# Fortune

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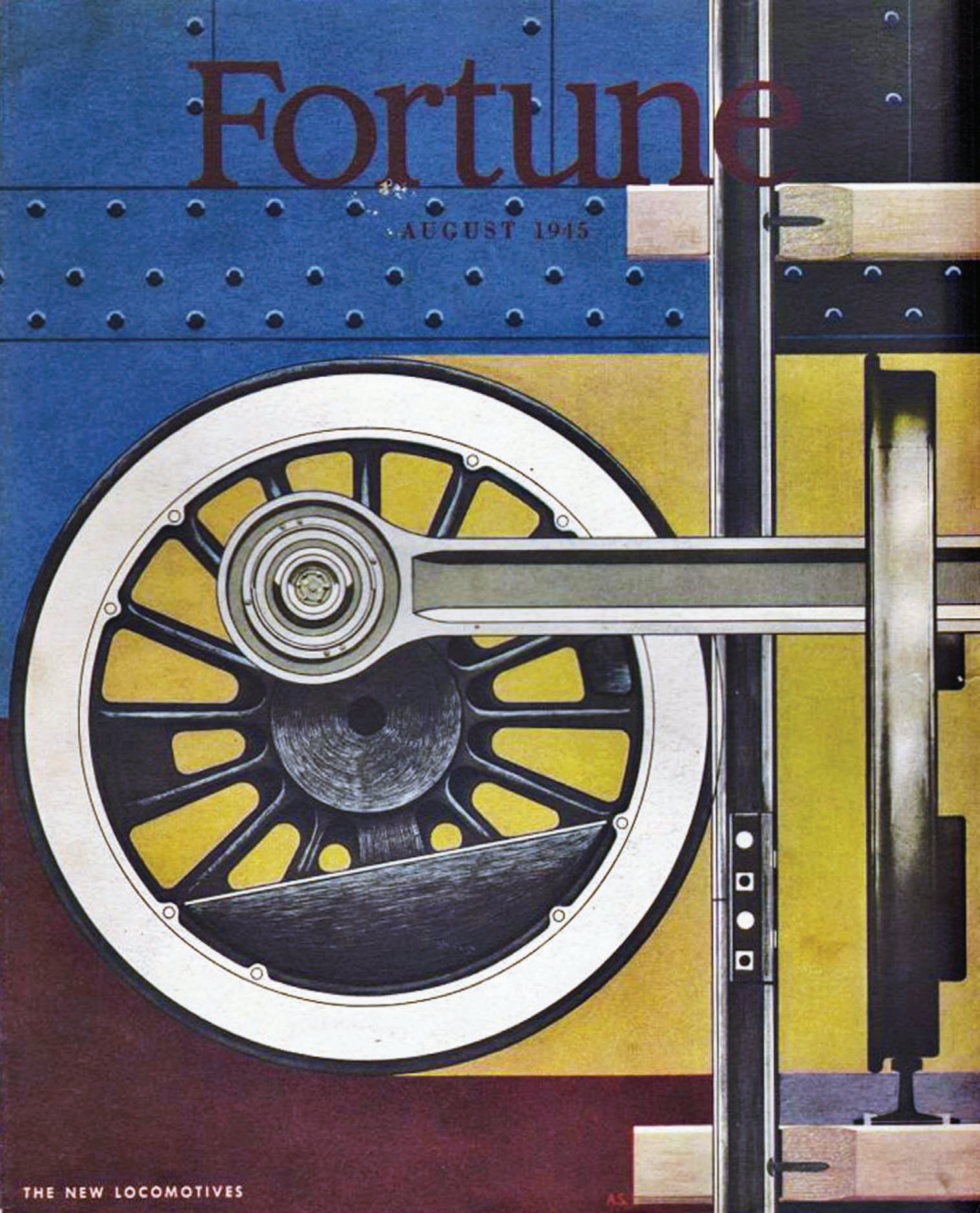


