenance requirements.

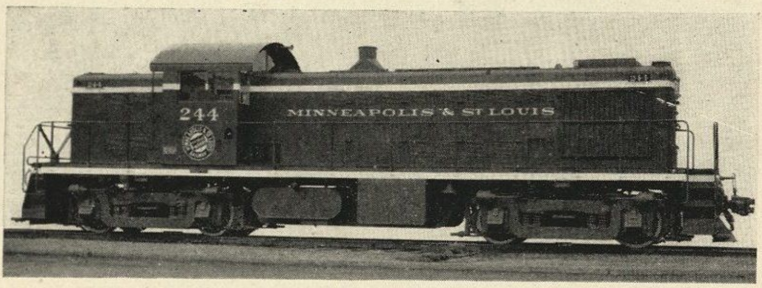


Fig. 1

2. There is nothing mysterious about a Diesel locomotive. It is no more difficult to operate than a steam locomotive, nor does it develop any more operating difficulties than may occur in steam locomotive operation.

3. A Diesel locomotive, such as the single-unit switching locomotive shown in Fig. 1, consists of a framework supported by trucks which contain the driving wheels. The locomotive is driven by electric motors. There is a separate motor for each driving axle. The motors are mounted on the trucks. Each motor is connected with its driving axle by gears. The propulsion is similar to that of an electric streetcar.

4. The electric current which furnishes the driving power for the motors of the locomotive is produced by a complete electric power plant mounted on the platform of the framework of the locomotive (Fig. 2). Each individual Diesel locomotive power plant consists of a Diesel engine which is directly connected to an electric generator. The generator is similar to those used to produce electric current in other heavy duty power plant units. Fuel oil is used in Diesel engines—not gasoline. The power plant is enclosed in a housing which forms the outside or body of the locomotive. The cab, which contains the locomotive controls, usually is at one end of the housing.

5. While the propulsion of a Diesel locomotive is similar to that of an electric streetcar, a streetcar has a

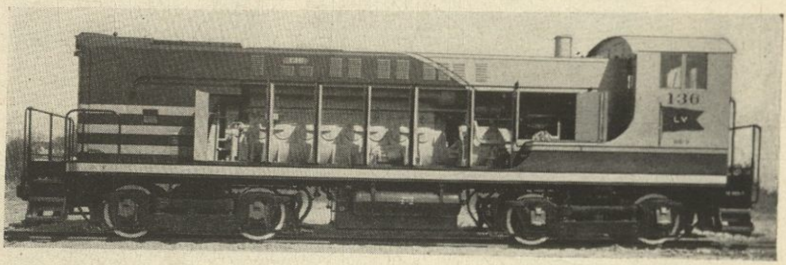


Fig. 2

constant supply of current available in the trolley wire at all times. The streetcar motorman is concerned only with supplying current to the motors in accordance with the load and desired speed and with the braking. A Diesel locomotive engineer, however, must control the operation of the power plant of the locomotive in order to run the locomotive properly. Varying amounts of current are supplied to the traction motors by increasing or decreasing the *speed of the Diesel engine* and, consequently, the electrical output of the generator.

6. Diesel locomotives are built with full observance of every refinement of engineering design and construction necessary to meet the exacting demands of railroad operation. In fact, the superb engineering and workmanship that have produced the Diesel locomotive have made possible super-speed passenger trains and the continuous heavy tonnage freight train operation of today.

THE DIESEL POWER PLANT

7. The engine of the Diesel power plant may be either a two- or four-cycle oil burning engine. Some engines consist of two rows or banks of cylinders in V form. In other engines the cylinders are in one straight line. One make of engine has opposed pistons. There may be three, six, or eight cylinders in each bank of a V engine.

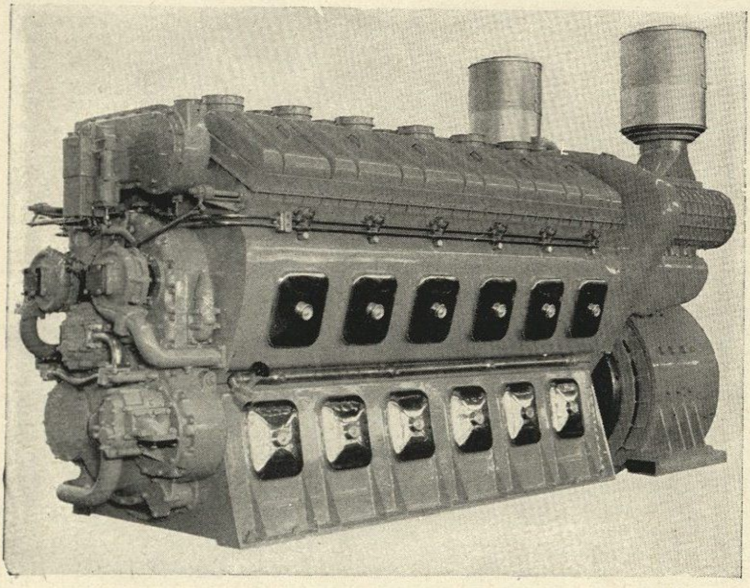


Fig. 3

Fig. 3 shows a twelve-cylinder V-type engine. Fig. 4 shows a six-cylinder engine of the opposed piston type. Essential features of such engines are the fuel system—including the device that injects the fuel into each cylinder, the cooling system, the lubricating system, and the control valves and governor. The generator is wired so that it can be used as a motor for starting the engine.

8. The electric generator, which can be seen at the rear of the engine (Figs. 3 and 4), is directly connected with the engine by means of a flexible coupling. The generator is no different in principle from other elec-

tric generators. There are the necessary electric circuits so that current can be delivered to the traction motors under the control of the operator.

9. The traction motors are mounted on the trucks. (Figs. 8 and 9.) The motors are connected with the driving axles by gears. The trucks may have either four or six wheels. Only two of the three axles of a six-wheel

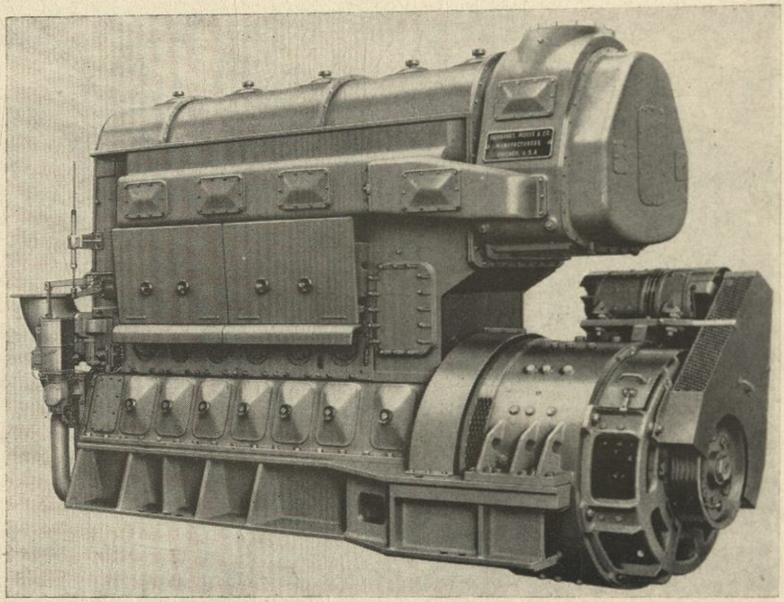


Fig. 4

truck are drivers. The motors are no different in principle from other heavy duty motors. Their wiring circuits are a part of the general wiring plan of the power unit.

10. Braking is accomplished by air brake apparatus similar to that used in steam locomotive service. However, a distinctly new type of brake equipment, known as High Speed Control (H.S.C.), was developed for use on super-speed trains. The H.S.C. brake operates with air pressure but can be electrically controlled. It has automatic adjustments to regulate the braking power in accordance with the speed. Dynamic braking also is used in freight service to supplement air braking; the traction motors themselves provide a retarding force on long descending grades, thereby saving brake shoe wear.

