Diesel Traction Development in U.S.A.

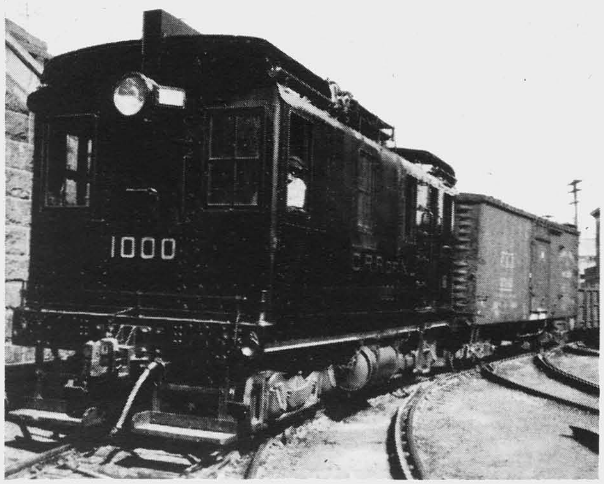
I—The period down to the end of 1935

IF one considers the activities and pronouncements over the last two years of the American Anti-Trust Commission one may be forgiven for wondering if the origins of diesel traction in the United States were shrouded not in the mists of antiquity but in the mists of iniquity. But the real beginnings were in the hands of Herman Lemp and Henry Chatain, in whom was no guile, at the direction of their employer, General Electric, who sent the pair to Europe in 1911–12 to see the Diesel-Sulzer-Klose direct-drive locomotive and investigate any other proposals that were afoot for diesel traction. After their return they put forward suggestions for diesel-electric locomotives (G.E. had already built a number of petrol-electric railcars), and though these ideas were rejected by the G.E. board, Lemp gave further thought to the technical aspects, and in June 1914 patented a system of control that was so fundamental that it, and a further patent of his ten years later, were the parents of most of the electric-transmission control systems of today. Though G.E. just prior to the first world war took out a licence for Junkers oil engines, and actually installed five in 200 h.p. locomotives about the year 1915, this activity went no further and does not seem to have been tied up in any way with Lemp's studies and recommendations.

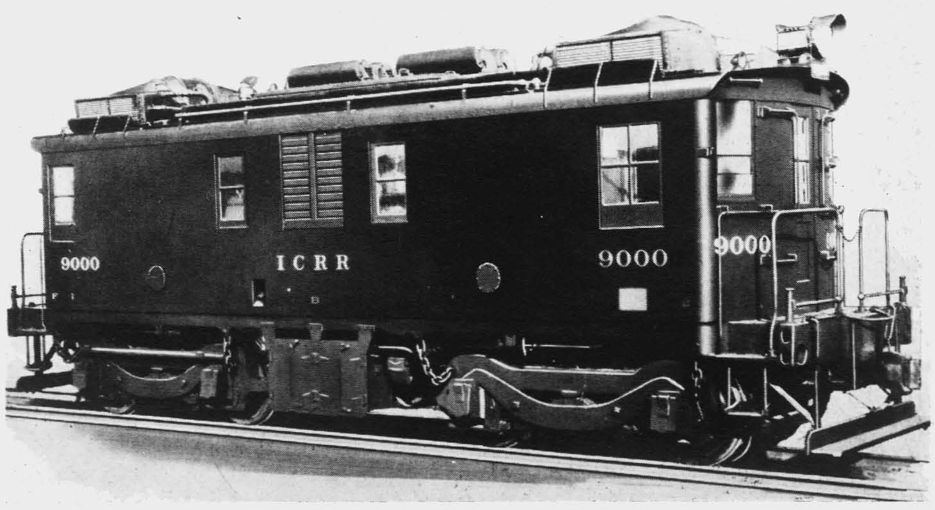
However, in 1920, G.E. once more became interested in diesel locomotive possibilities, and in 1920 instructed Lemp to draw up a specification for a 300 h.p. railway oil engine. This was circulated in 1921 to oil-engine builders in the States, but no one was interested except Ingersoll Rand, who a year or two previously had acquired the Price patents for airless fuel injection, and were seeking to exploit them as far as possible. The result was that Ingersoll Rand agreed to build an engine at its own expense to meet Lemp's specification, and to install it in a locomotive to be provided by G.E. Thus was born the G.E.-Ingersoll Rand-Alco partnership, for Alco came in to build the mechanical portion. In 1924 a 300 b.h.p. Bo-Bo bow-ended diesel-electric locomotive was ready for demonstration on shunting jobs; it embodied Lemp's further ideas on control, which eventually became the forerunner of many of the automatic controls used since in several countries, but the locomotive began to run with these at the end of February 1924, three and a half months before Lemp filed his patent.

This demonstrator proved the possibilities, and two production models were designed. One was a 300 b.h.p. single-engine Bo-Bo of 53·5 tons weight, the first of which began work on the Central Railroad of New Jersey in October 1925, and was withdrawn from service only in 1957. The second production model was a double-engine Bo-Bo of 600 b.h.p. and 89 tons weight, and the first of these began work on the Long Island Railroad in February 1926. The Ingersoll-Rand six-cylinder 600-r.p.m. 300 b.h.p. engine was used in each. There was a constant though small flow of orders for these; they were built until 1931 or thereabouts, to a total of about 150, but the partnership then split up when Alco acquired the oil-engine manufactory of McIntosh & Seymour, so that it could provide two-thirds of the locomotive instead of one-third.

In general these locomotives were quite successful



Above: The first 300 *b.h.p. commercial G.E.-Ingersoll Rand-Alco Bo-Bo diesel-electric locomotive, Central Railroad of New Jersey,* 1925. *This locomotive was withdrawn in* 1957



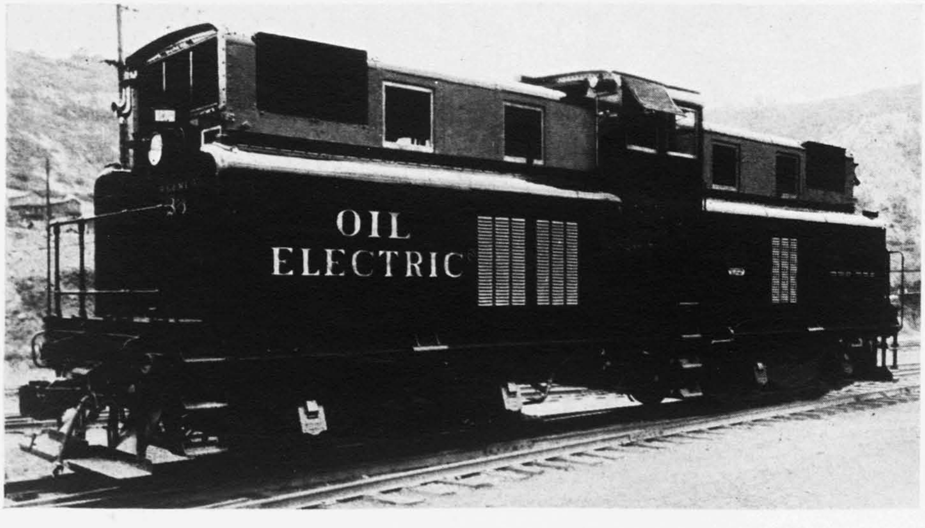
Right: A standard 600 *b.h.p. twin-engine G.E.-Ingersoll - Rand - Alco shunting locomotive of* 89 *tons weight,* 1925

Early effort of the New York Central at a line-service locomotive, a 2-Do-2 diesel-electric of 750/800 b.h.p. and 130 tons weight, 1929

mechanically, but it is probable that the 300 b.h.p. size was not powerful enough, and the engine-transmission group not suitable for providing those rapid surges of power needed to "kick" heavy cars in flat shunting. There were sundry developments, eventually up to a single 800 b.h.p. Bo-Bo switching and transfer locomotive of 103 tons weight for the Erie in 1931, which was notable in having a control system in accordance with Lemp's 1914 patent; but in general American railroads were not yet ready for a major change-over in switching power, and the 1930–31 depression, which made such big inroads into passenger traffic, was before the time when a promising line-service locomotive was at hand.

There were other developments in the mid-1920's, however, and two of these involved line-service locomotives, though the first in time was a 122·7-ton A1A-A1A switcher by Baldwin in 1925, in which a 450-r.p.m. Knudsen inverted V engine was installed. This was supposed to be of 1,000 b.h.p. but actually it never gave more than 750 b.h.p., and 560 r.h.p.; and Lomonossoff, who made some tests on the locomotive, told the writer two or three years later that, though it was quite reliable in service, as a smoke producer it rivalled an American bituminous-coal-burning steam locomotive. The 12-cylinder inverted V engine was interesting in having a common combustion chamber for the two opposite cylinders; it was, in fact, half-way to the already established opposed-piston engine. This locomotive was designed and built at a time when Lemp's ideas were known and available only to a small circle, and so this locomotive retained a primitive form of control in which the driver had to manipulate both a controller handle and a throttle lever. It did the heavy shunting in the Baldwin yard for six years or so.