THE NEW LOCOMOTIVES


# STEAM POWER: ROLLING ALONG

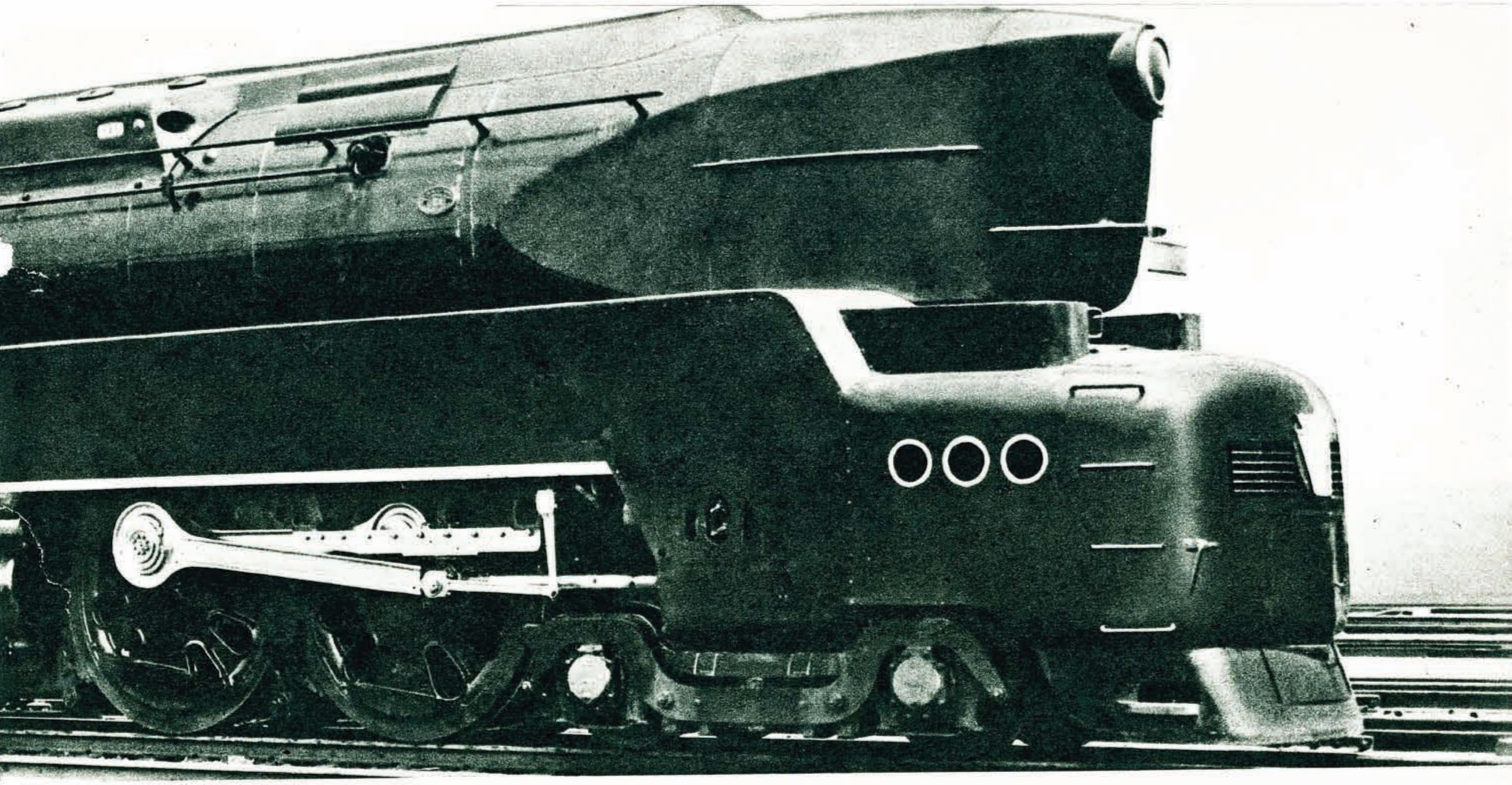
## PACED BY THE AMBITIOUS DIESEL-ELECTRIC, IT IS STILL GOING PLACES

THIS big machine, one of the Pennsylvania Railroad's two "experimental" Class T-1 steam locomotives, has the railroad industry by the ears. Designed to average 100 miles an hour with eleven cars weighing 880 tons, it has averaged more than 100 and actually run more than 130 (on test runs) with sixteen passenger cars weighing nearly 1,200 tons. Its boiler is smaller than that of many engines rated at around 5,000 hp; yet it has developed more than 6,500 hp. The first of several steam-locomotive projects originating in the resolve of the coal-carrying roads, locomotive builders, and coal industry to combat the growing acceptance of the oil-burning Diesel-electric, it has proved so successful that the conservative Pennsylvania, noted for never adopting a new engine design that it has not tested beyond a shadow of doubt, is spending between $15 and $17 million on fifty engines like it.

The T-1 differs from a comparable conventional steam locomotive in two respects: it has four cylinders instead of two; and it feeds steam to the cylinders by means of a new poppet-valve arrangement. The comparable standard passenger locomotive today is the 4-8-4 type; it has a four-wheel leading truck, four pairs of drivers, and a four-wheel trailing truck. The drivers are driven by a single pair of pistons and connecting rods, which at 100 miles an hour thrash around seven or more times a second. Even when made of light alloys, the rod assembly weighs as much as three tons, and unless carefully counterbalanced can pound the rail unmercifully. An important advantage of the Diesel-electric in high-speed service is that it does not pound the rail.