11. There are a number of auxiliaries on a Diesel locomotive. One is an oil-fired boiler (Fig. 14) which generates steam for heating passenger trains. This is required in the absence of the usual steam locomotive boiler and because it is impractical at present to heat trains of mixed equipment electrically. Other auxiliaries are the sander, bell ringer, windshield wiper, storage battery for starting the engine, train control apparatus, headlight, various control and lighting circuits, etc.

12. Practically all of the electrical equipment on a Diesel locomotive is new and strange to those whose experience has been entirely with steam locomotives. It is not difficult for a steam locomotive man to learn the purpose and operation of the various types of electrical equipment on a Diesel locomotive. However, the maintenance of this electrical equipment and electrical trouble shooting require special knowledge and experience. Mechanical and electrical maintainers need the preliminary instruction contained in this series of texts in order properly to master the maintenance texts which will follow.

TYPES OF DIESEL LOCOMOTIVES

13. Figure 5 shows a single-unit passenger locomotive, a two-unit passenger locomotive, a three-unit locomotive for either passenger or freight service, and a four-unit freight locomotive similar to the one illustrated in the frontispiece of this text. Single-unit passenger locomotives usually are rated at around 2000 horsepower. Each unit of a multiple-unit freight locomotive, such as is shown in Fig. 5, is rated at from 1350 to 2000 horse-

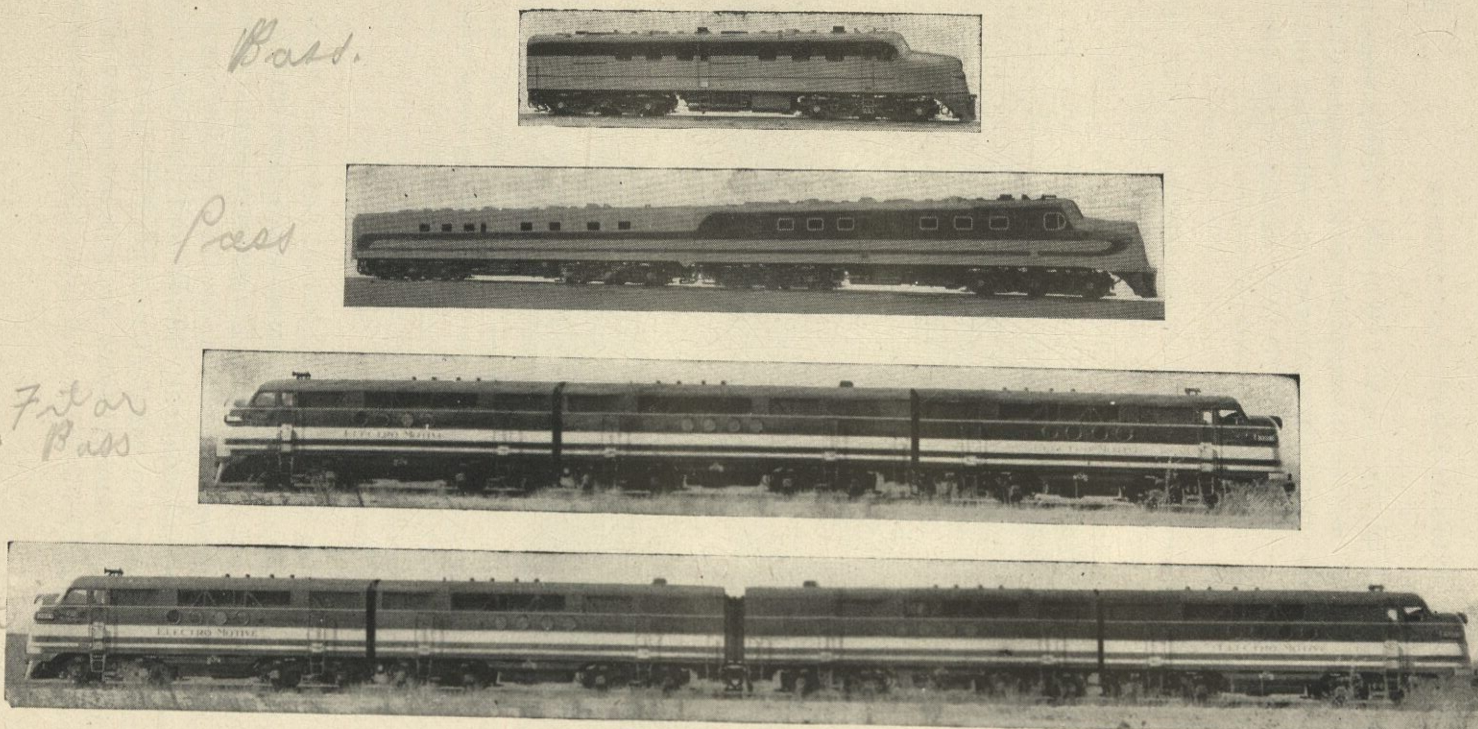


Fig. 5

power. The four-unit freight locomotive illustrated is rated at 5400 horsepower. Heavy single-unit switching locomotives, such as the one shown in Fig. 1, usually are rated at 1000 horsepower and weigh about 125 tons. Smaller sizes run from 600 horsepower down to industrial switchers of 360 horsepower or less. Fig. 6 shows a single-unit transfer locomotive of 2000 rated horsepower

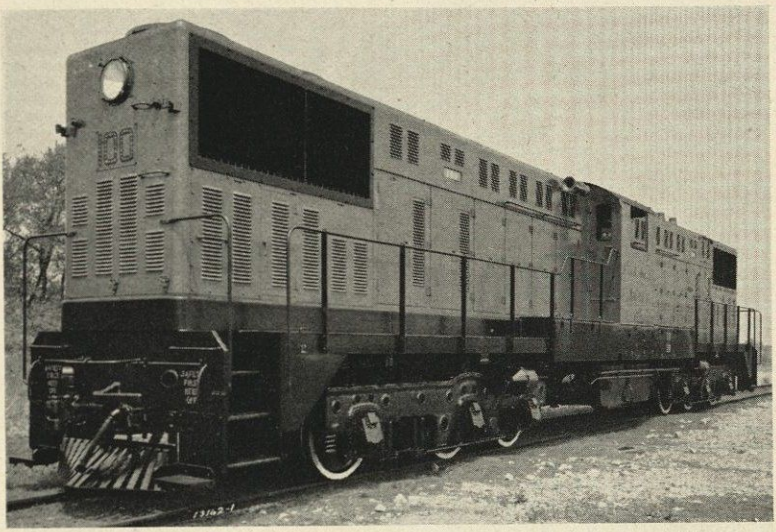


Fig. 6

which weighs 180 tons. Some single-unit 2000 horsepower switchers and some two-unit 2000 horsepower switchers are used as road locomotives on branch lines or for special service.

14. Figure 7 shows two small 180 horsepower Diesel engines with Westinghouse generators. These two engine units are mounted on a single locomotive frame which is carried on motor-driven trucks. When completed, this combination becomes a 40-ton, 360 horsepower switcher. This illustration emphasizes the simplicity of the principle of a Diesel locomotive.

15. A multiple-unit locomotive is controlled by one operator. Many multiple-unit locomotives have a cab at each end to avoid the necessity of having to turn the locomotive at the end of a run.

16. The power plant of a single-unit Diesel locomotive may consist of either one or two engines. Each unit of a multiple-unit Diesel locomotive may contain one or two engines. However, each engine of the power plant

Fig. 7

of a Diesel locomotive is independent of all other engines so that one engine can be cut out without affecting the operation of the other engine or engines. On long runs, one or more engines may be shut down temporarily to allow the maintainer to make necessary adjustments. Similarly, one engine can be cut out in case of engine trouble or a breakdown and the train handled with the remaining engine or engines. The motor drives of each unit also are independent of the other motor drives so that any one of the driving units can be cut out without interfering with the operation of the other driving units.

