CHAPTER XXV

GENERAL MOTORS DIESELS

The Famous 567 Series

Wherever steel rails reach in the nation the big, blunt nose of the General Motors Diesel-electric locomotive is a familiar sight. It is instantly identified, and it seems to reflect the power that is behind it. There have been many improvements since the earlier Diesels began their conquest in a new railroad world, and it is my purpose to review here something of the progress accomplished, as represented in some of the Electro-Motive main-line power.

The General Motors Diesel story began away back in 1922 and was covered in my book, *Railroads of Today;* also in an earlier book, *Railroads at War,* when I wrote the early history of these Diesels, which now have come to play so great a part in modern railroading.

In the spring of 1949, the Electro-Motive Division of the General Motors Corporation, of La Grange, Illinois, announced three new main-line Diesel locomotives, designed to increase train tonnage and speed up the schedules of trains in both freight and passenger service. We will, first, identify these locomotives as the F7, the FP7, and the E8.

The F7 and the FP7, for freight and heavy-duty passenger service, supplant the F3 general-purpose locomotive brought out in 1946. The new E8 model succeeds the E7 high-speed passenger locomotive.

The F3 is a great piece of motive power and it made a record for itself on the head end of some of the best-known name trains in the country. And it still is a valiant locomotive, performing well and faithfully.

When Diesel power began crowding the steam locomotive a lot of railroaders called these new engines the "big growlers" and muttered that they were not all they were cracked up to be. True, the early Diesels had their shortcomings and there were bugs to be ironed out, but even in those days they had the ability to handle tonnage. They were constantly improved until only respect was employed in conversations concerning them. The Diesels have proved themselves everywhere, but nowhere have they done a finer job than in the difficult Tehachapi Mountains in California. The story of this fabulous grade is told in an earlier chapter.

The Diesel made possible the use of the dynamic brake, used first on freight Diesels; then on the modern high-speed passenger Diesel. It has performed wonders in today's railroading. For the nonrailroad reader, we might explain that the dynamic brake performs a service comparable to that of an automobile or truck employing a lower gear when descending a heavy grade. That is, it reduces the need for train-brake application to a minimum, thus effecting a saving in wear and tear on wheels and brake shoes.

In dynamic braking the traction motors are turned into generators, thus aiding in retardation. On straight electric locomotives this power is turned back into the line. On a Diesel this current is dissipated by means of grids in the roof of the locomotive.

Another feature of this latest Diesel is the automatic transition, successfully used in high-speed passenger locomotives, and made basic equipment in the new freight power.

Earlier Diesels had the fault of being limited as to water capacity for train heating, but this has been increased, which lengthens the mileage between necessary water stops and makes for faster passenger-train schedules.

Fast passenger schedules do not always mean constant speed in the higher brackets, but rather a reduction in stops and slowdowns, which can play havoc with a fast schedule.

The General Motors people are always forward looking when they bring out a new locomotive, in that it is so designed that it can be operated with older units, which permits interchangeable use and protects the railroad's investment in older Electro-Motive Diesels.

The new traction motors and generators developed by Electro-Motive utilize silicon insulating materials and other new methods of application of insulation. This, plus improved cooling, permits higher load factors, and these are translated into greater tractive force. The new motors and generators were built to last longer, to give top service longer between major overhauls.

With a steam locomotive the observer sees all of the major moving parts, threshing away there under the boiler, straining, crashing, threatening. The Diesel, on the other hand, has silent, powerful driving units geared to the driving axles. These electric traction motors perform, in substance, what is accomplished by the drivers of a steam locomotive, and, though they make less fuss about it, they are at the same time subjected to heavy burdens, as the electric power that flows into them from the direct-driven generators on the big Diesel motors is, in turn, transmitted through gears into the axles and so becomes the tractive force that pulls the train.

The new type injector perfected for Electro-Motive Diesels has broadened the range of fuels which may successfully be used. Before, Diesel locomotives required fuel of at least 55-cetene rating. With the new General Motors injector it was possible to use cheaper fuels of as low as 40-cetene rating. An important by-product of the new injector is the reduction of peak-shock-cylinder loads for all qualities of permissible fuel, with resultant longer life.