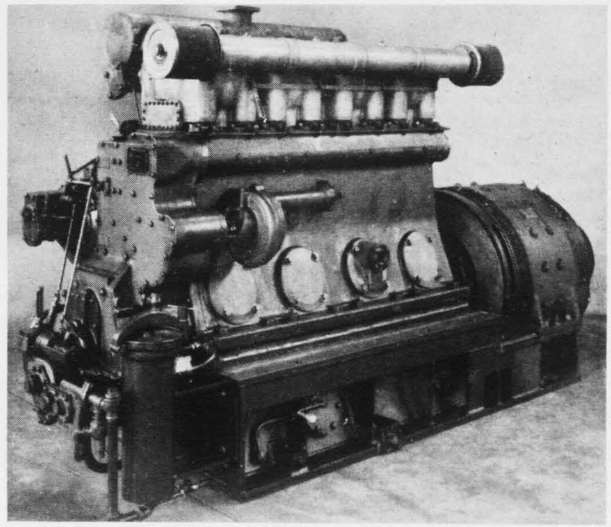
It was the New York Central which sponsored the line-service locomotives. One was a 2-Do-2 passenger unit which operated for some time on the Putnam division. It weighed 162 tons, and of this 45 tons was accounted for by the enormous 12-cylinder V McIntosh & Seymour engine, producing 900 b.h.p. at 310 r.p.m. from 14 in. by 18 in. (355 mm. by 466 mm.) cylinders, and with one exception the largest cylinder ever used in railway traction. General Electric transmission and control equipment was



Left: Westinghouse Electric demonstration Bo-Bo heavy switcher equipped with two 400 b.h.p. Westinghouse - Beardmore engines

Left: The first Alco shunter to be equipped with the then new 600 b.h.p. Alco/McIntosh & Seymour engine with six 12½ in. by 13 in. cylinders, 1931

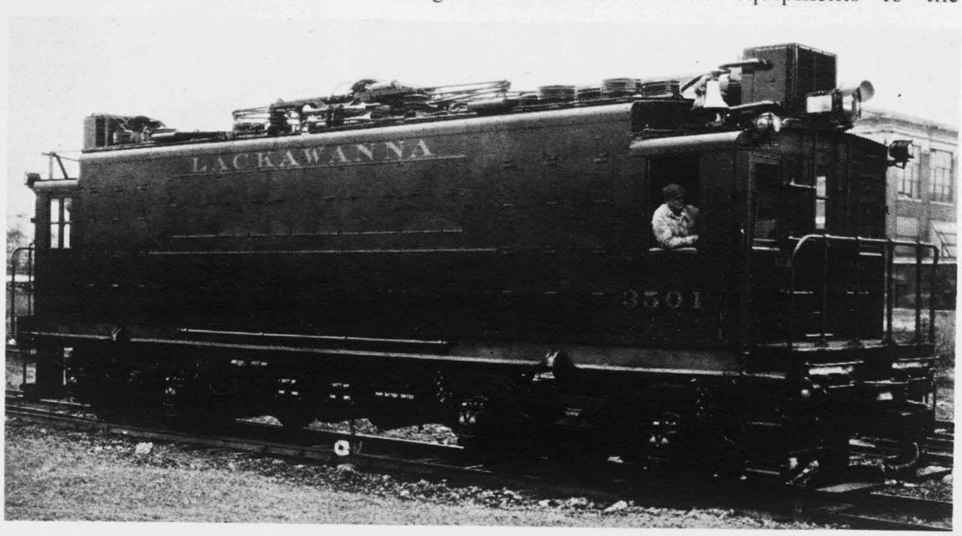
Below: Westinghouse-Beardmore four-cylinder railcar engine of 1930/31



installed, which meant Lemp's control applied to the main generator and its 10 main and 10 commutating poles. Continuous rated tractive effort was 16,000 lb. at 13 m.p.h. (7,280 kg. at 21 km.p.h.). The other unit was also 2-Do-2, but for freight work; it had an Ingersoll-Rand 750 b.h.p. engine and a weight of 130 tons.

There were other spasmodic efforts about this time such as the 1,400 b.h.p. 2-D-2 single engine diesel mechanical locomotive which the Boston & Maine ordered from Krupp in 1928, but which was never delivered to the States; and, in 1930, the large Baldwin Bo-Bo with a six-cylinder mechanically charged 1,000 b.h.p. Krupp engine and Westinghouse transmission. This locomotive was illustrated on page 336 of our September 1957 issue, and, along with the 1,450 b.h.p. engine being built about the same time for the Boston & Maine unit, probably formed the first application of pressure-charging to locomotive oil engines. But the locomotive activity about this time which bore most fruit, though it did not have any long-term effect, was that which arose through the entry of Westinghouse Electric into the field, by the acquisition of the Beardmore engine licence following the encouraging performance of that engine make in railcars and one locomotive in Canada from 1925 onwards. Yet even so the total was only about 20 locomotives in the U.S.A. plus a number of railcars, though Westinghouse supplied additionally a number of engine-transmission-control equipments to the

Above: Two-power diesel-battery locomotive of the New York Central; the N.Y.C. also had 35 three-power units with third-rail shoes for 600-volt d.c. (1931)



Right: Three-power unit of the Delaware, Lackawanna & Western; 3,000 volts d.c. through pantograph, 300 h.p. Ingersoll Rand engine, and large storage battery

Boston & Maine 800 *b.h.p. mail and parcels diesel-electric railcar hauling four-car suburban train; the B. & M. had two of these, one powered by a single Ingersoll-Rand engine and the other by two Westinghouse-Beardmore engines* (1933)

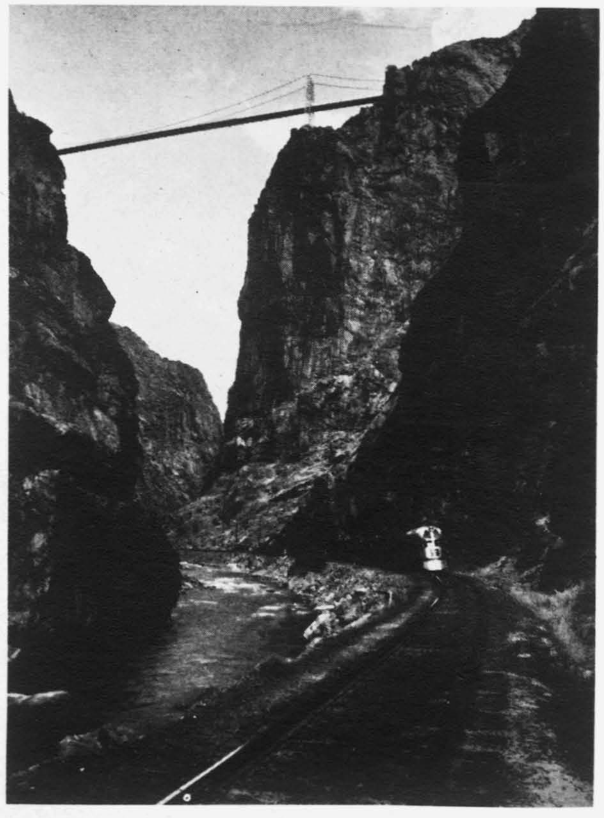
Canadian National for railcars. The locomotive applications were mainly of the 300 and 400 b.h.p sizes, though in at least one case (illustrated here) two 400 b.h.p. engines were put into a 94-ton Bo-Bo. Probably these 800 b.h.p. units were the first diesel-electric locomotives in which the weight transfer was compensated by an arrangement for weakening the fields of the forward traction motors and passing increased current through the rear motors, a feature which Westinghouse applied also to straight electric locomotives about this time. There were also two two-axle 300 b.h.p. switchers for the Long Island Railroad.

Three-Power Units

At this time began a variation which at one time looked as if it might become widespread. This was the three-power oil-electric-battery locomotive. It was developed out of the standard G.E.-I.R.-Alco 300 b.h.p. shunter and retained the engine-generator set, but was also equipped with current pick-up so that it could operate on electrified sections without running the engine, and had a very large storage battery so that it could run into warehouses where no electric conductor rails or overhead wires could be taken, and wherein no diesel exhaust would be permitted. One was supplied in 1928 to the N.Y.C., and in 1931–32 that company acquired another 39 (of which 36 were for Manhattan Island) and also, for operating at Chicago, two more locomotives the same except that no current pick-up was fitted, and so these two were two-power (diesel-battery) locomotives. The oil engine was of 300 b.h.p., and the battery of 650 amp. hr.; either could be used alone, but they could also be used together to furnish up to 800 h.p. for short periods. Full electric capacity was up to 1,600 h.p. Some of these units are still operating today. The Delaware, Lackawanna & Western followed suit in 1931 with two similar locomotives, but here pantographs were fitted to collect 3,000 volt d.c. from the overhead wire, whereas the N.Y.C. locomotives had shoes for picking up 600-volt d.c. from conductor rails.

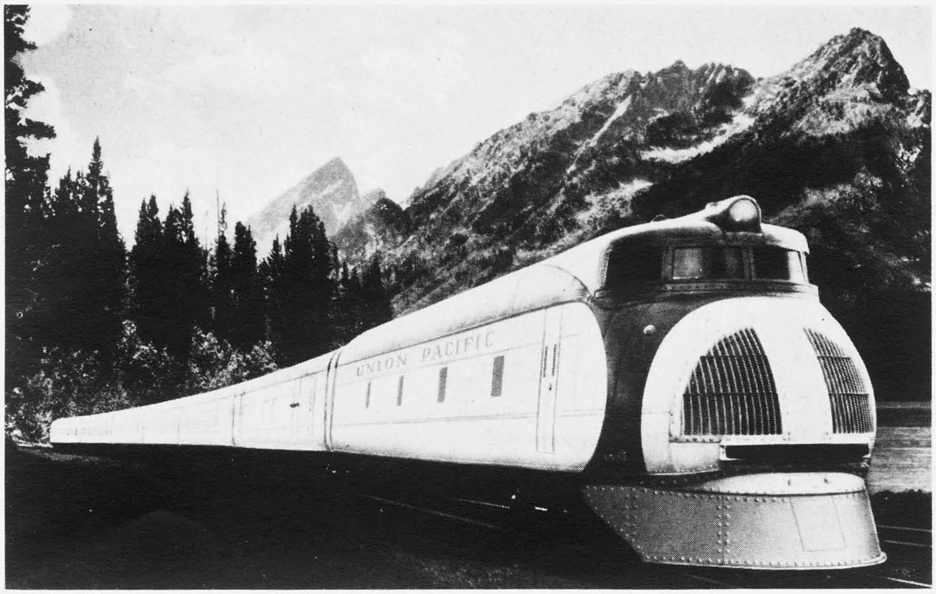
A Vital Development

The 1930–31 trade recession, and the availability of a lighter engine, the Westinghouse-Beardmore, turned thoughts towards diesel railcars and a few were built up to 800 b.h.p., some of 600 and 800 b.h.p. with the heavy slow-running Ingersoll-Rand engine. But the real background in this development was something quite different, and was one which really led in a single unbroken line to diesel traction as it is known in the U.S.A. today. To consider this, one must go back to the time in 1923–24 when G.E.-I.R.-Alco were planning and running their first demonstrator locomotive. In 1922 H. L. Hamilton and Paul Turner founded the Electro-Motive Engineering Corporation to develop and sell petrol-electric railcars, and in the



The original three-car 660 *b.h.p. stainless-steel Burlington Zephyr* (1934) *on a special trip through the Royal Gorge*

Right: Union Pacific's original City of Portland train, with 900 b.h.p. diesel-engine, which followed (1934) the U.P.'s Three-car distillate (carburettor)-engined City of Salina train of 1933



following year were introduced to Lemp's variable-voltage generator and control, and it was applied to the company's first railcar along with a 175 b.h.p. Winton petrol engine.