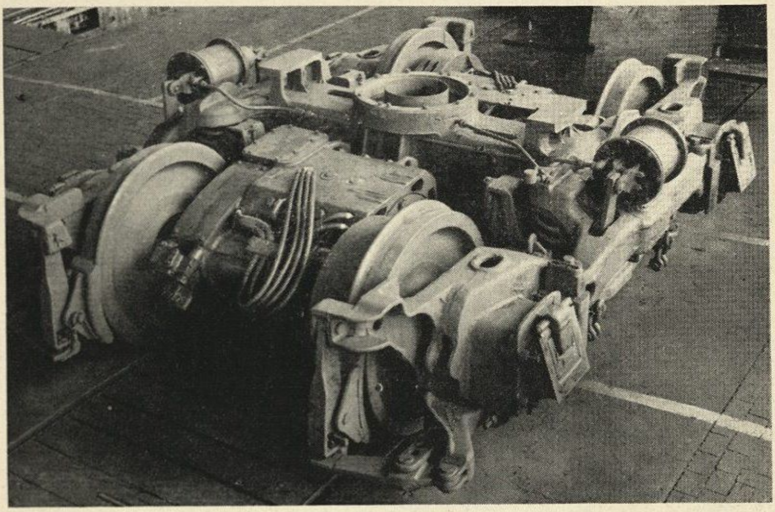


Fig. 8

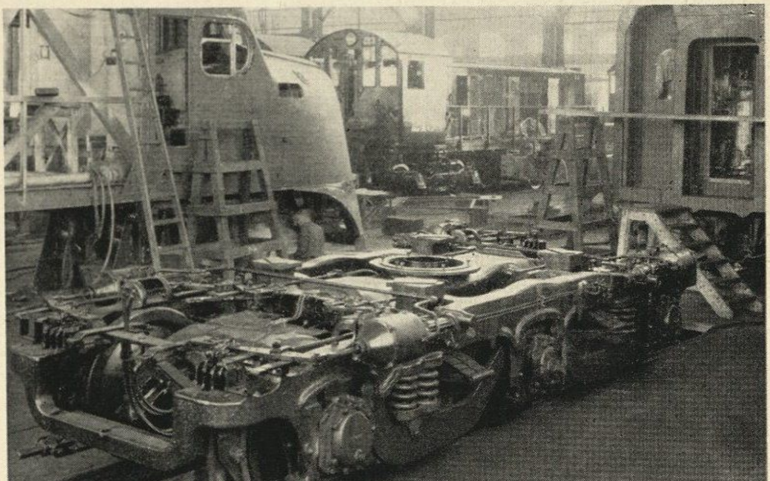


Fig. 9

17. Where a two-unit locomotive has a cab at each end, one whole unit can be cut out or set out and the train brought in with the other unit. Wiring circuits are arranged so that necessary emergency circuit changes can be made with little loss of time. Each unit of a multiple-unit locomotive that does not have a cab may have an emergency or hostler's control station. Such a unit can be moved independently, if necessary, to cut it out from the other units of the locomotive. Locomotive units which are built with a cab are known as "A" units. Other units are known as "B" units. The A and B units of a locomotive may be permanently coupled like a steam locomotive and its tender. If so, there is no hostler's control station on the B unit.

18. Figure 8 illustrates a four-wheel driving truck for a Diesel electric locomotive. Fig. 9 illustrates a six-

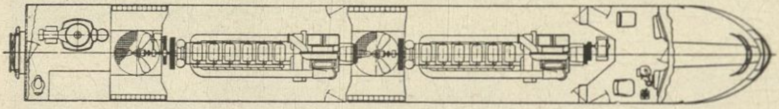


Fig. 10

wheel driving truck. Only two of the axles (four wheels) of a six-wheel truck are motor driven. The middle pair of wheels is the idler pair.

19. Figure 10 is a floor plan which shows the arrangement of the two "in-line" engines of the single-unit passenger locomotive illustrated in Fig. 5. It is very helpful to anyone who is not familiar with Diesel locomotives to study the plans of different types of these locomotives. Some of the plans show the names of many of the different parts of the apparatus and their approximate locations. With this information in mind, one can get on a Diesel locomotive with a good idea of what to expect.

20. Figure 11* shows the floor plan of two units of the four-unit freight locomotive shown in Fig. 5. The other two units are duplicates of the two shown. Each unit carries a power plant. The floor plan shows the names of many of the auxiliaries which are a part of the complete power plant and locomotive assembly. The side

*Figure 11 is on a folded insert at the back of the text.

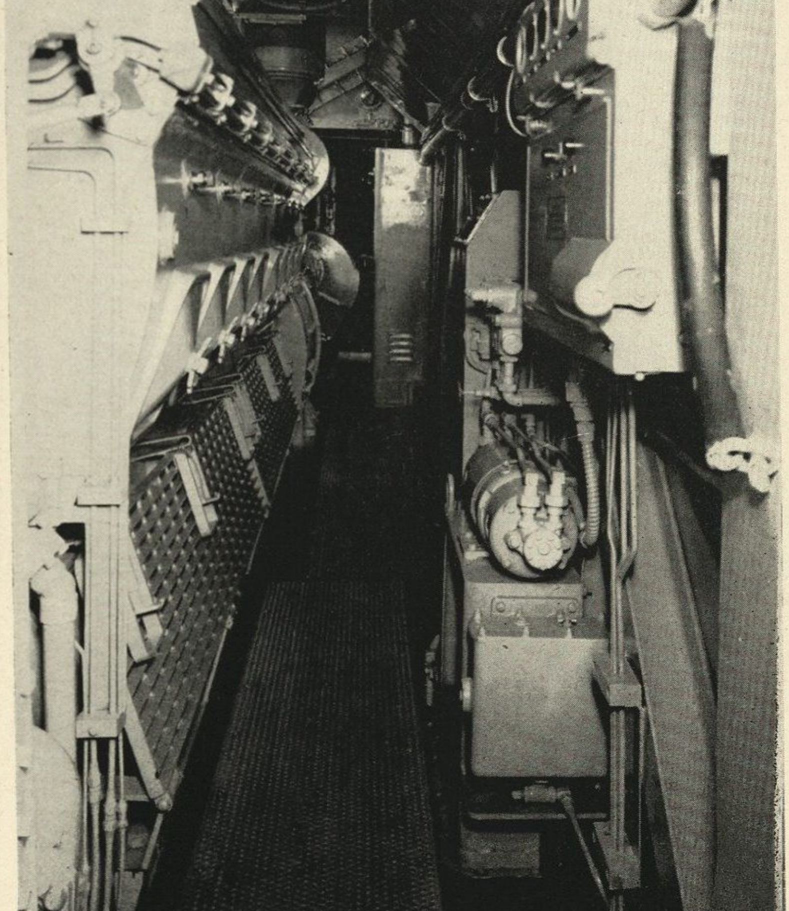


Fig. 12

view at the bottom of the diagram gives other information, such as the location of some of the filling openings,