Because of the improvements in the Electro-Motive traction motors and generators, the maximum continuous tractive force of the F7 unit is increased to 52,400 pounds, as compared with 42,500 pounds in the F3. Horsepower rating of the Diesel engine remains at 1,500 for propulsion alone. Top speed remains at 102 miles per hour, as in the F3, but, with greater tractive force, the F7 is able to haul heavier tonnage.

The F7 can haul 25 per cent more tonnage up a 1 per cent grade at continuous rating, and 30 per cent more tonnage at short-time ratings for two hours. Since there are few grades in the country which require more than two hours to climb with the heaviest train permissible with present drawbars, the effect of this is that most railroads will be able to increase tonnage 30 per cent with the new motive power units.

We have referred to the dynamic brake. On the F7, 23 per cent greater tonnage than formerly can be safely controlled, which means decrease in the use of air brakes on grades and a resultant savings in brake shoes, wheels, and air-brake equipment. This has been done by increasing the capacity of the brakes from 540 to 600 amp.

Electro-Motive engineers increased the pulling ability of the F7 by developing hot-pressed silicon and glass insulation for coils in the traction-motor armature, and by designing a new kind of insulation for field coils. Another factor was greatly improved motor cooling. It was found that the elimination of organic material in insulation, through the use of this hot-pressed silicon and glass, reduced deterioration caused by heat. Silicon, glass, and mica are unaffected by cold or moisture or heat, and through the employment of these for insulation a greatly increased service life of the new motors is anticipated.

Further, these improvements are something that can be built into existing Electro-Motive traction motors as these locomotives go in for repairs.

In the past, the human element has entered into the handling of Diesel locomotives to a certain extent, and sometimes damage to equipment resulted from the improper handling of the various shifts as a Diesel got under way or reduced speed. General Motors successfully used automatic transition on high-speed passenger locomotives over a period of years. This automatic transition became standard equipment on the F7 heavy-duty locomotives.

Without automatic transition, the changing of connections between traction motors on the F series locomotives to give variations in performance for varying requirements in starting, accelerating, and maintaining speed with heavy loads had been a manual operation performed with a control lever by the engineman. As a locomotive gathers or reduces speed, automatic performance of the different shifts relieves the engineman of the responsibility for making them in a manner that will contribute the most to the train handling.

Another pronounced improvement in the F7 is the increase in capacity of the steam generators for train heating. Train heating has been something that the engine builders had to learn by the trial and error formula, for they did not have a titanic steam boiler at their command to draw from under unusual extremes. Instead, the Diesel locomotive units were equipped with generators that performed satisfactorily in average cold weather but which ran into trouble in extreme subzero conditions. This was true, in particular, when there were extra cars added to the train and which were sometimes a mixture of old and new cars.

The new F7 Diesels are equipped with 2,500-pound steam generators, for the A units, while the B units can be equipped with either 2,500-pound or 4,000-pound generators. Thus a two-unit F7 locomotive may have a total 6,500-pound capacity, or an increase of 1,900 pounds over the older F3 maximum. The total capacity of a four-unit F7 locomotive can be 14,500 pounds, as compared to 10,600 pounds in the four-unit F3.

The F7 Diesel has the same length, height, and weight as the F3, plus the wide range characteristics made possible by eight optional gear ratios and variations in number of units that can be coupled or uncoupled to fit the locomotive capacity to the size of the train. The range is broadened, however, by the increase in the tractive force of the more modern locomotive.

The F7 was General Motors' contribution to modern railroading, in that this is a versatile freight and heavy-duty passenger locomotive, operating as a single unit of 1,500 horsepower or in combinations of 3,000, 4,500, or 6,000 horsepower.

The F7 looms large as the most effective tool available to American railroads in the mighty struggle for traffic against competitive services. For here is a locomotive that already is achieving new levels of performance in both freight and passenger service.

The field for heavy passenger service has been considerably broadened by the new General Motors FP7 lead unit, which provides increased train heating capacity and longer distance between water stops.

The FP7 is basically the same as the F7-A, with car body extended four feet to permit installation of a 2,500-pound steam generator, together with 1,750 gallons of water if dynamic brakes are not required, or 1,150 gallons of water if dynamic brakes are installed.