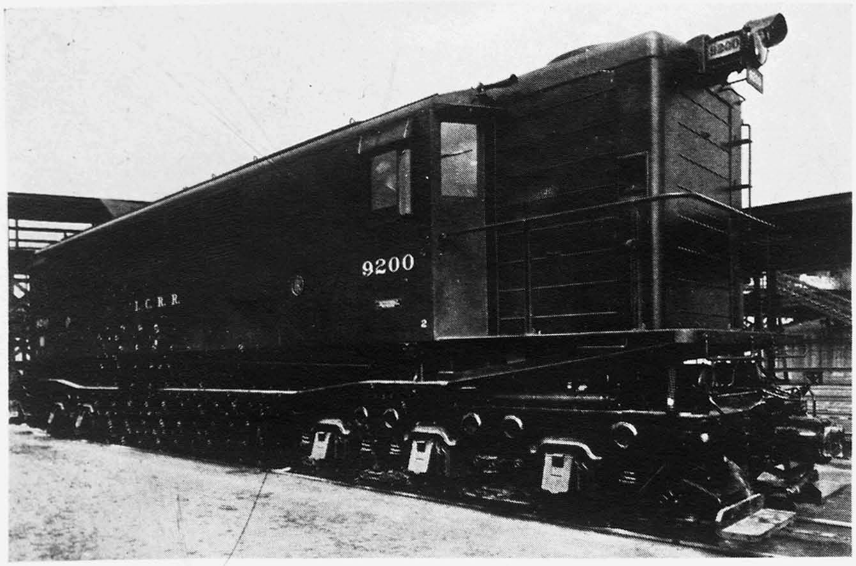
By 1930 many cars up to 400 b.h.p. had been sold, but a turning point was coming in that the power demand was seen to be rising above what the Winton Engine Co. in its then state could provide, and that diesel engines would have to be used because of the high aggregate fuel costs of powerful petrol engines. But in 1930 General Motors Corporation bought the Winton company in order to acquire facilities for manufacturing a diesel engine then in the early stages of development by C. F. Kettering; and, after purchase, G.M. finding that Electro-Motive was Winton's principal customer, bought that organisation, too; thus they came almost at the same time into the oil-engine business and the railway business. By the time the Winton-G.M. diesel engine was developed to the point of a couple of prototypes running, the stage was set for the next great railway development, and the solution was then practically ready, though few people at the time could visualise that.

The Burlington Zephyr running through a small snowdrift at 80 *m.p.h.*

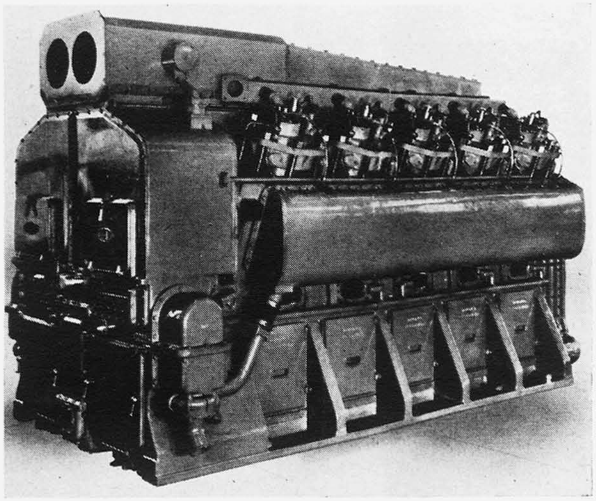
Between 1920 and 1933 passenger-miles in the U.S.A. had fallen by 65 per cent. and passenger revenue had decreased by a thousand million dollars, and the years 1930–33 had shown acceleration of the drop. This had led to larger, and sometimes quite new, types of railcar, such as the Texas & Pacific stainless-steel twin-car set with steel-tyred driving wheels, and rubber-tyred carrying wheels, and to the Pennsylvania's light twin-car stainless-steel Michelin set with each vehicle on 12 rubber-tyred wheels. But this was not enough and by the first months of 1933 some railroads were deciding that strong efforts with something new in equipment or methods must be made to get a substantial part of the lost traffic back again. Coincidently came the news of the *Flying Hamburger* in Europe and the exhibition of Winton's first 660 b.h.p. two-stroke diesel engine at Chicago. Under the aegis of Averell Harriman the Union Pacific was contemplating a fast lightweight fixed-formation train; but they would not take what they considered the risk of the first Winton 660 b.h.p. diesel, and selected a 12-cylinder 600 b.h.p. distillate-burning (carburettor) engine. Thus was the three-car *City of Salina* born, the first streamliner in the States.

Streamliners

Coincidently the Burlington Lines were thinking along similar lines; but Ralph Budd, the president, felt any unit must have public appeal as well as economy and operating efficiency, and after he had decided on the step of having a three-car train of the then new stainless-steel type, he saw the first Winton diesels and ordered one for his first train, the Burlington Zephyr, later known as the *Pioneer Zephyr*. The *City of Salina* was ordered at the end of May 1933 and the *Zephyr* in the middle of June. Both entered service early in 1934, but long before that Harriman had ordered the 900 b.h.p. six-car *City of Portland*, to have a 12-cylinder V 900 b.h.p. Winton diesel, and the way was now set for the spate of diesel streamliners which continued in construction until about 1938, and which was encouraged by the non-stop run of the



Left: One of three Illinois Central diesel-electric Co-Co locomotives of 1,800 to 2,000 b.h.p. built in 1935. This one has two Ingersoll-Rand engines



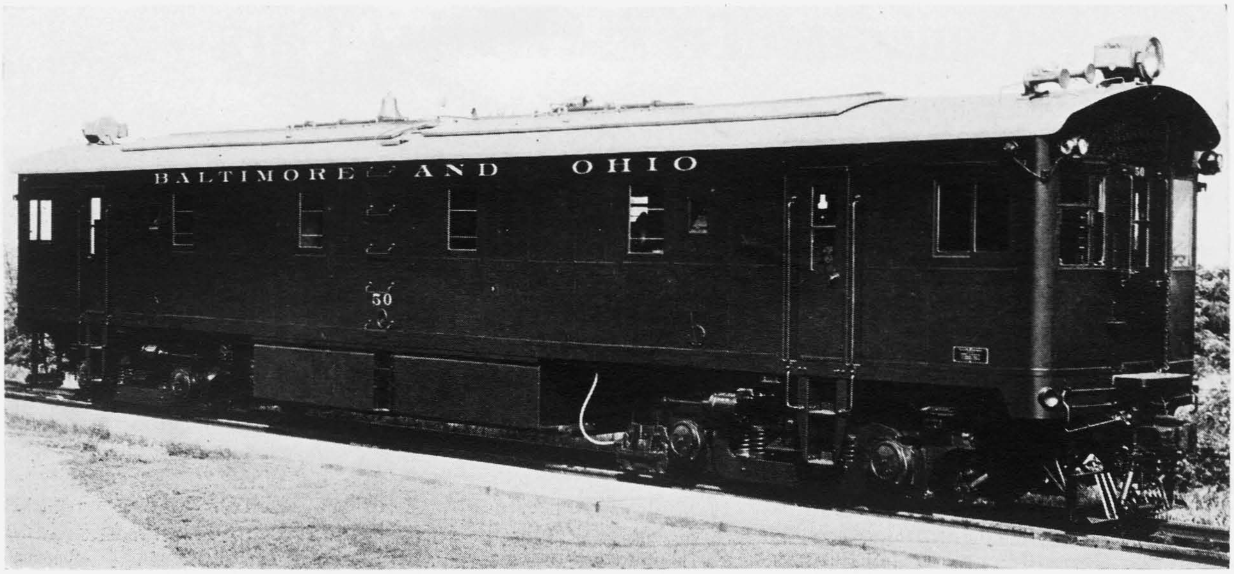
Below: Busch - Sulzer two - stroke 10-cylinder engine of 2,000 b.h.p. as installed in one of the three Illinois Central locomotives mentioned above

Zephyr on May 26, 1934 over the 1,015 miles (1,626 km.) from Denver to Chicago in 13hr. 5min., *i.e.* an average of 77·6 m.p.h. (124 km.p.h.). By the end of 1935 the *City of Portland* had been rebuilt as a seven-car train, the Burlington had three more *Zephyr* trains in service, the Boston & Maine had the *Flying Yankee* and the first of the Gulf, Mobile & Northern's *Rebel* trains was in traffic. All except the last-named had Electro-Motive power equipment. Several further much larger and more powerful fixed-formation trains were also on order. One might almost say the railroads had rushed the builders off their feet.

But by 1934 a new stream was in its initial stages both within the G.M.-Electro-Motive organisation and among other builders. In the first case the promise shown by the Winton-G.M. eight-cylinder vertical 660 b.h.p. and 12-cylinder V 900/1,000 b.h.p. model 201 engine naturally led towards consideration of heavy switching and line-service locomotives in which it could be installed, and with General Motors financial resources behind, Electro-Motive could afford to think in terms much different to what it could in 1929, so much so that from that time to this development has been continuous. Simultaneously, the progress made in slow-speed diesel engine design in the American industry generally had brought forward for trial one or two new types. While this second activity resulted in the construction of a few machines, it had no continuous effect, the later Alco and Baldwin large locomotives having other origins.

Admittedly shunting power and capacity had tended to rise since 1930, though not on a large scale. There were the Alco 600/660 b.h.p. machines with Alco/McIntosh & Seymour engines and one or two Westinghouse and Ingersoll-Rand 800 b.h.p. machines and even two Electro-Motive 600 b.h.p. switchers in 1934. But the new types gave the possibility of something altogether bigger. All this time, Electro-Motive, despite its acquisition by General Motors, had no manufacturing facilities of its own. The engines continued to be built by the Winton Engine Division of G.M., the electrical equipment usually by G.E., and the mechanical portions by St. Louis Car Co. or Pullman Car. Thus it came about that of the first five main-line prototype locomotives engineered by Electro-Motive three were built under contract at the Erie works of G.E., where the electrical equipment was made, and two at the works of the St. Louis Car Co. These square-ended 1,800 b.h.p. Bo-Bo machines each had two Winton 900 b.h.p. 12-cylinder oil engines, and each weighed about 108 tons. One was a demonstrator; two were for the Santa Fe, and on that road they operated in multiple-unit as a 3,600 b.h.p. 216-ton machine hauling *The Chief*, and then the *Super-Chief*, trains between Chicago and California; the last two were for the Baltimore & Ohio. It was one of the B. & O. machines which was withdrawn in 1959 and is now preserved in a museum. All these locomotives were powered by the Winton-G.M. model 201A engine, which was installed also in the streamliners, and something about its performance in the Burlington Zephyr trains was given in our issue of May 13, 1938.