As early as 1932 the Baldwin Locomotive Works proposed to offset the Diesel's advantage by using two pairs of lighter, smaller cylinders and rods instead of one (see diagram at right). The idea was not exactly new; for some fifty years railroads had been using two pairs of cylinders on huge freight engines. But they used them with an articulated connection, and only to enable the front set to swivel so the engine could negotiate curves. Baldwin wanted to use two pairs on a rigid frame, primarily to eliminate the pound of the heavy rod assembly, secondarily because it believed two pairs of pistons and valves would handle steam more efficiently than one. So in 1937 Baldwin, with American Locomotive Co., Lima Locomotive Works, and the Pennsylvania Railroad, designed the great Class S-1 four-cylinder engine exhibited at the World's Fair in 1939 and 1940. And in 1940 the Pennsylvania ordered two engines somewhat smaller from Baldwin. They are the T-1's, No. 6110, which is shown above, and No. 6111.

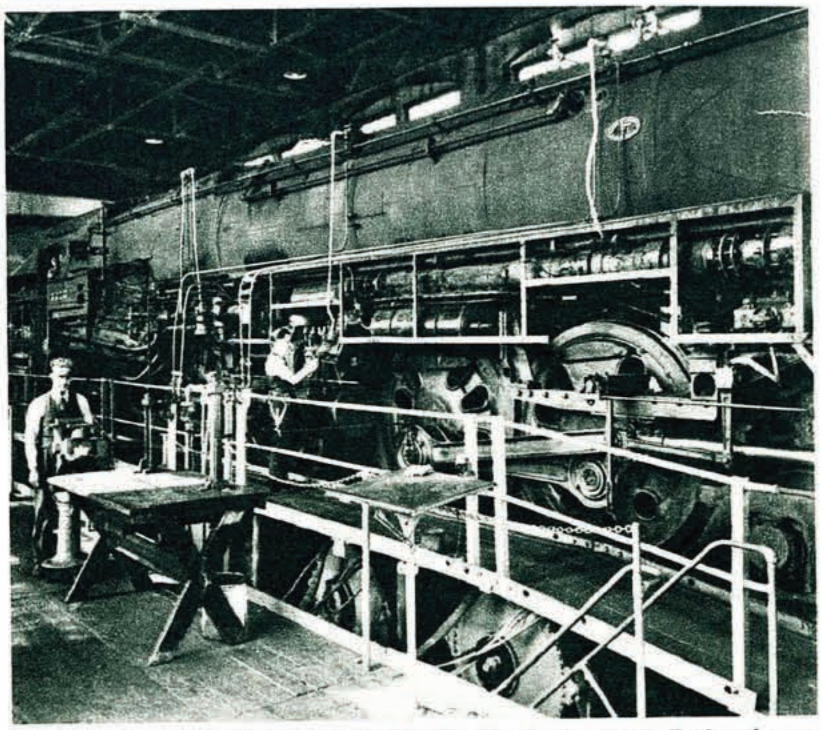
Meantime the Pennsylvania had been getting sensational results from an experimental poppet valve developed by the Franklin Railway Supply Co. The main trouble with the conventional piston valve at high speed is that intake and exhaust openings are not adequate and cannot be controlled separately. As a result the exhaust port is often closed before most of the steam is exhausted from the cylinder. The poppet system, using valves somewhat like auto valves, permits not only independent action of intake and exhaust "events," but more precise control of them. Poppet valves are common in Europe, but experimental