This extra water supply of 1,750 gallons is made possible for the reason that the tank can be installed in the roof space which otherwise would be occupied by the dynamic brake grids. It might be pointed out that the dynamic brake, so essential to mountain operation, is not required on divisions or railroads operating in predominantly flat country. With a locomotive made up of four units, the maximum water supply, without dynamic brakes, would be 7,100 gallons; thus it follows through that the supply would be reduced 600 gallons per locomotive unit when dynamic brakes were used.

Your Diesel locomotive is designed to use different gear ratios, which the manufacturer indicates in his specifications. For combination freight and passenger use most railroads order gear ratios based on desired top speeds ranging between sixty-five and eighty-nine miles per hour. With these FP7 units of 1,500 horsepower, it has been indicated that a three-unit 4,500 horsepower combination General Motors locomotive can be geared for a maximum speed of eighty-three miles an hour and still have a continuous tractive effort of 96,000 pounds.

An A unit, for those unfamiliar with Diesel locomotives, is the unit which contains the cab. The B unit has no cab and consequently no operating controls, and it must always be used in conjunction with an A unit. Two A units may be employed, back to back, and, to provide greater power, one or two B units may be used behind an A unit, or between two A units. Or even three B units may be used behind the A unit.

While the FP7 was built for heavy passenger service, the locomotive can, with the proper gear ratios, be used for combination freight operation, with the ability to haul heavy tonnage.

Ranked high in its field is the General Motors E8, a piece of motive power that by every standard of measurement broadens the application range of Electro-Motive streamliner locomotives, which have delivered millions of miles of the finest sort of service on America's fastest scheduled runs.

Because of improvements in traction motors, with their 25 per cent increase in continuous tractive effort, this modern sleek giant of the rails can haul heavier trains over longer grades without helpers, and that is a money-saving service, as well as a time saver.

This E8 has a six-wheel truck, which some believe gives it smoother operation in the higher speed range. The middle wheels were designed to aid in the weight distribution only. The E8 is a rugged piece of equipment, both in looks and performance, and these trucks are masterful and smooth in modern high-speed work.

The E8 is especially suited to single-unit passenger work because it has *two* Diesel engines, turning out 1,125 horsepower each, making a 2,250-horsepower locomotive. It also has two steam generators, thus providing a 100 per cent factor of safety in both propulsion and train heating.

Like all of these General Motors locomotives, this piece of motive power is designed for the maximum of interchangeability because of its standardized parts, which provides the utmost simplicity of maintenance. We are going to come back to this feature later because it is of the greatest importance. The motorist, years ago, in particular, knew the satisfaction and the peace of mind that came with the knowledge that his car was one that could be serviced and supplied with necessary parts anywhere in the country that repairs might be needed.

These 2,250-horsepower E8 units can be coupled to form single- or double-end control combinations to meet every motive power requirement, right up to 6,750 horsepower. The E8, of course, has a B unit for use in various desired combinations such as we mentioned previously.

Modern railroading certainly achieved distinction in having placed at its command such a high standard of motive power as this six-wheel truck passenger hauler.

Dynamic brakes are applicable with this passenger power, and the roof hatch containing the grids is interchangeable with the F7 locomotive. If dynamic brakes are not employed, as was pointed out in connection with the FP7, the hatch may be used for a 600-gallon water tank, which on the E8 would bring the total water capacity to 1,950 gallons per unit.

Road-switching Locomotive

One of the great locomotives that the Electro-Motive Division has produced, the General Purpose GP7, is not only a real work horse when it comes to handling freight, in the yard or on the main line, but it can get out and wheel passenger trains of the local or mixed variety. It can do more with its 1,500 horsepower than any railroad has a right to expect. As a unit, it combines the power and the versatility of the F7. It has a complete look of competence, with the muscles under its hood to back up its sturdy appearance.

In 1935 General Motors Diesel switchers began setting the pattern for this type of service. These doughty locomotives have established records for hard work, long life, high availability, and low operating and maintenance costs.

There was a distinct need for a general utility type piece of power—something more than just a switch engine. A design finally came off the drafting boards that gave every indication of being an outstanding contribution to the railroads' needs.