The other large new units of 1935–36 were confined to the Illinois Central, which had ordered three very large Co-Co locomotives, all different, specifically for the heavy freight-transfer service around Chicago. One had the largest railway oil engine then to be seen—a 10-cylinder V loop-scavenged Busch-Sulzer two-stroke. An eight-cylinder V prototype of 1,600 b.h.p. had been completed in 1933, and then the 2,000 b.h.p. unit was built for the I.C.R.R.; but it remained the only one of its type. The second of the three units had two Ingersoll-Rand 900 b.h.p. engines with six



One of the first five Electro-Motive 1,800 *b.h.p. main-line locomotives, all built in* 1935, *which was retired to St. Louis museum in* 1959 *after being in service on the B. & O.*

14·75 in. by 16 in. (374 mm. by 406 mm.) cylinders and weighed 152 tons. The third unit had two Winton 12-cylinder 900 b.h.p. two-stroke engines of model 201. General Electric was responsible for the electrical equipment in all three. It is interesting to recollect that the purchase prices of these one-off prototype machines, none of which was repeated, varied from £36,000 to £40,000, i.e. less than current price, mass production being offset by higher wages and costs.

But of all events of 1935, the closing year for this first part of the account of U.S. diesel traction development, when there were about 200 diesel locomotives, 10 streamlined trains, and quite a number of diesel railcars in operation (including one with the first Fairbanks-Morse two-stroke opposed-piston engine), the most important was the beginning of erection of the Electro-Motive works at La Grange, outside Chicago. An investment of $6,000,000 was made by G.M. in the original plant and its working expenses for the first year; but the policy which led to its sanction, and the production of the works itself, led to entirely new conceptions not only in diesel locomotive design and building but in the responsibilities of railways and railway mechanical officers which are felt strongly still today; and it is perhaps the most fitting point to divide into two the whole history of North American diesel traction between the original visit to Europe in 1911 of Lemp and Chatain and the supply of 4,000 b.h.p. single-unit diesel-hydraulic locomotives from Europe to the U.S.A. in 1961.

660 *b.h.p. three-car diesel-electric stainless steel train of* 1935—*the Flying Yankee of the Boston & Maine and Maine Central Railroads, with Winton two-stroke engine, the fore-runner of today's General Motors* 567-*series engines*

Diesel Traction Development in U.S.A.

II—The years from 1935/36 to date

THE account of the progress made until the years 1935/36, as given in the first instalment in the March issue, ended with the decision to found the General Motors/Electro-Motive plant at La Grange, at a time when a handful of 1,800/2,000 b.h.p. diesel locomotives were running, when the three-car and four-car streamliners were firmly established and orders had been placed for several much more powerful trains of eight to ten cars (including the 3,000 b.h.p. *Denver Zephyrs* and *City of Los Angeles* and *City of San Francisco* trains), and when the two principal steam locomotive builders were about to come into the diesel business much more strongly.

One may as well deal first with La Grange, for it, and the ideas which gave rise to it and which arose out of it, form probably the most important single factor in U.S.A. diesel traction since the original G.E.-Ingersoll Rand-Alco 300 b.h.p. locomotives. The first spadeful of earth was turned at La Grange on March 27, 1935; the first locomotive rolled out of the plant on May 20, 1936. Although Electro-Motive then had five 1,800 h.p. main-liners running, it was decided to initiate production at La Grange with an 89-ton switcher of 600 h.p. (traction); and on the assumption that it could put through 50 locomotives of the one design, E.M.D. was prepared to reduce the price to about $70,000 from the then current one-off price of about $84,000. Actually 24 of this locomotive model were delivered by the end of 1936; but by that time a 900 b.h.p. switcher, powered by a 12-V engine instead of a straight-eight, was on the stocks; and, much more important, the decision had been taken that eventually engine production and transmission production must come to La Grange.

Hitherto the engines, of model 201A, had been coming from the Winton Engine Division of G.M., and the transmission from the General Electric works at Erie. By the end of 1936 the Ketterings were in the initial stages of the design of the 567 engine, experience with the 201A having shown that though its performance was good enough to sell large diesel locomotives and train sets it had not enough potentialities for development in the power and production scales then coming to be visualised. By the end of 1936, also, a grant of $100,000 had been made to develop a traction motor and main generator of E.M.D.'s own design; and before the end of 1937 construction was proceeding on new shops for the manufacture of these components and the locomotive erecting-shop space had been doubled. The first prototype 567 engine to come out of the shops appeared in January 1938; it had 12 cylinders, but in the summer of the same year the first 16-567A engine was built. Almost simultaneously the first of the new E.M.D. electric transmission equipment was coming out of the shop. Yet there was little time to give long tests on the road to engines, generators or locomotives, for to an even greater scale than in 1934, railroad demands were on top of the manufacturers' capacities.

However, the two big steam locomotive manufacturers now began to see they could not let G.M. have all this growing diesel business. Alco, since its acquisition of the McIntosh & Seymour oil engine works, had gone along steadily on a small scale building 300 b.h.p. and 600 b.h.p. switchers; but by 1937 through their association with A. J. Büchi, they were able to raise the output of their standard engines to 900 and then to 1,000 b.h.p., so that they were then in a position to compete with Electro-Motive for switchers and road-switchers up to four-figure power, though the term "road-switcher" was not used at that time. The engines it was using were a 12·5 in. by 13 in. 700 r.p.m. (later 740 r.p.m.) model and a 9·5 in. by 10·5 in. 700 r.p.m. (875 r.p.m. for railcars)

Illinois Central 'Green Diamond' train of 1936, *built by Pullman Standard at a cost of* £86,000; *the power car had a* 12-*cylinder Winton* 201*A engine of* 1,200 *h.p.; train weight* 212 *tons;* 588-*mile daily run* model, in each case with six cylinders. It was the first model to which Büchi pressure-charging was first applied commercially, but the second, smaller cylinder, size was also subjected to pressure-charging development, and may rightly be considered as the fore-runner of Alco's current series 251 engines. Contrary to what one would be inclined to think, it was the larger cylinder engine which was put into the Gulf, Mobile & Northern's air-conditioned *Rebel* trains in 1935; but its specific weight of 36 lb. per b.h.p. was 7 per cent less than that of the smaller-cylinder model; and the latter also went up only to 400 b.h.p. as against 660 b.h.p. in the 12·5 in. by 13 in. engine.

Baldwin, after its desultory experiments with the Knudsen-and Krupp-engined locomotives of 1924 and 1929, had done practically nothing in diesel traction, but, like Alco, it had acquired control of a diesel-engine building company, De La Vergne, and so by the middle 1930's was in a position to build two-thirds of a whole diesel locomotive instead of one-third. It thereupon set about developing a heavy switcher of 600/660 b.h.p. using the 625-r.p.m. De La Vergne engine. By 1937, when Baldwin shunters were appearing, Electro-Motive was using its own engine, transmission and mechanical portion, Alco was using G.E. electrical equipment, and Baldwin had taken up Westinghouse electrical equipment, this last-named company having already decided to give up the Westinghouse-Beardmore traction activities.

One other coming event cast its shadow before at this time. The first Fairbanks-Morse opposed-piston two-stroke engine to be applied to traction was installed in 1935 in a railcar belonging to the Chicago Milwaukee St. Paul & Pacific Railroad. It was applied transversely, too, along with main and auxiliary generators all in one shaft line. Cylinders were 5 in. (127 mm.) bore, and individual piston stroke was 6 in. (152 mm.), and output was 300 b.h.p. at 1,200 r.p.m.; upper and lower crankshafts were connected by chain drive. In the next two or three years a few larger engines were applied to railcars on the Southern Railroad, and these were the first model 38 engines and the first to have the 8·125-in. bore by 10·0 in. stroke cylinders. However, not until after the war did Fairbanks-Morse come into the big-engine field and also into the locomotive-building industry.

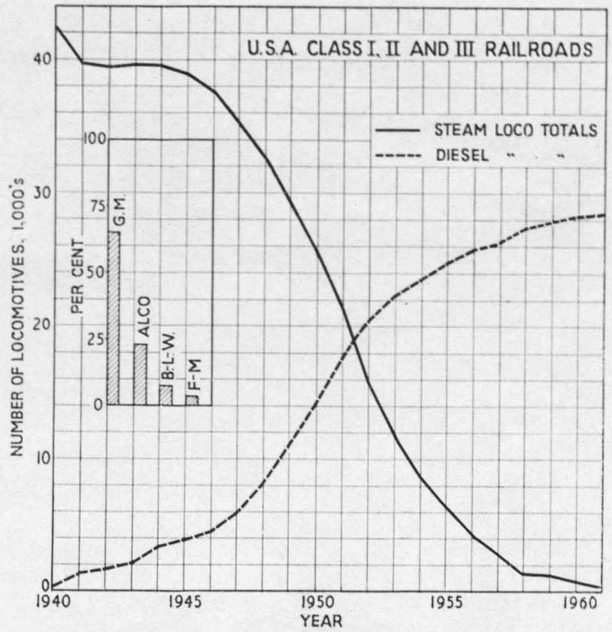
Despite these locomotive activities of Electro-Motive, Alco and Baldwin in the years 1935-38, the great feature of U.S.A. diesel practice in that period was none of these things; it was the great increase in the number of fixed-formation streamliners going up to 10 and 12 cars and 3,000 b.h.p., and tending to revolutionise long-distance travel by startling acceleration and greatly superior amenities. By the end of 1938, however, coming events were once again casting their shadows before, with the streamlined trains retained but quite separate locomotive units at the head. The Santa Fe really had kept to this all the time, from its initial 1,800 h.p. E.M.D. prototypes in 1935, and the Rock Island had used them for its *Rockets* since 1937; but the Burlington, after the *General Pershing Zephyr* of 1938, also began to acquire separate high-power locomotive units, and though the first of such 2,000 b.h.p. units, completed in 1940, were built throughout by Electro-Motive they had, in response to Burlington requests, stainless-steel outer panelling to match the coaches of the various Zephyr trains.