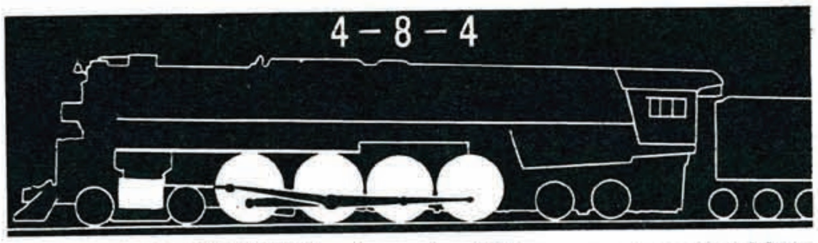
applications met with little success here because they proved troublesome and because few steam engines ran fast enough to justify their higher cost.

Nevertheless the Franklin people decided to design a set for U.S. service. After a dozen years of testing and redesigning, they persuaded the Pennsylvania to try their system in 1939. With the new valves, a Pennsylvania standard K-4 passenger engine rated at 3,500 hp developed about 4,200 hp. On one run it hauled a 914-ton train from Warsaw to Liverpool, Indiana, nearly eighty miles, at an average of eighty-four miles an hour. Delighted, the Pennsylvania decided to equip the T-1's with Franklin valves. The valves and engines performed so well in nearly three years of experimental operation that the Pennsylvania has ordered fifty more—twenty-five from Baldwin and twenty-five from its own Altoona shops. They cost an estimated $300,000 apiece, of which some $30,000 is accounted for by the valve system.

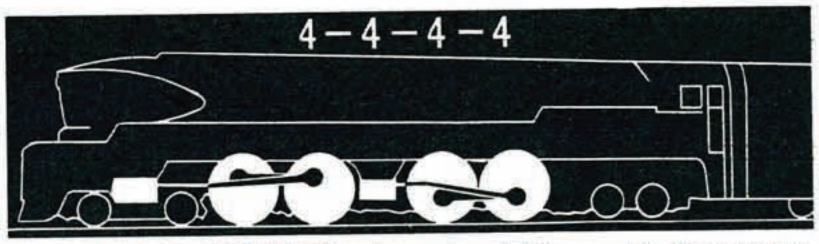
Both Baldwin and Franklin are jubilant. "These locomotives," said Ralph P. Johnson, Baldwin's chief engineer, to the New York Railway Club last May, "will outperform a 5,400-hp Diesel locomotive at all speeds above twenty-six miles per hour, and if given comparable facilities for servicing and maintenance will do the work more cheaply." Even if the new steam projects discussed on the following pages turn out as well, there seems little doubt that the T-1 will influence strongly the trend of steam-locomotive design.