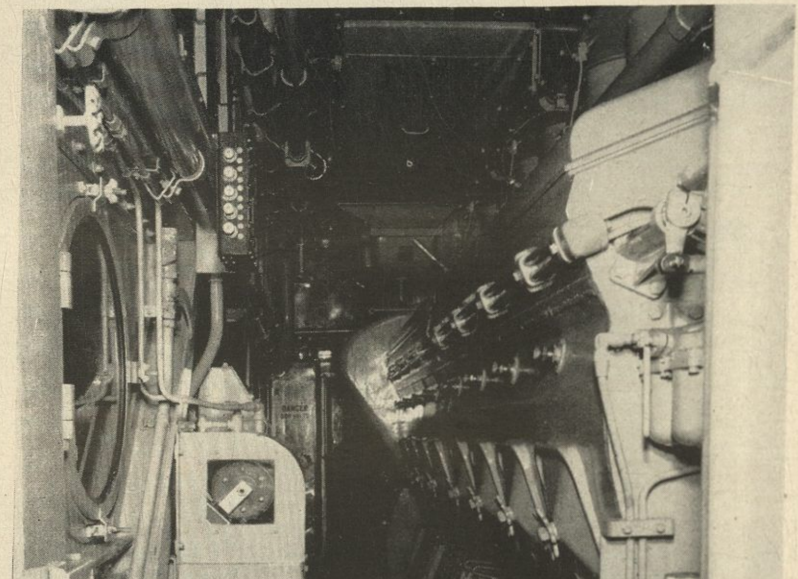


Fig. 13

electrical receptacles, etc. The view to the right at the top of the diagram shows the plan of the radiators and cooling fans which are located at the roof of the car above the engines. The view to the left at the top of the diagram shows the arrangement of the four units of the

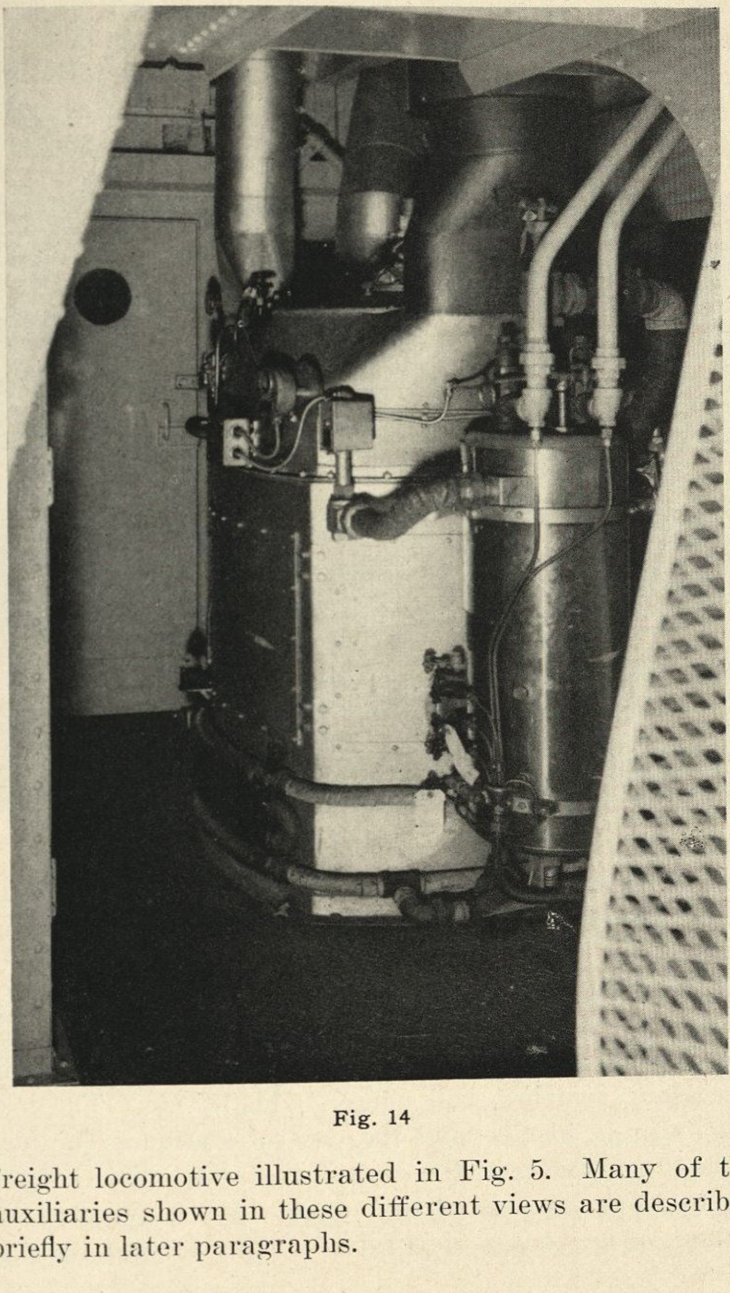


Fig. 14

freight locomotive illustrated in Fig. 5. Many of the auxiliaries shown in these different views are described briefly in later paragraphs.

21. Figure 12 is a view looking forward along the aisle on the engineer's side of the "A" unit shown in Fig. 11. The *engine* control panel, indicated in Fig. 11, can be seen on the wall, at the right, in Fig. 12. The sand box is just ahead of the control panel. The fuel filter is on the floor at the right. The fuel pump assembly is above and just beyond the fuel filter. The engine, of

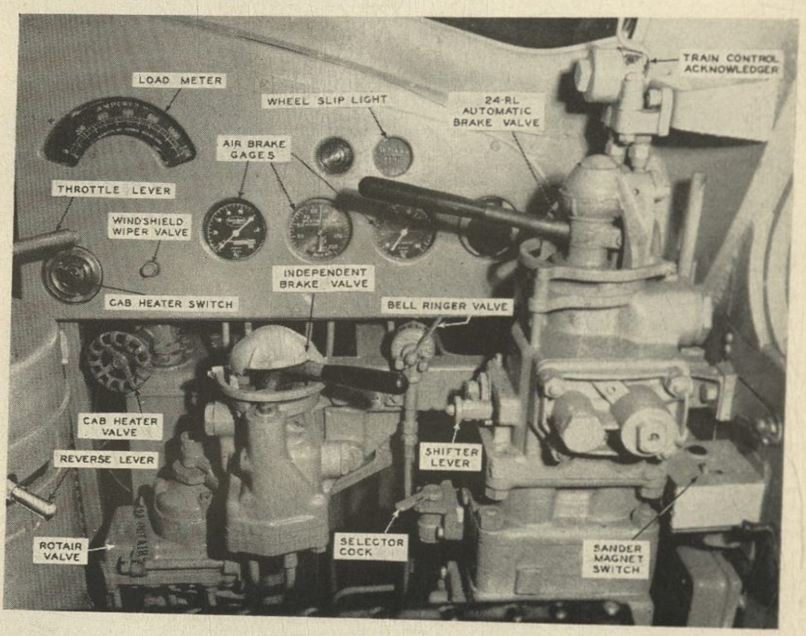


Fig. 15

course, is on the left side of the aisle. The case at the end of the aisle is the low voltage electrical cabinet. Fig. 13 is a view taken rearward from a point between the door and the water tank of the same side of the "B" unit. Of particular interest is the hostler's control station which consists of a small controller, a brake valve, and the necessary switches, bell ringer, whistle, etc, The load regulator is just beyond the control station. The high voltage cabinet is at the end of the aisle. The knurled knobs along the side of the engine are the cylinder test valves. Fig. 14 is a view taken looking toward the rear door of the unit shown in Fig. 10. This view shows the steam generator. The steam generator of the locomotive shown in Fig. 11 is in the center of the space near the rear door of the B unit. Careful comparison and study of these llustrations with the diagram which is Fig. 11 will be helpful to a man who has not had experience on a Diesel locomotive. He will have some idea of what to expect to see when he first has occasion to climb aboard one of these locomotives.

22. Figure 15 shows the engineer's controls in the cab of one make of Diesel locomotive. No explanation of the various controls and indicators is given here. Their purposes are a part of the explanation of the operation of the power plant and the locomotive which is given in following texts.