Looking back on that time and the design and

Above: Rock Island 'Rocket' train, one of the first to have a separate locomotive, in this case of Electro-Motive build and of 1,200 *h.p.*

City of Los Angeles train, at first with nine cars and then with 12 *(inclusive of two power cars) introduced in* 1936 *jointly by the Chicago & North Western and Union Pacific; each train made a round trip of* 4,600 *miles every six days between Chicago and Los Angeles* productive facilities then available, it is amazing to see how the possibilities of high-power fast-speed diesels had caught on, both with fixed-formation trains like the first *Zephyrs* and the *City* trains and also with locomotive-hauled trains like the *Super-Chief* of the Santa Fe, and the *Orange Blossom Special* of the Seaboard Air line with its triple-unit six-engine 6,000 h.p. locomotive at the head of the 800-ton train. A picture of those days is given in Table I, which shows the trains of these types at work at the end of December 1938. At an earlier date, in May 1936, an Interstate Commerce Commission report listed 14 lightweight passenger trains of modern type, of which 12 were of diesel propulsion and two (the two *Hiawatha* trains on the C.M.St. P. & P.) were steam. The capital investment cost of a *Hiawatha* including locomotive and seven-car 238-seat train was given as $279,847; that of the eight-car 258-seat *Abraham Lincoln* on the Alton, with 1,800 h.p. diesel locomotive, was $418,757; and that of the triple-car 112-seat stainless-steel original *Zephyr* was $251,654.

All this development was stopped, and the fixed-formation train part of it never resuscitated, when the U.S.A. entered the war. The three diesel locomotive builders were given specific models they had to build, and they could no longer develop anything fresh. However by that time E.M.D. had got one or two steps forward, for by 1940 they had a standard 2,000 h.p. unit of Co-Co and A1A-A1A formation equipped with two of the 12-567.A engines, as well as the standard switchers; and, even more potent for the future, had completed towards the end of 1939 the first four-unit heavy freight locomotive of 4(Bo-Bo) axle arrangement, having dynamic brakes and with one 1,350 h.p. 16-567 engine in each unit. The earlier 2,000 h.p. passenger units had a driving cab at one end only; the four-unit freights had a driving cab at each end, being composed of two outer A units and two inner (cab-less) B units, each unit weighing about 98 tons.



Graph showing the growth of diesel units and the decline of steam locomotives over 20 years

Over 11 months in 1940 this 16-motor locomotive ran 83,000 miles in demonstration revenue trips on 20 railroads. This proved to be a happy move for E.M.D., for when full government control was instituted in 1943 Electro-Motive was directed to line-freight locomotive building only, the switcher-production for home service and for the armed forces abroad being allocated to Alco and Baldwin, each making 1,000 b.h.p. A1A-A1A and Co-Co units of 98/108 tons, with smaller switchers made by G.E., Whitcomb and others. Locomotive production of any kind actually ceased at La Grange for a few

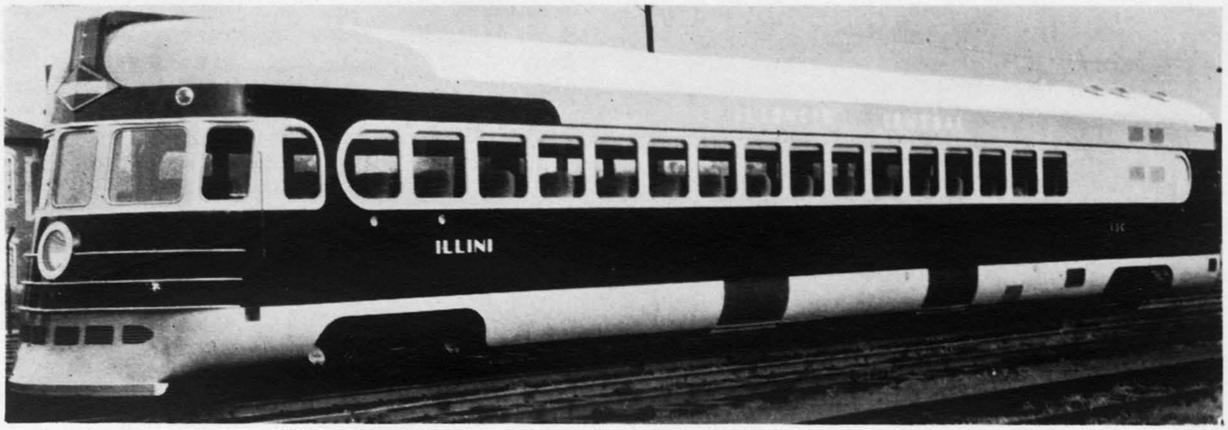
Inaugural run of the Seaboard Air Line " Orange Blossom " at the end of 1938; *a* 6,000 *h.p. triple-unit Electro-Motive locomotive at the head of* 15 *passenger cars*

Railroad	No. of trains	Name of train	Route	Trailing load, Short tons Light	Loaded*	Total no. of cars	Car builder	No. of locos.	Wheel arrangement	H.P. per loco.	Loco. builder	Loco. wt., short tons	Elec. equpt.	Eng.	No. and b.h.p. of engines	Date in service
Alton	1	Abraham Lincoln	Chicago–St. Louis	390	414	8	A.C.F.	1	Bo-Bo	1,800	GE	126	GE	EMCO	2–900	July, 1935
A.T. & S.F.	1	Super Chief	Chicago–Los Angeles	425	452	9	Budd	1	2(A1A-A1A)	3,600	EMCO	284	GE	EMCO	4–900	June, 1937
	1	,, ,,	,, ,, ,,	518	545	9	P.S.	1	2(A1A-A1A)	3,600	EMCO	284	GE	EMCO	4–900	Feb., 1938
	2	El Capitan	Chicago–San Francisco	252	267	5	Budd	2	A1A-A1A	1,800	EMCO	147	GE	EMCO	2–900	Feb., 1938
	1	San Diegan	Los Angeles–San Diego	252	267	5	Budd	1	A1A-A1A	1,800	EMCO	147	GE	EMCO	2–900	Mar., 1938
	1	Kansas Cityan	Chicago–Kansas City	353	374	7	Budd	1	A1A-A1A	1,800	EMCO	147	GE	EMCO	2–900	Apr., 1938
	1	Chicagoan	Kansas City–Chicago	353	374	7	Budd	1	A1A-A1A	1,800	EMCO	147	GE	EMCO	2–900	Apr., 1938
Baltimore & Ohio	2	Royal Blue Columbian	Washington–New York	390	414	8	P.S.	2	2(A1A-A1A)	3,600	EMCO	285	W. CO.	EMCO	4–900	June, 1937
	4	Capitol Ltd. National Ltd.	Washington–Chicago	720	750	9	P.S.	4	2(A1A-A1A)	3,600	EMCO	285	W. CO.	EMCO	4–900	Feb., Mar., 1938
Boston & Maine	1	Flying Yankee	Boston–Bangor	108	118	3	Budd	—	—	—	—	—	GE	EMCO	1–600	Feb., 1935
C.B. & Q.	1	Pioneer–Zephyr	Kansas City–Lincoln	144	156	4	Budd	—	—	—	—	—	GE	EMCO	1–600	Mar., 1934
	1	Sam Houston	Houston–Fort Worth	113	121	3	Budd	—	—	—	—	—	GE	EMCO	1–600	Apr., 1935
	1	Mark Twain	St. Louis–Burlington	144	156	4	Budd	—	—	—	—	—	GE	EMCO	1–600	Oct., 1935
	1	Ozark State Ld.	St. Louis–Kansas City	113	121		Budd	—	—	—	—	—	GE	EMCO	1–600	Apr., 1935
	2	Denver Zephyrs	Chicago–Denver	60	441	16	Budd	2	2(Bo-Bo)	3,000	EMCO	213	GE	EMCO	2–900 1–1,200	Oct., 1936
	2	Twin Zephyrs	Chicago–St. Paul	254	275	7	Budd	2	Bo-Bo	1,800	EMCO	121	GE	EMCO	2–900	Dec., 1936
	1	Ozark-State Zephyr	Kansas City–St. Louis	99	111	4	Budd	—	—	—	—	—	EMCO	EMCO	2–1,000	Jan., 1939
C.R.I. & Pacific	1	Texas Rocket	Houston–Fort Worth	131	140	3	Budd	1	Bo-Bo	1,200	EMCO	114	GE	EMCO	1–1,200	Sept., 1937
	2	,, ,,	Kansas City–Minneapolis	131	140	3	Budd	1	Bo-Bo	1,200	EMCO	114	GE	EMCO	1–1,200	Sept., 1937
	1	,, ,,	Kansas City–Denver	131	140	3	Budd	1	Bo-Bo	1,200	EMCO	114	GE	EMCO	1–1,200	Sept., 1937
	1	Peoria Rocket	Chicago–Peoria	165	177	4	Budd	1	Bo-Bo	1,200	EMCO	114	GE	EMCO	1–1,200	Aug., 1937
	1	Des Moines Rocket	Chicago–Des Moines	165	177	4	Budd	1	Bo-Bo	1,200	EMCO	114	GE	EMCO	1–1,200	Aug., 1937
G.M. & N.	2	Rebel	Jackson–New Orleans	229	241	4	A.C.F.	—	—	—	—	—	W. CO.	ALCO	1–660	July, 1935 July, 1937
Illinois Central	1	Green Diamond	Chicago–St. Louis	238	253	5	P.S.	—	—	—	—	—	GE	EMCO	1–120	May, 1936
N.Y., N.H. & H.	1	Comet	Boston–Providence	127	136	3	G.Z.	—	—	—	—	—	W. CO.	W. CO.	2–400	June, 1935
Seaboard Air Line	2	No. 21–22	Rutherfordton–Hamlet	78	93	1	St. L. C.	—	—	—	—	—	GE	EMCO	1–600	Feb., 1936
	1	—	New York–Florida	405	426	7	Budd	1	A1A	2,000	EMCO	147	EMCO	EMCO	2–1,000	Feb., 1939
	3	Orange Blossom	New York–Florida	760	799	13	P.S.	3	3(A1A-A1A)	6,000	EMCO	450	EMCO	EMCO	6–1,000	Dec., 1938
Southern	6	—	Chattanooga–Birmingham	90	102·5§	6	St. L. C.	—	—	—	—	—	W. CO.	Fbks.-Morse	1–750	Oct., 1938
Union Pacific	1	City of Salina	Kansas City–Salina	116	125	3	P.S.	—	—	—	—	—	GE-W CO.	Winton	1–600	Feb., 1934
	1	City of Portland	Chicago–Portland	308	329	7	P.S.	—	—	—	—	—	GE	EMCO	1–1,200	Oct., 1934
	1	City of Los Angeles	Chicago–Los Angeles	318	345	9†	P.S.	1	2(Bo-Bo)	2,100	EMCO	185	GE	EMCO	1–900+ 1–1,200	Apr., 1936
	1	City of San Francisco	Chicago–San Francisco	318	345	9	P.S.	1	2(Bo-Bo)	2,400	EMCO	215	GE	EMCO	2–1,200	May, 1936
	1	City of Los Angeles	Chicago–Los Angeles	818	857	14	P.S.	1	3(A1A-A1A)	5,400	EMCO	438	GE	EMCO	6–900	Dec., 1937
	1	City of San Francisco	Chicago–San Francisco	818	857	14	P.S.	1	3(A1A-A1A)	5,400	EMCO	438	W. CO.	EMCO	6–900	Dec., 1937
	2	City of Denver	Chicago–Denver	452	482	10	P.S.	2	2(Bo-Bo)	2,400	EMCO	215	GE	EMCO	2–1,200	June, 1936

* Estimated 3 tons per car loading
† Chair car and room sleeper added August, 1938
§ Weight of power car only. Each power car carries mail and baggage and hauls 1 trailing coach

EMCO Engines, 600, 900 and 1,200 h.p.—8, 12 and 16—8 × 10 cylinders—2 cycle—750 r.p.m.
EMCO Engines, 1,000 h.p.—12—8½ × 10 cylinders—2 cycle—800 r.p.m.
ALCO Engines, 660 h.p.—6—12½ × 13 cylinders—4 cycle—750 r.p.m.
W. Co. Engines, 400 h.p.—6—9 × 12 cylinders—4 cycle—900 r.p.m.
Winton Distillate, 600 h.p.—12—7½ × 8½ cylinders, 4 cycle, 1,200 r.p.m.
Fairbanks-Morse, 750 b.h.p.—5—8 × 10 × 10 cylinders—2 cycle (opposed pistons)—720 r.p.m.