The GP7, in the first place, introduced a new and simplified electrical control system which provides instant response to the throttle for ease and speed in switching. Starting tractive effort is under the control of the operator. Acceleration is velvet smooth.

The engineer of this locomotive is one of the first to appreciate what it offers for he is the man who works closest to it. The cab is especially designed for single-control operation in either direction, but dual controls may be installed when required. The narrow hood provides excellent visibility for the men in the cab. Doubly insulated against noise and heat, the GP7 cab provides positive ventilation in summer and individual temperature control for both engineer and fireman in winter, which in itself is a great feature.

Many demands are made on a road switcher, including all sorts of emergency calls. There is that excursion train and that helper job, or perhaps motive power is needed for a snowplow. Or it may be needed for a branch-line passenger train.

With 1,500 horsepower, 125 tons, this locomotive offers a choice of six different gear ratios, making it possible to meet a wide range of services. Fitted to meet certain conditions at the time of delivery, the GP7 can quickly be tailored to perform other than the work originally planned by simply changing gears and pinions.

Perhaps this general purpose locomotive is wanted for passenger work, and, consequently, will need heating facilities; in that case, space ahead of the cab is provided for a 2,550-pound steam generator with 800-gallon water supply. This space also contains a toilet.

The GP7 can meet many and varying traffic conditions. It can be equipped to multiple with other GP7's, for additional tractive effort, and with any other General Motors locomotive for emergency service when required.

The Diesel engine is the same as the engine in the F7 road type locomotive, with 1,500 horsepower driving the main generator, which also is the same powerhouse as we find in the road locomotive. The four-wheel trucks also are interchangeable with the F7. They are designed for maximum stability and good riding quality, even on secondary branch lines, and to perform perfectly on the sharp curves in yards.

One of the most important Electro-Motive developments is the outside swing hanger suspension used on both the six-wheel and four-wheel roller-bearing trucks. Placing the swing hangers outside the rails practically doubles the distance between them, thus providing greatly increased stability on curves, which makes for better riding and reduced body roll. These latest and finest trucks are used on this road switcher, which indicates that the best of everything has gone into it, with the result that it is making a name for itself as a remarkable piece of motive power.

There are many special features that go to make this road switcher the kind of power that railroad men like to work with and that yard and main-line operating forces like to have at their command.

A great feature is accessibility, which is one of the highlights of the GP7, of all parts and equipment. Cab heating and ventilation is taken care of by means of forced air circulation, including ducts and diffusers for defrosting all cab windows. People look at a Diesel switch engine and wonder what kind of heating arrangements it has, if any. Heat for cold-weather operation in the cab of the GP7 is obtained from two engine radiator sections that have individually operated shutters for controlling air from the outside. And, as we have mentioned, engineer and fireman have precise control of heat on each side of the cab.

In doing freight roadwork, a head brakeman rides the cab. To provide for this member of the crew, a third seat is available, it being optional equipment. The cab has no divisions, making it easy for the engineer and fireman to call signals or engage in conversation.. Upholstered armrests on window ledges on each side provide comfortable arm- or backrests when leaning out of the windows.

Ample space is provided at one end of the locomotive for the oil cooler, cooling water, oil filter, fuel filter, and fuel pumps, which are conveniently grouped for checking, servicing, or other attention. Air filters in hoods protect the engine and generator from dirt and snow. Headlights are twin sealed-beam, with bright and dimmer switch in the cab at a convenient location.

A feature of the main generator is its separate compartment housing. This has a "blizzard hatch" to draw warm air from the radiator, thus keeping the temperature well above freezing; it also prevents an accumulation of ice and snow in the air filters.

The many modern features of this work-horse switch and road engine reflect the vast experience of Electro-Motive in building the Diesel. The years that were behind created a vast reservoir of experience from which to draw when the GP7 went onto the drafting boards.

The GP7 does well in transfer service—those trains of freight being moved from one road to another—it can be used to handle work and supply trains, or to buckle on behind a snowplow. It performs well in hump switching service, and it will handle any assignment in local freight and passenger work.

We watch and admire the powerful Diesels on the long freight train and we look with keen pleasure at the colorful passenger Diesels, but our glance at the Diesel switch engine is brief almost to the point of being contemptuous. We see no glamour there, and yet there is perhaps more concentrated modern railroading wrapped up in a locomotive like the ubiquitous road switcher than in anything of like dimensions around the railroad plant. It is powerful and compact. It is built to do not alone one job well but many jobs.