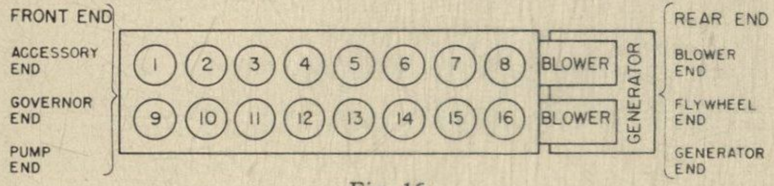


Fig. 16

23. The generator is considered as being at the rear end of a Diesel engine. The fly-wheel and blowers are at the generator end. Various accessories, such as the governor, pump, etc., may be at the front end of the engine or at some other suitable location. When a locomotive, such as a switcher, has but a single power unit, the generator of the power unit usually is toward the cab of the locomotive. The right and left sides of the engine are located from the generator end, looking toward the front of the *engine*. Cylinders on the right side of a V-type engine (not necessarily on the right side of the locomotive) are numbered from one to six or eight, beginning at the forward end; on the other side, they are numbered from seven to twelve or from nine to sixteen, also beginning at the forward end. This marking is shown in Fig. 16 for the engines of the locomotive shown in Fig. 11.

AUXILIARY EQUIPMENT

24. As has been stated, there are a number of auxiliaries on a Diesel locomotive. Some of these are found on steam locomotives also, such as the electric headlight, bell ringer, sander, air brake, train control apparatus, etc.

25. There is no uniformity among manufacturers as to the type of auxiliaries used, their location on the engine or locomotive, or their mechanical or electrical driving connections. Plans must be consulted to determine location and drive in individual cases.

26. Auxiliaries which are peculiar to Diesel locomotives are as follows:

STORAGE BATTERIES. Storage batteries of generous size are necessary for turning over each engine by power in order to get it started. The storage batteries are similar to those used in an automobile except that they are larger—32 cells, 64 volts. All low voltage current required for lights, controls, etc., comes from the storage batteries.

AIR OR POWER WHISTLE. The locomotive whistle is operated by air.

AIR COMPRESSOR. The air for the air brake system and for other high pressure uses is furnished by a two- or three-cylinder, two-stage, air- or water-cooled compressor which may be located at either the front or the rear end of the engine. It may be connected directly to the main shaft, it may be driven from the main engine shaft by "V" belts, or it may be driven by a separate motor.

AUXILIARY GENERATOR. This is a small generator. It may be mounted on the same shaft as the main generator or it may be belt driven. Its purpose is to charge the storage battery.

ALTERNATOR. An alternator may be added to one end of the main generator. It supplies alternating current for some auxiliaries.

Traction motor blower. The traction motors on the trucks are enclosed. They generate considerable heat while the locomotive is running. Each motor is cooled by a current of air which flows through ducts inside the motor casing and escapes through small vents in the casing. The current of air is furnished by traction motor blowers which are located in the engine room. They may be belt driven from the engine or else by separate motors. The air is conveyed to the motors by flexible ducts. An auxiliary blower sometimes is required to furnish additional cooling air on long ascending grades.

Radiators. The radiators of the cooling system are similar to those used in automobiles although they are larger and come in several sections.

Cooling fans. There are one or more of these fans in the cooling system for each engine. They force air through the radiators to cool the water that circulates through the engine. Cooling fans may be belt driven or may be driven by separate motors. When belt driven, they are equipped with clutches so that a fan can be cut out if not needed in very cold weather.

Shutters. There is a shutter at the opening through which air is admitted to each cooling fan or to the radiators. Shutters are used to regulate the amount of air admitted for cooling the circulating water on its passage through the radiators. Shutters are adjusted either by hand levers or automatically, by thermostatic control.

Oil filters. There are a number of oil filters throughout the fuel oil and the lubricating oil systems. It is particularly important that dirt be prevented from reaching the fuel injectors.

Oil cooler. Lubricating oil, after passing through the engine, is so hot that it must be cooled before being recirculated. The cooling is accomplished by passing the oil through a series of tubes which are in a case and are surrounded by circulating water from the engine cooling system.

AIR CLEANER AND SILENCER. One of these is mounted on the air blower of a two-cycle engine. It filters the air taken into the blower for use in scavenging the cylinders and supplying the charge for combustion. Without the silencer, the air passing through a blower often sets up a high-pitched screech.

DYNAMIC BRAKING CONTROL. There may be a dynamic brake control handle located on the control stand in the cab of road locomotives. It controls electrical circuits that allow the traction motors to be used as retarders on long descending grades.

GRIDS AND LOUVERS. The grids are heavy cast metal electrical resistors which absorb the electrical energy generated during dynamic braking on descending grades by converting the energy into heat. The grids are cooled by fans. The heat escapes to the outer air through the louvers (air ducts). The principle is similar to that of a brake shoe, which absorbs energy through friction, thus converting the energy into heat.

DEAD-MAN'S PEDAL. This is a pedal which must be held down by the weight of the engineer's foot while power is on the locomotive. Any letup of this pedal will shut off the power and apply the brakes.

27. AIR BLOWERS. An air blower is an integral part of a two-cycle Diesel engine. It furnishes air under pressure to scavenge the exhaust gases from the cylinders and to charge the cylinders with the air which is compressed on the upstroke of the piston. Many four-cycle Diesel engines are equipped with a turbo-charger. The turbo-charger serves somewhat the same purpose as the air blower of the two-cycle engine. It not only assists in scavenging the burned gases from the cylinder on the exhaust stroke, but in addition, it forces an extra volume of air into the cylinder on the admission stroke and thus increases the power of the engine.

28. CONTROLLERS AND ELECTRICAL CABINETS. These serve various purposes as follows:

High voltage cabinet. The automatic electrical switching of circuits between the main generator and the traction motors takes place in the high voltage cabinet. The voltage in this cabinet ranges from zero up to 1000 volts. No unauthorized or unqualified person should open this cabinet or tamper with any of this high voltage equipment, especially while the engine is running or the locomotive is in motion.*

Low voltage cabinets. Nearly all of the electrical circuits of the locomotive, other than the high voltage circuits, are supplied from the 64-volt storage battery. The switching and control equipment between the auxiliary generator and the storage battery is contained in the low voltage cabinet.

Distribution cabinet. This cabinet contains the various switches and fuses which connect the battery to the various circuits on the locomotive, such as, the engine-room lights, headlights, steam generator motor, etc.

Resistor cabinet. The various resistors used to limit the current in the battery field of the main generator usually are located in a separate cabinet.

Load regulator. This is an electrical device which automatically regulates the output of the main generator in accordance with the throttle setting. It prevents overloading the generator.

Controller. This is the name given to the stand located ahead of and at the left of the engineer's seat in the cab. It contains the reverser lever and the throttle.

Hostler's control. There may be a hostler's control position in the "B" units of a multiple unit locomotive. The arrangement consists of a small controller, brake valve, air whistle, and bell ringer. It provides a means whereby the unit may be moved independently of other units if necessary.

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*The high and low voltage cabinets are combined on some types of locomotives.

The Diesel Principle

29. The design of the cylinders of a Diesel engine is such that, as a piston approaches the top of its cylinder during a compression stroke, the charge of air in the cylinder is compressed into a very small space. When air or any other gas is compressed in a closed chamber, it is a law of nature that its temperature will increase in proportion to the increase in pressure. The compression pressure in a Diesel cylinder is so great that the temperature of the fully compressed charge of air is higher than the temperature at which fuel oil ignites.

30. Fuel is injected into the cylinder of the Diesel engine by mechanical pressure. The fuel injectors contain a mechanically-driven plunger that operates to force a measured quantity of fuel oil into the cylinder in the form of a fine spray each time the piston of the engine reaches the top of its compression stroke. The fuel is sprayed into the compressed air above the piston when the compression is greatest. Since the temperature of the compressed air is higher than the igniting temperature of the fuel, the fuel ignites as it is sprayed into the compressed air. Its burning produces the expansion or power stroke of the piston.

31. Only air is compressed in the cylinder of a Diesel engine, whereas in a gasoline engine a mixture of vaporized fuel and air is compressed. However, in the gasoline engine, the compression pressure is comparatively low so that the temperature of the fuel mixture is not raised sufficiently to cause it to ignite. A spark plug or other igniter must be used to fire the charge.*

Two-stroke Cycle and Four-stroke Cycle Operation

32. Diesel engines, as well as gasoline engines, can be divided into two groups, according to whether they operate on a two-stroke cycle or a four-stroke cycle.