P.S. .. Pullman-Standard
St.L.C. .. St. Louis Car
GZ .. Goodyear-Zeppelin
S.F. .. San Francisco



Illinois Central air-conditioned 38½ ton single-unit railcar with two Waukesha-Hesselman spark-ignition oil engines of 225 b.h.p. each below the floor driving Twin-Disc torque converters, 1941

months in the winter of 1942/43, but then increased enormously over 1941 level and was supplemented by numerous 567.A engines for non-railroad purposes.

By the end of 1943 La Grange was producing 48 units a month of the 1,350 h.p. unit, but in 1944 expansion was initiated to bring the production up to 100 units a month, and in 1947 a peak rate of five locomotive-units a working day was achieved for a time, as against the average of 0·9 a working day for the whole of 1941. Similarly, Alco and Baldwin diesel locomotive productive capacity for diesels was stepped up; and so at the end of the war all three found themselves in possession of facilities which by 1939 standards were astronomic, so much so that, allied with the obvious coming trend towards diesels throughout world railways, Alco took the step in 1948 of closing down all steam locomotive production and concentrating solely on diesels in its locomotive department.

Some technical development work was permitted during the last part of the war. For example, the Alco test engine of the new type was constructed in 1940-43, and by the beginning of 1946 was being developed into a 12-cylinder production model of 1,580 b.h.p. Similarly, some development work could be done, as it was really needed, by General Motors on the 567.A engine, so that in 1946 the first production models of the 567.B engine were coming off the line, though the B design was still further developed over the two or three ensuing years. Also development of a new locomotive design, the F-3, suited with few changes to passenger or freight work, was permitted in 1945, so that units were announced in that year and put on the market in 1946.

While General Motors, Alco and Baldwin had built large numbers of oil engines during the war for railway and non-railway uses, other oil engine builders also had had to step-up their production by astronomic ratios, among them Fairbanks-Morse and Cooper-Bessemer. These firms, also, had to cast around for new peace-time markets. Cooper-Bessemer could look forward to railway sales for certain sizes of General Electric locomotives for export, and though at that time its main size was the FV-type 660 b.h.p., a 16-cylinder 1,600 b.h.p. prototype was running. On the other hand, Fairbanks-Morse decided to build complete locomotives, and began to do this in 1946, and up to 1,200 b.h.p. built the oil engine, electric transmission and mechanical portion; above 1,200 b.h.p. the electrical equipment came from General Electric.

High though the diesel locomotive production rate

A war-time steeple-cab 450 b.h.p. 58-ton Bo-Bo switcher built by Mid-West Locomotive Works, and purchased as war surplus by the Stockton Terminal & Eastern, California had been during the war, it rose still further afterwards, for the traffic capacity of the diesels had been proved, and the average age of the steam locomotives in service was increasing and many steam units were overdue for replacement. According to H. F. Brown more than 40 per cent of all locomotives in the States in 1945 were over 30 years old. The way was thus open for all four of the principal builders to have substantial home markets, and also for a fifth, G.E., to increase its industrial shunter market, for while this originator of diesel traction in the U.S.A. supplied electrical equipment to two of the main and some of the subsidiary diesel locomotive builders, it had never entered into the Class I railroad locomotive business, though it was the principal supplier of Class II railroad and works shunters up to 660 b.h.p. and about 80 tons in weight.

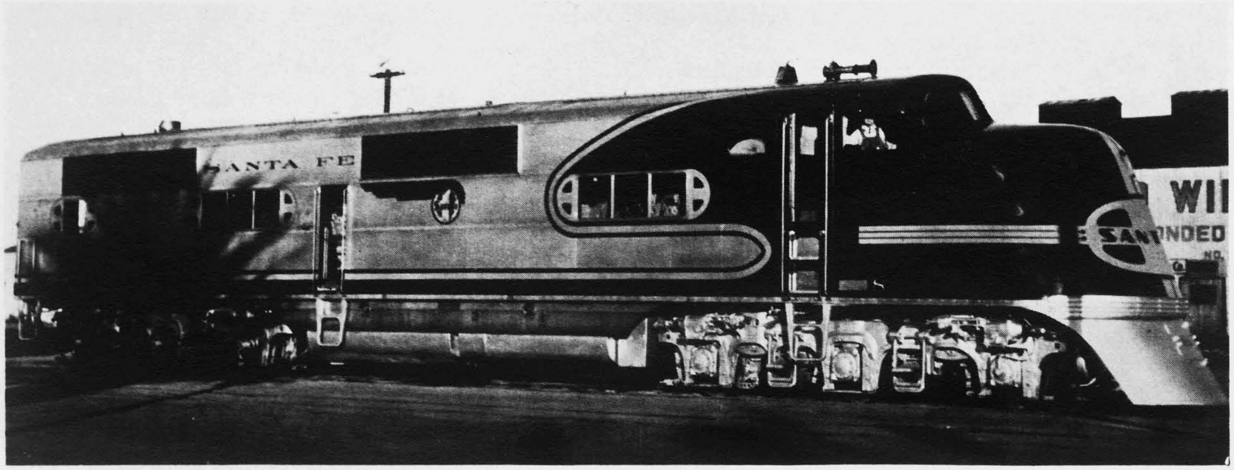
New models were not long in coming off the bat. From La Grange, the F-7 and then the E-8 were out by 1948, using the 16-567.B engine set to 1,600/1,665 b.h.p. and 1,500 h.p. traction input to main generator. Compared with the A1A-A1A and Co-Co main-line locomotives built up to 1940, the F-3 and F-7 were of Bo-Bo type and both weighed 230,000 lb. The F-3 was the first to have an a.c. auxiliary generator in-built with the main d.c. generator. The F-7 was very similar, but with newer electrical equipment, including the D.27 traction motor, it gave improved continuous rated tractive efforts, and this was applied also to the E-8. Also the F-7 was developed into the FP-7A (freight and passenger).

The Alco line-service locomotives were of bull-nosed single-cab form like the General Motors units, and also of road-switcher contour. They were built round the then new Alco series 244 engine, which for that time had phenomenal ratings. Using a 9 in. by $10\frac{1}{2}$ in. cylinder, the 12-cylinder V model was rated at 1,580 b.h.p. at 1,000 r.p.m. in 1946, equal to 157 lb. per sq. in. (11 kg. per sq. cm.) b.m.p. and 1,750 ft. per min. (8·9 m. per sec.) piston speed. By 1954 the rating had been raised to 1,760 b.h.p., or 174 lb. per sq. in. (12·2 kg. per sq. cm.).

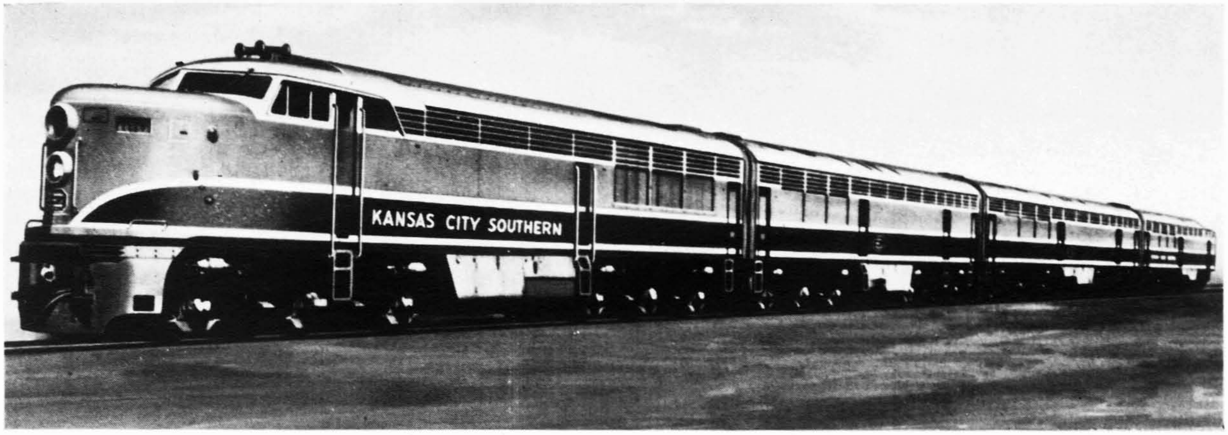
Baldwin in accordance with its long tradition of enormous steam locomotives, coupled with ownership of an enormous slow-speed oil engine, did not see fit to invest in new designs and new equipment for an up-to-date power plant, and so all its diesel locomotive productions were colossal. It fell far behind Alco and General Motors, even after the fusion with Lima and Hamilton, and after the Rentschler group acquired control its dwindling locomotive activities were closed down altogether. Typical of Baldwin productions were the 2,000 h.p. centre-cab twin-engine transfer locomotives for the Elgin, Joliet & Eastern with 27 tons maximum axle load, the tremendous four-unit shark-nosed 6,000 h.p. units for the Pennsylvania, and the 3,000 h.p. twin-engine single-superstructure 2-Do-Do-2 locomotive of 260 tons weight for the Seaboard Railway.