**100 MILES AN HOUR STANDING STILL:** The Pennsylvania Railroad tests engines at Altoona in the only modern locomotive test plant in the Western Hemisphere. The huge T-1 (above) was hoisted into place and its performance measured at various speeds up to more than 100 mph. The T-1 used only 11 per cent more steam in developing 46 per cent more horsepower than the Pennsylvania's standard 4-8-2 type freight and passenger engine.

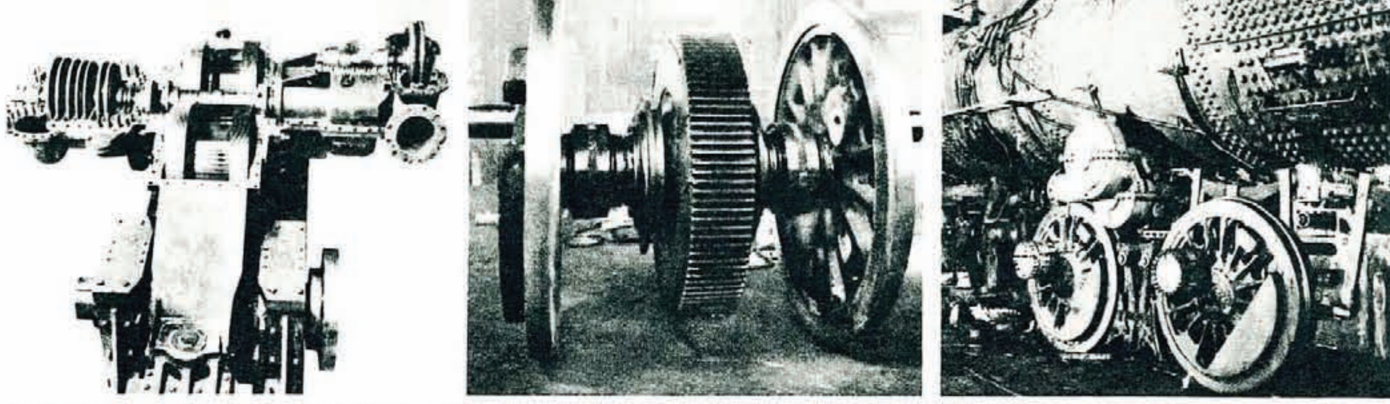



**ONE PAIR OF CYLINDERS** to four pairs of drivers on a conventional locomotive means big pistons, heavy main rods, tendency to pound rail.




**TWO PAIRS OF CYLINDERS** to four pairs of drivers on the Pennsylvania T-1 locomotive means lighter rods, negligible rail pound, smooth starting.


6200



NO BIGGER THAN A TRUCK MOTOR: The great locomotive opposite is driven by the turbine mechanism shown left above, with its blades exposed. It is placed on top of and geared to two pairs of driving wheels. One of the pairs with its gear is shown in the center, and at the right the whole turbine-wheel assembly.