***The compression ratio for a gasoline engine is about 6 to 1 as compared with 16 to 1 for a Diesel engine.**

33. Most gasoline engines operate on a four-stroke cycle. The automobile engine is an example. On a four-stroke cycle each piston makes four complete strokes, two up and two down, for each single firing or explosion that takes place in its cylinder. It takes two strokes to complete one revolution of the crankshaft, so each cylinder fires only once for each two revolutions of the crankshaft.

34. The events that occur during the successive piston strokes of a FOUR-STROKE CYCLE engine may be described as follows:

FIRST STROKE. The piston moves downward from the top of the cylinder or upper limit of travel. The vacuum which tends to form above the piston causes a charge of fuel and air to enter the cylinder through the admission valves. This is called the air admission or suction stroke. The exhaust valves close early in this downstroke and the intake valves close at the end of the stroke.

SECOND STROKE. As the piston starts upward on the second stroke, the charge above the piston is compressed. Both the intake and the exhaust valves remain closed during this stroke. This is called the compression stroke.
THIRD STROKE. When the piston reaches the top of its second stroke, the spark plug of the gasoline engine will flash, thus igniting the charge of fuel and air. The compression temperature in the cylinder of the gasoline engine is not high enough to ignite the fuel and air mixture—the spark is necessary. The burning of the fuel at the beginning of the third or power stroke of the piston causes a violent expansion of the gases in the cylinder. This forces the piston down and thereby delivers power to the crankshaft.* The exhaust valves open

*As a matter of fact, the explosive charge in the cylinder usually is ignited an instant before the piston completes the compression (second) stroke. This is because the speed of the piston is such that the firing must occur an instant before the piston reaches the top of its stroke in order that full power of the burning of the gases will be developed during the first part of the firing (third) stroke.

as the piston nears the end of this downstroke to permit the used gases to escape.

FOURTH STROKE. The fourth and last stroke of the cycle is known as the exhaust stroke. The exhaust valves remain open as the piston moves up. Thus, all the burned gases are pushed out of the cylinder into the exhaust pipe. The exhaust valves do not close until the piston completes this stroke and is ready to start the downstroke of a new cycle.

35. Many Diesel engines are designed to operate on the four-stroke cycle principle. The operation is practically the same as with a gasoline engine except that *only air* is admitted above the piston during the first or admission stroke. During the second or compression stroke, the charge of air is compressed to a much higher pressure than is practicable with the gasoline engine. When the piston reaches the top of the second or compression stroke, a charge of fuel oil is sprayed into the charge of compressed air. The temperature of this compressed air is high enough to ignite the oil as it is sprayed into the cylinder. No spark is necessary. When a turbocharger or supercharger is used, air under pressure from the charger enters the cylinder during the exhaust stroke and helps clear the cylinder of exhaust gases. Then, on the admission stroke, air is supplied to the cylinder under pressure in greater volume than is possible with the ordinary admission valve arrangement.

36. A TWO-STROKE CYCLE ENGINE delivers a power stroke on *each* downward stroke of the piston, that is, for each revolution of the crankshaft. Air under pressure is admitted to the cylinders through ports in the cylinder walls, instead of through mechanically operated admission valves. These ports are uncovered by the top edge of the piston on its downward stroke.

37. Figure 17 illustrates the cycle of events which take place during a down and an upstroke of the piston of a two-stroke cycle engine. The device shown at the left of each diagram is an air blower which forces air under pressure to ports around the cylinder wall. The exhaust valves are operated mechanically.

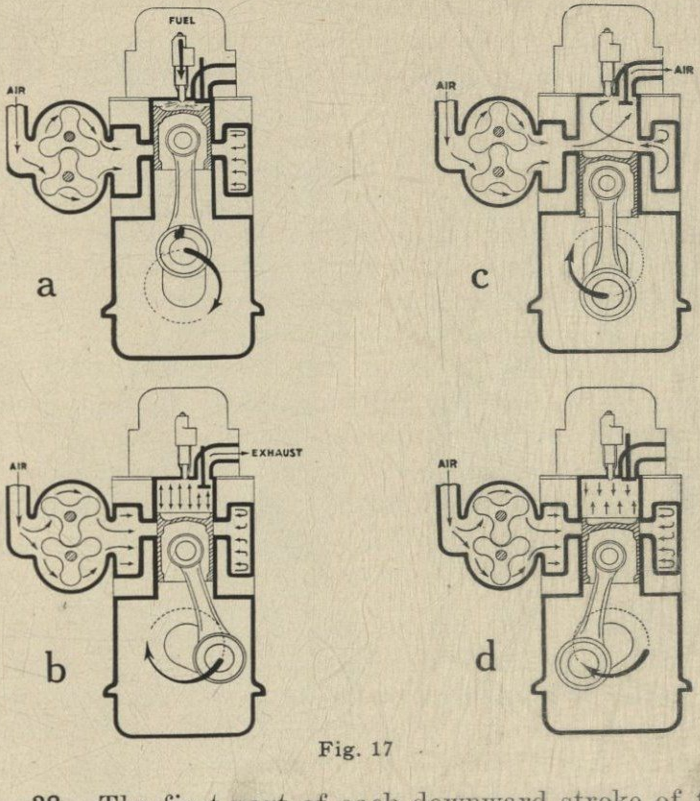


Fig. 17

38. The first part of each downward stroke of the piston of a two-cycle engine is a power stroke and the rest of the downward stroke is an exhaust stroke The first part of the upstroke is a continuation of the exhaust and also takes the place of the admission stroke of a four-cycle engine. The last part of the upstroke corresponds with the compression stroke of a four-stroke cycle engine.

39. The TWO-STROKE CYCLE may be described as follows: In Fig. 17a, the piston is shown at the top of its stroke. The charge of air above the piston has been compressed to one-sixteenth of its original volume. The temperature of this compressed air at the top of the piston has been increased by the compression to about 1000 degrees Fahrenheit, which is more than 300 degrees higher than the igniting temperature of fuel oil. When the charge of fuel is forced into this compressed air, the fuel ignites rapidly. The expansion, which is a result of the explosive burning of the fuel, produces the power stroke of the piston.

40. As the piston moves downward on the power stroke, the exhaust valves start to open an instant before the top edge of the piston reaches the top edge of the air ports in the cylinder walls (Fig. 17b). While the exhaust valves are opening, the air ports in the cylinder walls are uncovered by the further movement of the piston. When the air ports are uncovered, a current of air under pressure will flow into the cylinder and sweep or scavenge the burned gases out through the open exhaust valves (Fig. 17c). This sweep of fresh air into the cylinder continues while the piston finishes its downstroke and until the piston returns far enough on the upstroke so that the top of the piston again covers the air ports in the cylinder walls.

41. The exhaust valves close an instant before the air ports are covered on the upstroke. When the exhaust valves close, additional air under about 3 to 5 pounds pressure is crowded into the cylinder and is trapped when the air admission ports in the cylinder walls are covered. This trapped air forms the charge that is compressed. This is shown in Fig. 17d.

42. The rest of the upstroke of the piston is the compression part of the stroke. The air in the cylinder is compressed to a high pressure (about 550 pounds per square inch) ready for the injection of the fuel for the next power stroke.