Fairbanks-Morse began with 1,200 and 1,600 h.p. line-service locomotives of road-switcher contour, and then brought out a 2,000 b.h.p. unit; but in this last-named type an alternative bull-nosed design was available, and two A and an intermediate B unit were coupled together to give a 6,000 h.p. locomotive. Then about 1954 came the best-known of them all, the 2,400 h.p. Co-Co *Trainmaster* of 168 tons weight. This embodied the first single oil engine of that power to run in U.S.A. locomotives. Throughout, Fairbanks-Morse installed its 38D model opposed-piston engine, and the *Trainmaster* had the 12-cylinder (24-piston) version running at 850 r.p.m. As a newcomer to the field, with no previous locomotive tradition or clientele, Fairbanks-Morse did very well. The chart showing the numerical progress of the diesel locomotive on U.S.A. railroads indicates that Fairbanks-Morse did about 4 per cent of the total business, and that means a total of over 1,100 units, most of them above 1,000 h.p., as well as others for Mexico and, in association with the Canadian Locomotive Co., some for the two big railroads in Canada. Fairbanks-Morse also was the supplier of the most powerful diesel locomotive ever to run in the States, a four-unit 4(A1A-A1A) locomotive of 8,000 h.p. for the haulage of freight trains on the Kansas City Southern, introduced at the end of 1946. Each unit had a 10-cylinder (20-piston) engine. Total locomotive length was 259 ft. 4 in. (79 m.) and service weight 1,355,000 lb. (605 tons). This locomotive proved too cumbersome, and not enough work could be given it to justify the output, so it was divided into two 4,000 b.h.p. twin-unit halves.

At the beginning of 1954 Electro-Motive began to instal the new 567.C engine in all its production



Alco twin-engine 2,000 *h.p. A*1*A-A*1*A passenger locomotive for the Sante Fe*, 1947



Fairbanks-Morse four-unit 8,000 h.p. freight locomotive for the Kansas City Southern, used in 1947 but subsequently divided into two double-unit 4,000 h.p. locomotives

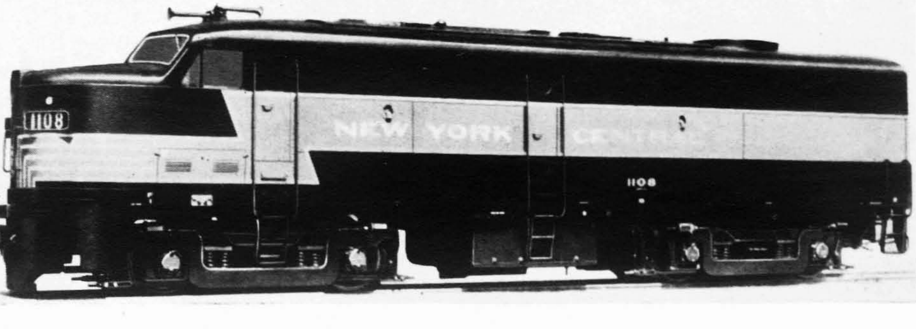
models in place of the 567.B There were many new features of design, but a number of these could be put into the B engine, just as a complete C engine could replace a B as far as mounting, couplings, pipe connections and space were concerned. But only an organisation the size of General Motors could have gone in 20 years through the gamut of the 201A, 567.A, 567.B and 567.C, all different from each other in major design features and production aspects.

Later in the same year Alco began its engine turnover from model 244 to the 251; but it is interesting to note that a feature which was introduced into the G.M. series 567.C two-stroke engine had been a feature of the Alco four-stroke engine from 1945; that is cooling water is kept away from all stressed members in the crankcase-cylinder block to avoid possible corrosion difficulties. Alco's pressure-charged and charge-air cooled 251 engine, in current use today, retained the 9 in. by $10\frac{1}{2}$ in. cylinders, but the output was raised to 162·5 b.h.p. per cylinder, involving a b.m.p. of 194 lb. per sq. in. (13·6 kg. per sq. cm.) and the highest in traction service until topped slightly in the last two years by Maybach charge-air cooled engines. These new ratings of Alco meant that the 12-cylinder engine produced 1,950 b.h.p. at 1,000 r.p.m., and the 16-cylinder model 2,600 b.h.p. There is also a straight six of 975 b.h.p., but this has been installed mainly in export deliveries.

These two new oil-engine designs led inevitably to new locomotive designs, which culminated, after the still further development into the pressure-charged 567.D engine (the 13th development stage from the model 106 petrol engine by Winton with which Electro-Motive started in 1924), in the Electro-Motive SD.24, with a 16-cylinder 567.D two-stroke engine giving 2,600 b.h.p. and 2,400 h.p. traction on a Co-Co wheel arrangement; and in the Alco model DL-600, also a Co-Co of the same outputs from a 16 cylinder four-stroke engine and weighing 335,000 lb. (149 tons). These two makers thus got up to the level of the Fairbanks-Morse *Trainmaster* in regard to output from a single engine and single-unit locomotive, and it is worth remark that all three of these 2,600 b.h.p. standard locomotives are to road-switcher contour. At the same time, subsequent to the introductions of their new engines, both Alco and G.M. applied their 12-cylinder 1,950 b.h.p. engines to Bo-Bo standard locomotives of about 240,000 lb. (108 tons) minimum weight, and suited almost solely to U.S.A. conditions because of the 60,000 lb. (27-ton) axle load and the U.S. loading gauge contour.

The other locomotive models of the last four or five years are too well known and too conventional to warrant notice here; and only passing reference need be made to that phase in the mid-1950's when attempts were made to build satisfactory lightweight trains on "single-axle" principles, like the G.M. *Aerotrain*, the Talgo types, and even the *Xplorer*. Unfortunately none of these proved the right solution within the money and time which could be devoted to their development; and equally unfortunately there was no determined effort to reduce the weight of normal passenger stock to the European level of about 33 tons per 80-ft. (24-metre) coach. Probably now it is too late for such trains or coaches, even when technically successful, to recapture the last passenger traffic in the States.

After the streamlined-train construction ended in 1938-39 very little was done in the way of self-propelled passenger vehicles. The Illinois Central made a spasmodic attempt in 1940 with a few cars having Waukesha engines and Twin Disc hydro-mechanical transmission; but the only development of any moment has been with the Budd stainless-steel



Alco 1,580 b.h.p. Bo-Bo unit for freight service on the N.Y.C., 1946–47; as a rule two to four units of this power were coupled together railcars, which is a post-war one, and which seems to have passed its zenith. In any case railcars, and even passenger coaches, form but a small percentage of the Budd company's products nowadays. Several standard models were evolved by Budd, all essentially the same except for the interior passenger and baggage/mail accommodation. Power is provided by two underfloor General Motors engines with individual top rating of 275 b.h.p., and each driving the inner axle of one bogie through an Allison (General Motors) torque converter and cardan shaft. Disc brakes are fitted to the axles. Several U.S. railroads have these R.D.C. cars for long and short distance transport, and there are a number in Canada also.

Maintenance and Repair

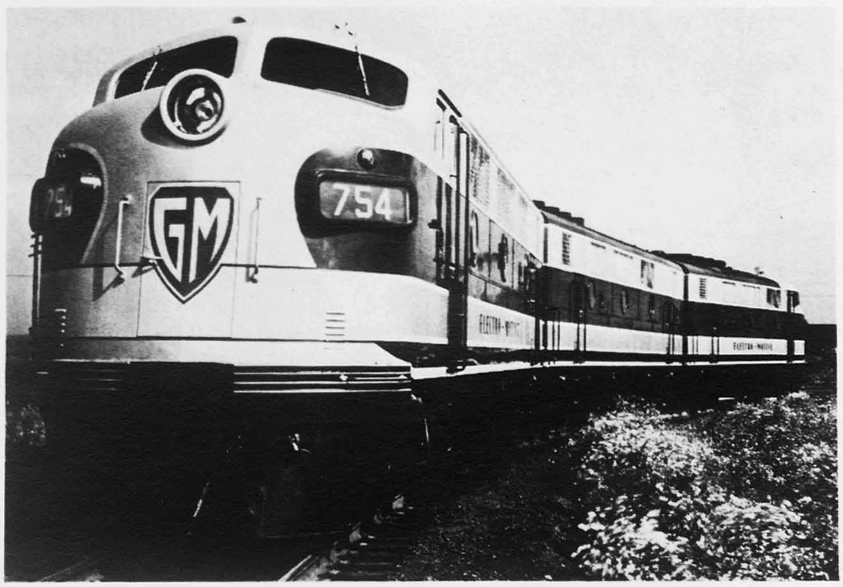
Shortly after the war, when diesel locomotives were being introduced at a rapid rate, and it was obvious that such power would replace steam traction entirely, serious consideration had to be given on a wide scale to the facilities for servicing, maintenance and repair. Certain railroads such as the Burlington already had specialised facilities on a small scale, and the Santa Fe in 1939 had erected at Chicago a maintenance and repair depot for the large locomotives assigned to the *Super-Chief* and *El Capitan* trains, and later this depot was enlarged to handle further main-liners.

But after the war there was an urgency for proper depots and shops all over the States and on a very large scale too, and the thought and work involved in providing these was one of the principal aspects of American diesel traction over the years 1948-52. Repair and maintenance became a major operation, particularly on those railroads which undertook the repair of engine and transmission constituents as well as of mechanical parts, and depending on how far they looked to builders for complete reconditioned engines or on " ready-to-wear " sub-assemblies like cylinder heads. The position was complicated also because many large railroads had three and even four different makes of diesel locomotives, and in those days they were rarely segregated in districts. Moreover, none of the parts in different builds were interchangeable, and often there was little interchangeability between one model and another of the same builder. For example, as late as 1950/51 the different builders were using so many sizes of air hose that some railroads had to carry in stock as many as two dozen variations. Also the locomotive designs themselves were by no means always fully developed. The intensity of the nightmare was increased by the fact that there were still thousands of steam locomotives in service, which also had to be maintained and repaired, even if at a different place. The Santa Fe was one of the earliest large railroads to concentrate diesel repairs, choosing Barstow and San Bernardino, both in California, as the repair shops; but by 1950-51 the latter plant, with 660 diesel-locomotive-units assigned to it for repairs, was accounting for well over one-and-a-half million man-hours a year with nearly 1,000 men working two shifts a day and a five-day week, while Barstow, with 530 locomotive-units, was accounting for well over a million man-hours.