A railroad would not get far without the services of the humble switch engine. It is the drudge of the road, unheralded, unsung. In a slightly older era it was the "yard goat" in some railroad vocabularies. It shuffles back and forth, performing endlessly the humble duties attendant to assembling and disassembling freight trains and passenger cars. It pulls in cars from sidings, which previously it had distributed. It works the clock around, except for a bit of servicing now and then. It clasps hands with cars from every state and every clime.

A great breed, the Diesel switcher, it really does its share of work.

In the fifteen years after 1935 General Motors Diesel switchers put in more than 50,000,000 hours of service, and they have set many records for long life and high availability, and it follows out that this means low maintenance costs. To accommodate the wide range of railroad service demanded, General

Motors, already with a strong pattern, set their engineering sights on the highest possible goal for switching motive power. Standardization has been one of the things that raised this company's motive power to the position it holds in the railroad world today.

The standardization, we might say, starts in the lowly switcher —in the heart and core of the locomotive—the Diesel engine, which we will return to shortly. For ten years General Motors' 125-ton, 1,000-horsepower switcher performed the toughest assignments in every field of heavy switching service. Then there was introduced to modern railroading the same rugged switcher, but with the horsepower increased to 1,200, utilizing the surplus power of the twelve-cylinder 567 series engine and so providing power for a 20 per cent increase in speed with the same tonnage rating. This new locomotive, therefore, was even more adaptable to fast transfer service and opened up a wider field in freight application.

An eight-cylinder 567 series Diesel went into a new addition of General Motors' switchers—an 800-horsepower, 115-ton switching locomotive. This power handles just about all of the work performed previously by the 1,000-horsepower locomotive at a considerably lower initial cost and, of course, lower operating cost. It has the same generator and traction motor as the 1,200-horsepower switcher and it works in many types of hump operation.

Now we come to the six-cylinder switch engine—600 horsepower, 100 tonner—with a decade of outstanding service. Transmission in this modern version of a veteran included a new generator, interchangeable with the 800- and 1,200-horsepower locomotives, and new silicone-insulated traction motors. This yard engine is a bruiser for work in a field that demands economy of operation. Remember, it is still a 567 series job, still that famous Diesel that powers all General Motors locomotives, only with less cylinders.

Now we come to a tandem job—a two-unit 2,400-horsepower transfer locomotive which delivers an astonishing 81,600 pounds continuous tractive effort at 8.7 miles per hour with a ratio of

65:12. This unusual switching locomotive is made up of two 1,200-horsepower power plants, *permanently* connected. The lead unit is the same as the 125-ton switcher. This duplication follows out in the booster unit, except that the latter has no cab, simply an extension of the hood.

Right straight through we find the same standard equipment employed in every piece of General Motors' motive power, except as to size of the main generator, one size of which is used with the sixteen-cylinder engines and the other with the twelve-cylinder engines.

For extra heavy transfer and humping operations, a three-unit combination of this type locomotive is available, which simply involves permanently hooking on a second booster unit.

General Motors—Diesel Pioneer

The General Motors Company is the father of the Diesel. They pioneered and developed it, and they are today the leading manufacturers of Diesel-electric locomotives, built by the Electro-Motive Division at La Grange, Illinois. Working from the ground up, General Motors achieved a power plant in which the co-ordination between the Diesel engine where the power is conceived and the electric drive, the force that turns the wheels, is marvelously smooth.

For the man who looks at the Diesel locomotive in action, without any clear notion of what is transpiring inside, a few words will tell the story. A Diesel engine drives a main generator, directly connected to it. Electric power flows from this generator, through suitable controls at the hand of the engineer, to direct-current traction motors, geared to the driving wheels. Simply, a Diesel converts mechanical energy into electrical energy.

General Motors uses only two generator sizes. One is used in the F7 and GP7 units, the other is used in the E8 road engines and the 600-, 800-, and 1,200-horsepower switchers. When used in road engines, the generators are equipped with alternators, built into the main units, to provide A.C. current for the induction motors which drive traction motor blowers and engine cooling fans. In the road locomotive the generator is force ventilated.