43. It is apparent that at the same crankshaft speed, a two-stroke cycle engine will deliver twice as many power strokes per minute as will a four-stroke cycle engine which has the same number of cylinders. Thus a two-cycle engine can be built that will deliver about

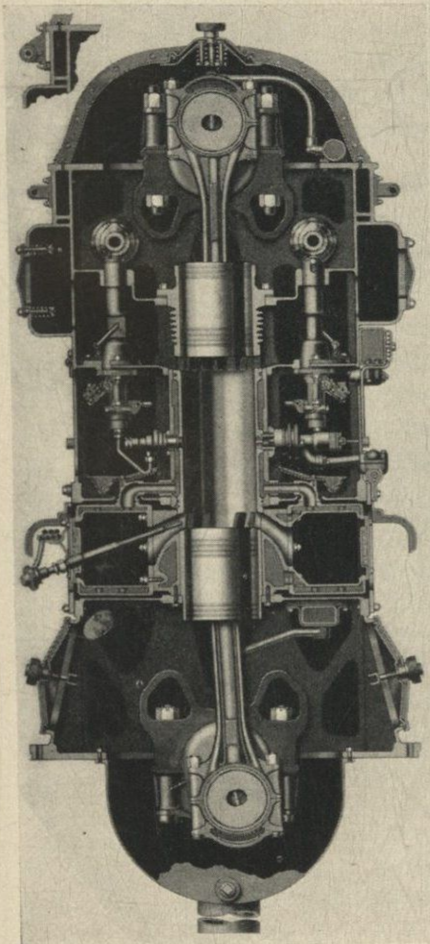


Fig. 18

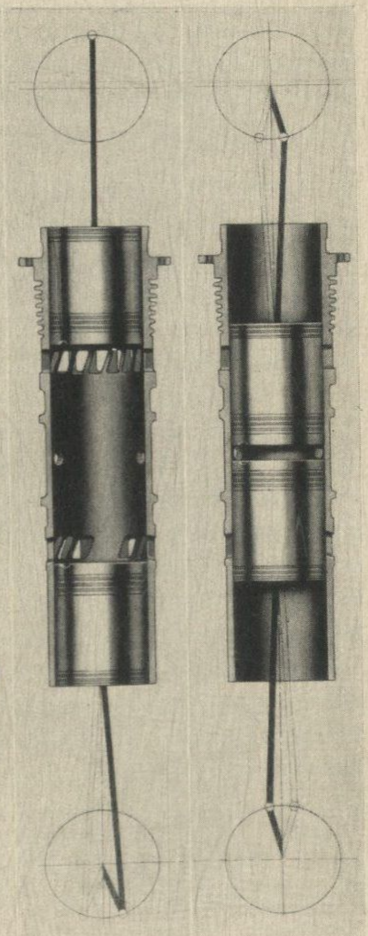


Fig. 19

twice as much power as an ordinary four-cycle engine of the same size and speed.

Two-stroke Cycle Opposed Piston Operation

44. One type of engine used in Diesel locomotives operates on what is known as the two-stroke cycle opposed piston principle. Fig. 18 shows a sectional view of one of the cylinders of such an engine. There are two pistons in each cylinder. There are two crankshafts, one near the top, and the other near the bottom of the engine. The crankshafts are connected by gearing so that they turn uniformly, one with the other. The engine operates on the two-stroke cycle principle but neither admission nor exhaust valves are required.

45. The right-hand view in Fig. 19 shows the two pistons nearest together. The left-hand view shows the two pistons farthest separated. When the pistons are closest together, the air that was trapped in the cylinder between them is compressed to a pressure of about 600 pounds. Fuel is injected into the space between the two piston heads when the heads come closest together. The compressed air is at a sufficiently high temperature to ignite the fuel as it is sprayed into the cylinder. The resulting explosion forces the pistons away from each other on their power strokes. As each piston nears the end of its stroke, the bottom piston uncovers exhaust ports in the cylinder wall and, a moment later, the upper piston uncovers air admission ports in the wall. An air blower forces fresh air through the admission ports to sweep the exhaust gases out of the cylinder and furnish the charge of fresh air which is to be compressed during the return strokes of the pistons.

46. The pistons are not on dead center at the same time. The crank of the lower piston leads the crank of the upper piston about 12 degrees.

EXAMINATION QUESTIONS

1 . . . What kind of fuel is used for a Diesel engine?

2 . . . What is the weight and horsepower of the Diesel switchers in general use?

3 . . . How is the electric energy, which is used to drive a Diesel locomotive, produced?

4 . . . How is the electric energy converted into power for driving the locomotive?

5 . . . What kind of air brake equipment is used on Diesel locomotives?

6 . . . Can one or more of the engines of a Diesel locomotive be cut out without interfering with the operation of the other engine or engines?

7 . . . What is the purpose of the air blower which is a part of a two-stroke cycle Diesel engine?

8 . . . How is the fuel introduced into the cylinders of a Diesel engine?

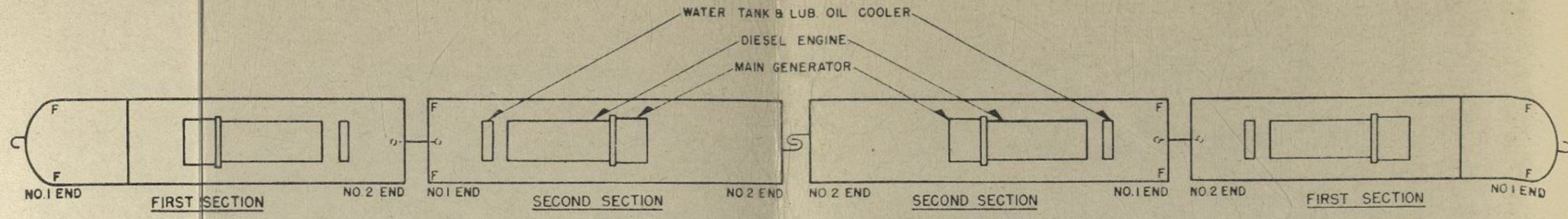
9 . . . How is the charge of fuel ignited in the cylinder of a Diesel engine?

10 . . . Describe briefly a two-stroke cycle of a Diesel engine.

11 . . . What is the purpose of the turbo-charger used with some four-stroke cycle Diesel engines?

12 . . . Explain the principle of the opposed piston engine.

R.E.B.—3-48-20.