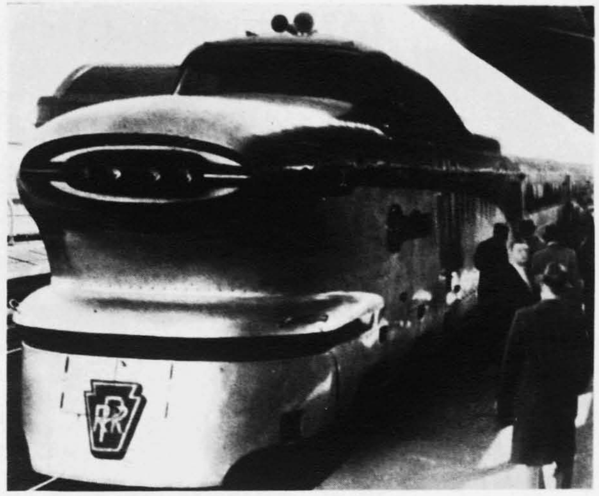
Hire Purchase

Characteristic of diesel traction in the States more or less from the beginning has been the extension to the new units of the century-old and widely-practised hire-purchase acquisition, used extensively for freight cars and to a lesser extent for steam locomotives and passenger cars. There have for long been two methods. One is hire-purchase of the locomotive from an equipment-financing organisation, with payment by instalments over a period, usually 15 years for a diesel locomotive, at the end of which time the railroad is considered to have purchased the locomotive or has then the option to purchase at a token sum. Until the completion of the whole contract the equipment-financing organisation retains full title to the locomotive. The second method is purely hire, usually on an initial agreement of 15 years; the railroad never becomes the owner of the locomotive, but usually has the option after 15 years of continuing to hire the locomotive at a much lower figure.

Most diesel locomotives on the Class I railroads have been obtained under the first heading; but up to the end of 1957 one organisation alone—the Equitable Life Assurance Company—had bought and had out on



General Motors (Electro-Motive) triple-unit diesel-electric locomotive with two A (or cab) units and one B (cabless) unit in the centre, 1947 pure hire over 500 diesel locomotive units. Equipment-trust financing has now been extended to the complete rebuilding of diesel locomotive power with the most modern constituents, on the lines so strongly advocated recently by General Motors and Alco; and such " remanufactured " power is regarded as new power under the New York Banking Law. In addition to these equipment-trust hire-purchase and pure-hire schemes, a third method has been practised to a limited extent, in the form of direct conditional-sale contracts straight between locomotive builder and railroad, these in fundamentals being hire-purchase agreements. But vital clauses in all three types ensure the retention of full title by the vendor or owner, and so such equipment cannot be lumped in with the general railway assets in the event of one of those bankruptcies or financial reorganisations to which so many Class I railroads have been subject in the last half century or so. Another essential part of all three types of contract is that the railroad must maintain and repair the locomotive.

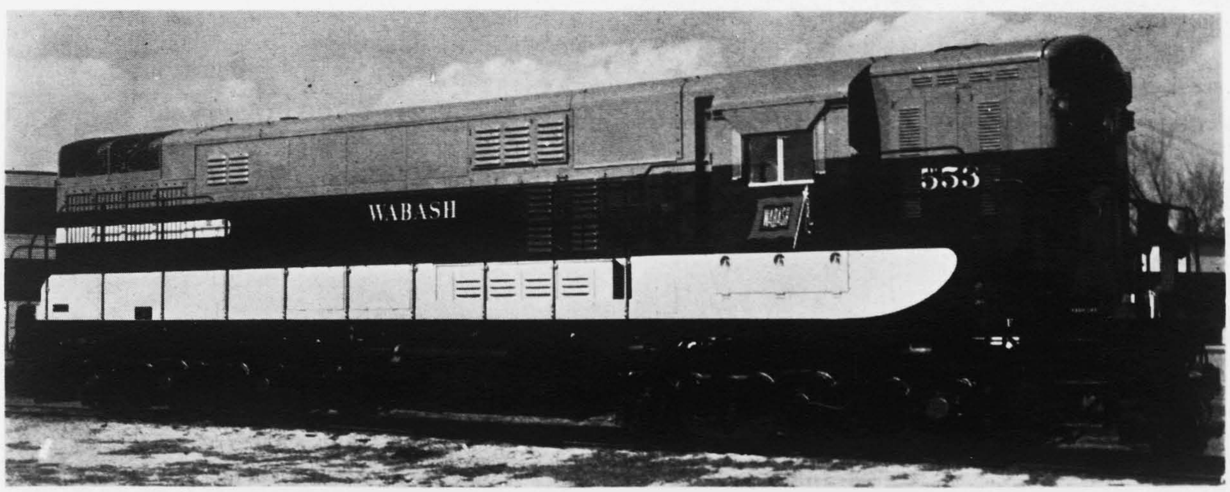


General Motors Aerotrain at Washington station—one of the attempts in the middle 1950's to get really light-weight trains by unconventional means

Complete Diesel Working

Dieselisation of Class I railroads is now complete except for the 1,900 route miles electrified. But with 28,400 diesel locomotive-units in stock, many of 15 and more years old, there must be a considerable number of new locomotives or " remanufactured " locomotives needed over the next few years. Even at 4 per cent renewal or remanufacture per year, this means 1,100 locomotive-units. Complete remanufacture is said to cost about 70 per cent of the cost of an entirely new modern locomotive, so that one may say broadly that 4 per cent renewal means the equivalent of 770 completely new locomotive units—not enough to keep going two plants with a combined capacity of over 2,000 units a year, but nevertheless a useful basic load. General Electric, a year or so ago, introduced a 2,500 h.p. (probably 2,650/2,700 b.h.p.) Bo-Bo locomotive suited to Class I roads, bringing a third builder in, but so far only prototypes are running.

However, tied up indirectly to these figures from the railroads' point of view is locomotive life and depreciation. The Interstate Commerce Commission has approved depreciation rates based on a 20-year life for line-service diesel locomotives and 25 years for switchers. Recently it has been stated that the substantial number of locomotives " remanufactured " during the last year or two, and the even more substantial number for which early " remanufacture " is advocated by the builders, means that the effective life is only about 14 years for the line-service units and 18 years for switchers; and that this is helping to upset all " economy " figures, and that the difference between the actual and I.C.C. values may have to be charged to profit-and-loss account. But in this respect one should note that the providers of the money for these locomotives reckoned in fact on a 15-year life before probable obsolescence, as evidenced by the common 15-year term of equipment obligations; and also that as a large proportion of all Class I railroad diesel power is not owned by the railroads, and much of it will never be, no depreciation charges can be marked up, and all expenses in connection with them are purely operating expenses.—B.R.



An early single-engine single-unit diesel locomotive of 2,400 h.p. (traction), the Fairbanks-Morse Trainmaster with a 12-cylinder (24-piston) two-stroke opposed piston engine, 1955. An earlier Co-Co range of 2,400 h.p. unit had been marketed by F-M about 1952/53

Letters to the Editor

American Diesel Traction

Jamaica, N.Y., U.S.A.

March 3

SIR,—Having read your brief article on diesel traction in North America in the February annual review issue, I think some statements need correction or emendation, particularly your statement that until 1958 no American standard unit exceeded 2,000 h.p. except for ten Alco 2,400 h.p. units on the Santa Fe. This is wrong. There were the Fairbanks-Morse units, for example; but other builders also had units of more than 2,000 h.p. on the rails long before 1958. In 1948 Baldwin built a dozen 3,000 b.h.p. units for the Seaboard Air Line, and two more went to the Mexican National Railways. Baldwin also had these units on trial on the N.Y.C., Pennsylvania, B. & O. and other lines; and as far as Baldwin was concerned this was a production model. It didn't sell, frankly because it wasn't very good—it was a handful to maintain. I think the Seaboard units are now out of service. The National of Mexico uses theirs sparingly, and the Pennsylvania, which bought about seven in 1950, still uses theirs on mountain grades, although I understand some are re-engined.

In 1950 General Motors came out with their E-8 model of 2,250 h.p. A1A-A1A, and sold these to at least 40 railroads. Alco and Fairbanks-Morse also met this challenge in 1951 with 2,250 h.p. models of Co-Co and Co-Bo axle arrangements respectively. In 1956 the E-8 was replaced by the E-9, which was rated at 2,400 h.p., and has since been re-rated at 2,500 h.p. Also in 1955 Fairbanks-Morse started building its Trainmaster 2,400 h.p. road-switcher and sold these to many lines, several of which, such as the C.R.R. of N.J., Reading, and S.P., use them in commuter service, on which they often pull only five coaches, the high h.p. being used for quick acceleration in multi-stop operation.

Fairbanks-Morse, in addition to its Trainmaster, and the 2,250 h.p. Co-Bo model of 1951 already mentioned, produced a 2,400 h.p. road-service unit with the same axle arrangement in 1951, and some of these are still in service on the L.I., N.Y.C., C. & N.W., and others, though some of the N.Y.C. stock has been re-engined with G.M. power. Baldwin also had its 2,400 h.p. transfer and switching design about 1950, as on the Elgin, Joliet & Eastern; and Lima-Hamilton (before it merged with Baldwin) built in 1953 some 2,500 h.p. Co-Co road-switchers which are on the Pennsylvania.

With regard to figures, I think you can make them prove anything you want, and Mr. H. F. Brown's report can go under that heading. Mr. Barriger is a highly-respected railway officer, and he may be right; but I wonder on what he bases his opinion that the U.S. railways will be electrified between 1965 and 1980. In 1910 and again in 1925 the same was promised, also by highly-regarded officers. In the past ten years our electric locomotive stock has fallen by 30 per cent to about 500 units; very little of this reduction was caused by introduction of more modern electrics, indeed diesels replaced most of them, although in one case steam power took over for seven years or so until replaced by diesels. Most U.S. railroads do not have a sufficient number of trains to warrant the expense of electrification. Mr. Barriger's Pittsburgh & Lake Erie Railroad has the heaviest tonnage per mile of any U.S. railroad, and is not yet electrified and has had no public plans for conversion; in fact it bought steam power as late as 1948 and was among the last of the systems to go over to diesel; though, to be sure, Mr. Barriger was then president of the Monon and did dieselise his property by 1947.

From a defence point of view, I am not sure that total electrification would be a good idea. Certainly it is much easier to knock out an electrified line in a war than to incapacitate one with hundreds of separate motive-power units. As has been proven on our railroads, wrecks, floods, snow and storms cause much more loss of money and service on electrified lines than on those not electrified. In recent years around New York the diesel has had to rescue stalled or disabled electric trains on the New York Central, Long Island, Pennsylvania and New Haven roads several times a year.

Yours faithfully,

ELLIOTT KAHN

[In making our statement about 2,000 h.p. diesels we are afraid we had been thinking in terms of single-engine single locomotive units, but even so, our omission of the Trainmaster was unforgivable. Reference to several locomotives mentioned by Mr. Kahn is made on pages 145-151.—ED.]