Many people wonder how the throttle for the mechanical energy (the Diesel engine) is co-ordinated with the electrical energy (the generator). Like the rest of the modern Diesel, these controls have been simplified and made foolproof to an amazing degree.

Let's take a look at the locomotive controls.

A highly selective load regulation system completely synchronizes the engine and transmission system. It ties the generator output, or voltage, directly to the fuel injection system of the engine, thereby assuring a constant horsepower output at each throttle position regardless of locomotive speed.

Now something called transition takes place, and that has been a baffler for many railroad enthusiasts. Transition is the process of connecting, or reconnecting, the traction motors to the generator in combinations which will give the best locomotive performance throughout the speed and load range. The various connections are accomplished by electropneumatic switches and contactors. These are operated by compressed air controlled by electrically actuated valves. Transition is designed for ease of operation and to avoid the possibility of operating errors that might cause damage to electrical equipment. This transition is fully automatic on the F7 and GP7 engines, and also fully automatic when running forward on the E8, and semiautomatic backward.

The finest machine in the world, proud of its newness, becomes absolutely worthless once part failure takes place. The ability to replace and repair quickly marks the degree of success of the organization which built the machine. A parts department, nationwide in scope, has given General Motors' railroad customers the kind of service modern transportation must have to keep trains moving on the high green.

The parts department can become a nightmare if frequent changes in design and model, over the years, burden the department with a vast number of parts. The greater variety of parts and part sizes, the greater the cost. There could be no better example of consistency in engine design than is found in the General Motors great 567 Diesel. Beside being a clean trim-lined piece of machinery, a dependable piece of machinery, it offers an interchangeability of parts, from the flashing streamliner motive power right down to that 100-ton switcher, that has inherently been interlocked in its design from the beginning of the 567 series.

All models of this 567—six, eight, twelve, and sixteen cylinder —have the same bore and stroke. And that is eight and a half inches by ten inches. The result is that all wearing parts are completely interchangeable.

The two-cycle principle is used in the General Motors engine, and that is the ultimate in simplicity of design. In the two-cycle engine the piston takes a power smash on every down stroke. The two-cycle gives more power in a more compact engine.

Fuel is introduced into the cylinder with a unit injection system that combines with a high-pressure fuel pump, a metering device and spray nozzle in a single unit, doing away with troublesome high-pressure lines. A Root's type displacement blower provides excess air for clean, efficient combustion at any speed or altitude. The pistons are the oil cooled, floating type, free to rotate in the cylinder, resulting in more uniform wear and longer life.

Needless to record is the fact that the materials and the workmanship that goes into the famous 567 is of the highest standard.