PLAN VIEW SHOWING ARRANGEMENT OF SECTIONS

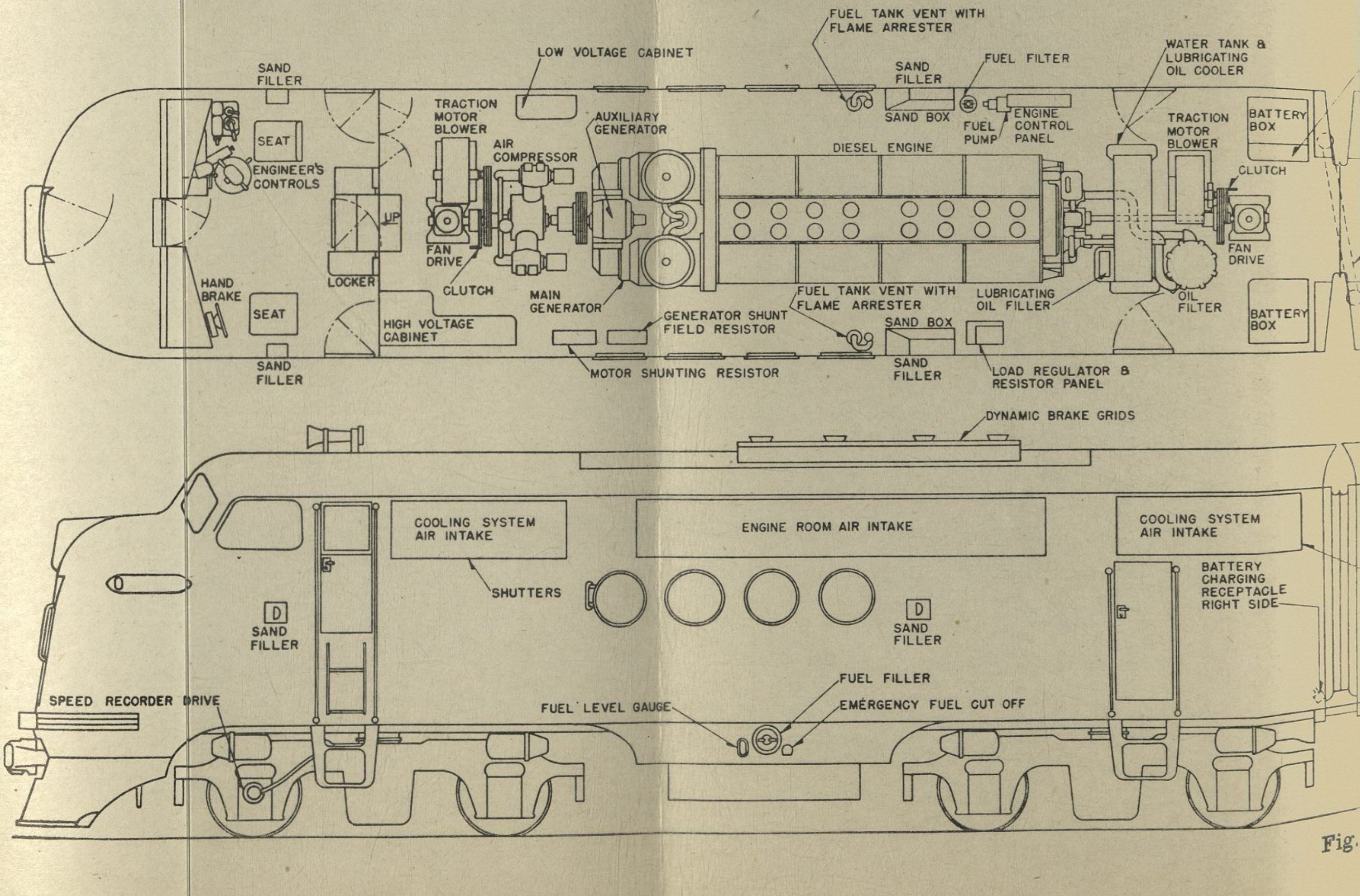
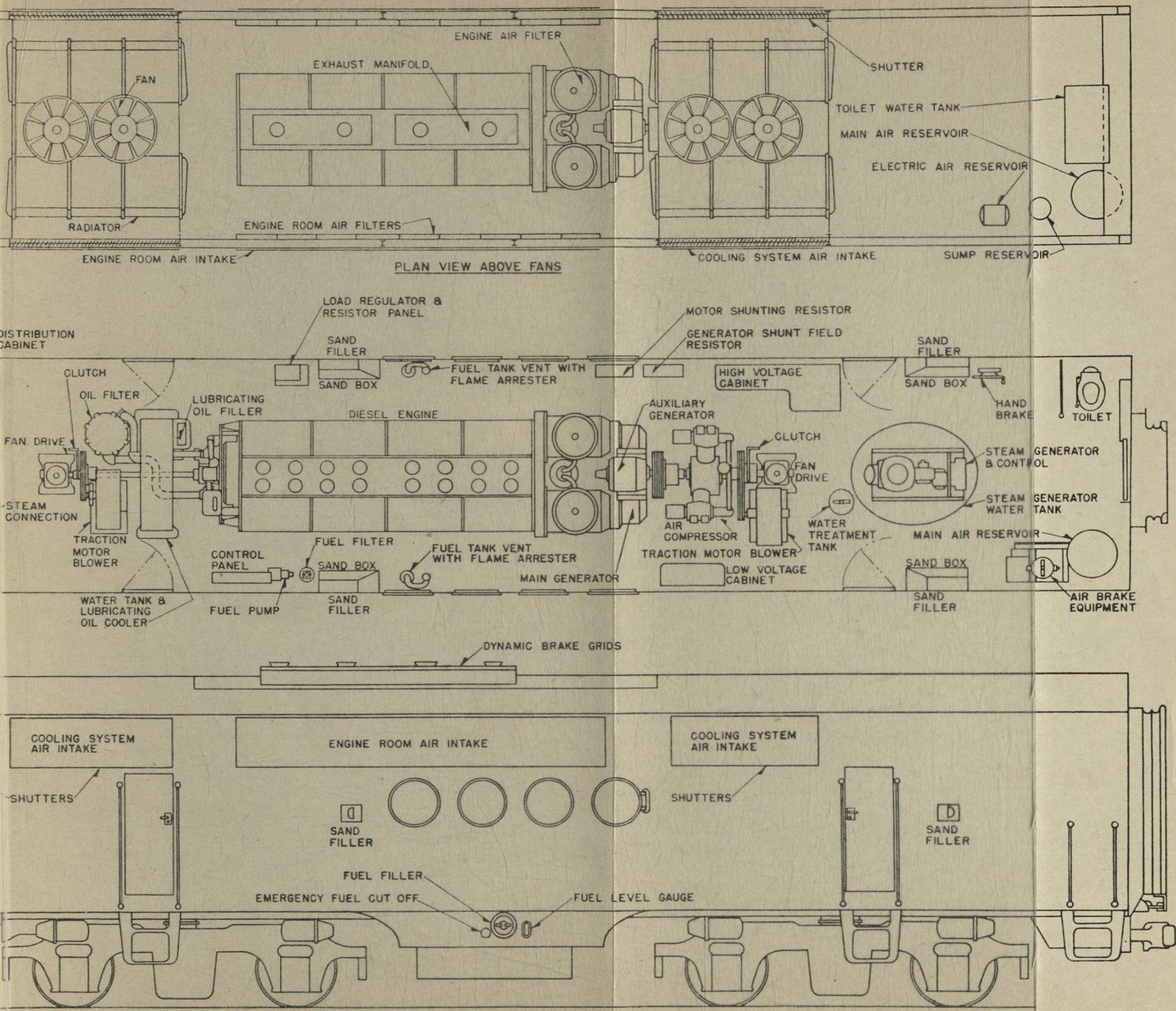


Fig.



ENGINE AIR FILTER
EXHAUST MANIFOLD
FAN
SHUTTER
TOILET WATER TANK
MAIN AIR RESERVOIR
ELECTRIC AIR RESERVOIR
RADIATOR
ENGINE ROOM AIR FILTERS
ENGINE ROOM AIR INTAKE
COOLING SYSTEM AIR INTAKE
SUMP RESERVOIR
PLAN VIEW ABOVE FANS
LOAD REGULATOR & RESISTOR PANEL
MOTOR SHUNTING RESISTOR
DISTRIBUTION CABINET
SAND FILLER
GENERATOR SHUNT FIELD RESISTOR
SAND FILLER
CLUTCH
FUEL TANK VENT WITH FLAME ARRESTER
HIGH VOLTAGE CABINET
SAND BOX
SAND BOX
OIL FILTER
LUBRICATING OIL FILLER
DIESEL ENGINE
AUXILIARY GENERATOR
HAND BRAKE
TOILET
FAN DRIVE
CLUTCH
STEAM GENERATOR & CONTROL
FAN DRIVE
STEAM CONNECTION
STEAM GENERATOR WATER TANK
TRACTION MOTOR BLOWER
AIR COMPRESSOR
WATER TREATMENT TANK
MAIN AIR RESERVOIR
FUEL FILTER
CONTROL PANEL
FUEL TANK VENT WITH FLAME ARRESTER
TRACTION MOTOR BLOWER
SAND BOX
SAND BOX
LOW VOLTAGE CABINET
MAIN GENERATOR
WATER TANK & LUBRICATING OIL COOLER
FUEL PUMP
SAND FILLER
SAND FILLER
AIR BRAKE EQUIPMENT
DYNAMIC BRAKE GRIDS
COOLING SYSTEM AIR INTAKE
ENGINE ROOM AIR INTAKE
COOLING SYSTEM AIR INTAKE
SHUTTERS
SHUTTERS
SAND FILLER
SAND FILLER
FUEL FILLER
EMERGENCY FUEL CUT OFF
FUEL LEVEL GAUGE