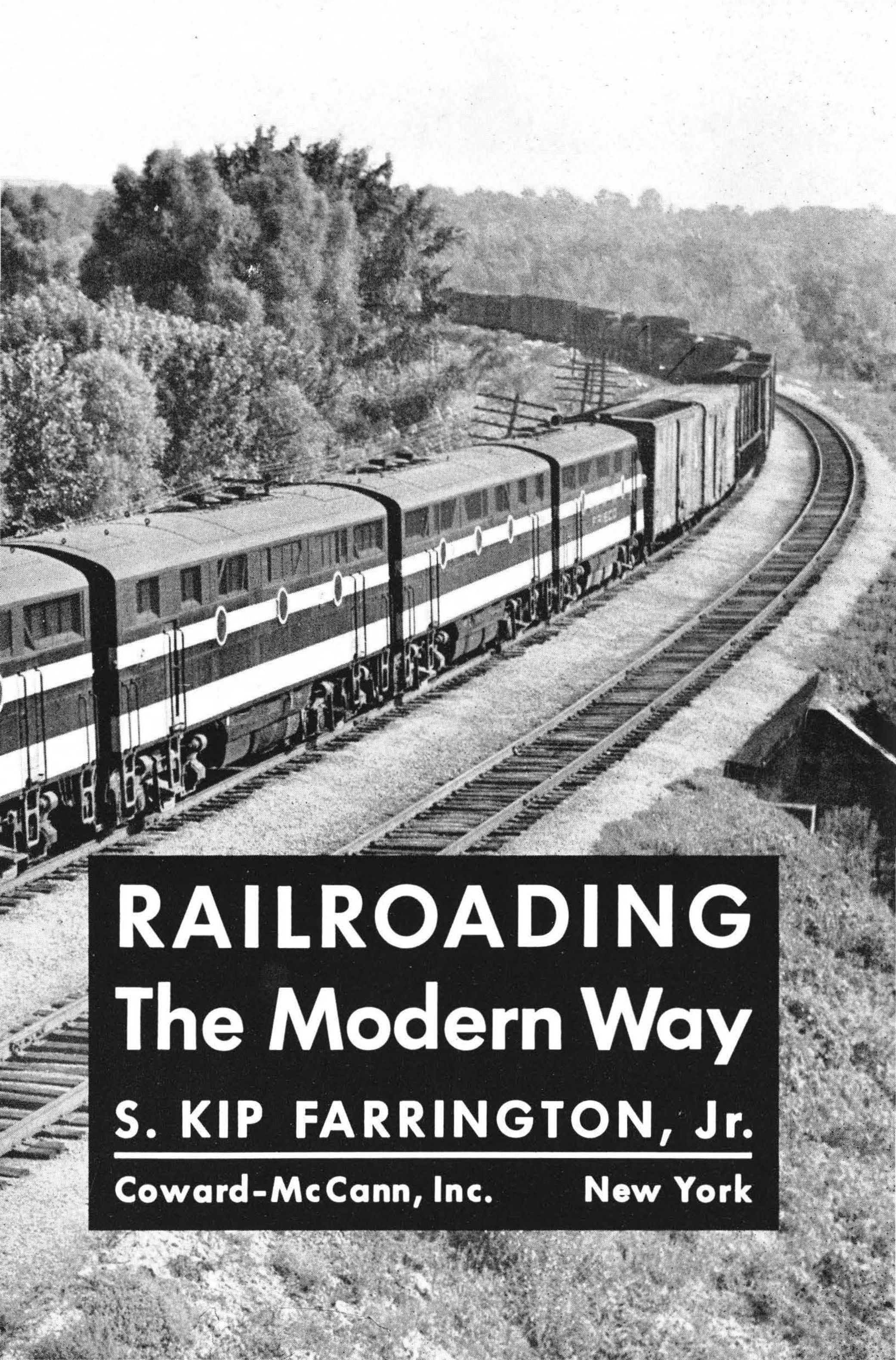
The Diesel body structure employs the bridge-type design and practically all of the weight above the trucks is carried on the rigid side frames. These bodies are built to stand a squeeze of 800,000 pounds, applied to the couplers, without any permanent deflection. This not only meets the requirements for passenger cars but protects locomotive crews as well as train passengers.

Switcher design is different. Here the underframe is the backbone. This supports the entire weight of the power plant and auxiliary equipment. The weight is built into the structure to obtain the desired drawbar pull without slipping the wheels. A switch engine is constantly taking and delivering blows, and it must stand up in this grueling service. Massive underframes consist of heavy, rolled steel components, welded into a structure capable of withstanding the most severe buff and drag stresses.

The fabulous General Motors Diesel has achieved distinction through the number of units delivered to the railroads from 1934 through 1949. This includes a total of 3,364 freight units, 1,893 switchers, and 1,456 passenger units. In terms of horsepower, it ranks as follows:

Year	Total Horsepower (Cumulative)
1934	600
1935	11,100
1936	45,900
1937	129,300
1938	222,000
1939	385,300
1940	610,600
1941	925,050
1942	1,209,450
1943	1,470,850
1944	2,145,850
1945	2,799,300
1946	3,458,800
1947	4,822,600
1948	6,676,200
1949	9,077,300

General Motors' Diesel-electric locomotives have provided *two billion* unit miles of railroad service, as of the latter part of 1950, and the fleets continue to grow in this era of modern railroading which has given the nation better trains and better locomotives.



RAILROADING The Modern Way

S. KIP FARRINGTON, Jr.

Coward-McCann, Inc. New York

Published simultaneously in the Dominion of Canada by Longmans, Green & Company, Toronto

MANUFACTURED IN THE UNITED STATES