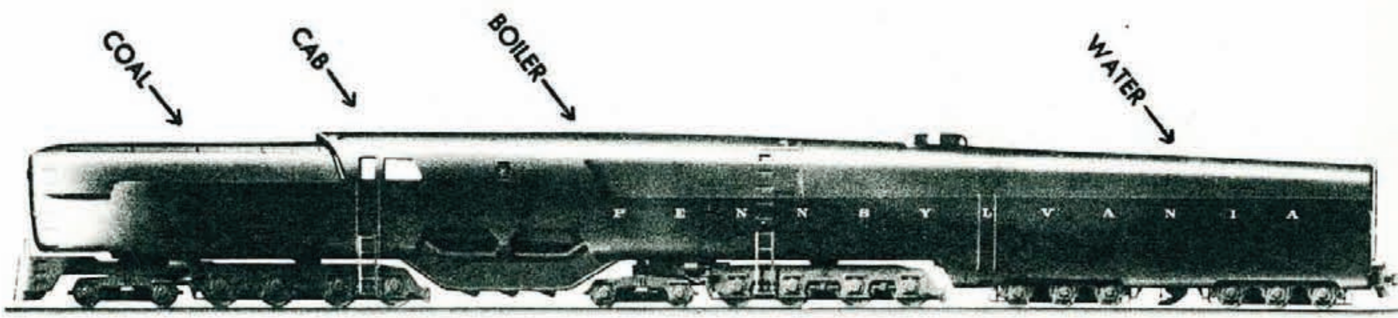
EVER SINCE de Laval and Parsons developed the steam turbine in the 1880's, engineers have dreamed of adapting it to locomotives. The turbine is not only the most efficient but the simplest way of converting heat into power; gear a turbine to driving wheels and you have a locomotive without pistons, valve gears, back-and-forth motion, jerk, or track pound. The catch is that the turbine is highly efficient and notably effective only when spinning swiftly and steadily. Thus it is the ideal power for ships, which travel at constant speeds for days on end. For best results, moreover, the turbine should be equipped with an exhaust-steam condenser, which performs the double function of saving feed water and eliminating the back pressure of the exhaust steam. Nothing is easier than to build a water-cooled condenser on a ship. But a locomotive does not travel at constant speed and is not a practical place in which to install a condenser.

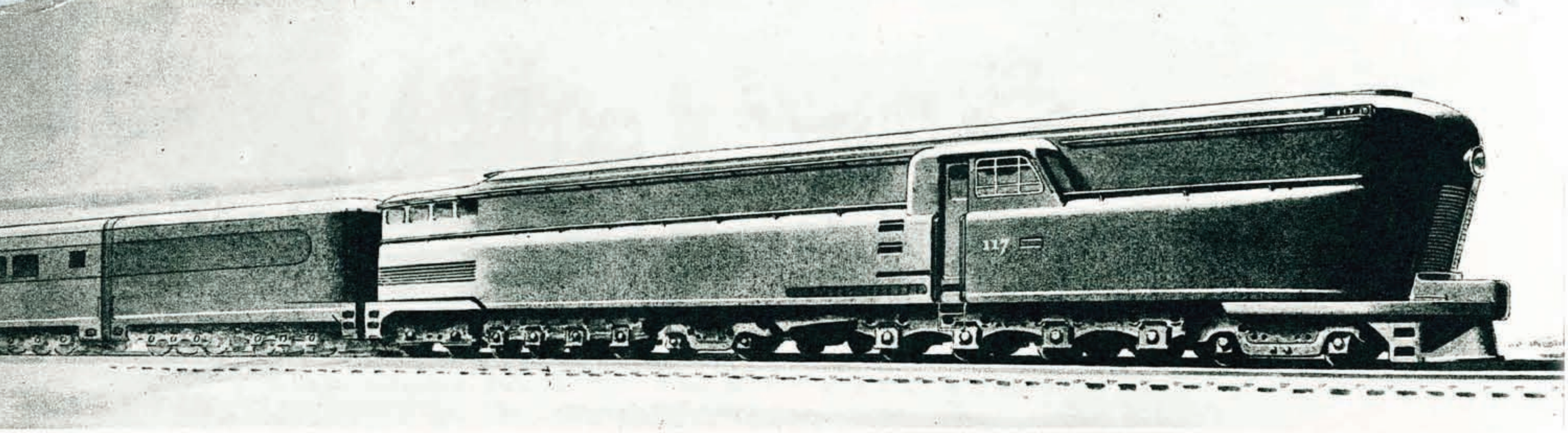
The Germans, Swedes, and British have built and operated turbine locomotives. The machines were more efficient than conventional reciprocating engines at high speed, but less efficient and effective at low speed. They ran more smoothly than reciprocating engines, and theoretically were easier on the track; but European equipment is so light that the question of track damage from the driving-wheel pound was not important. The net performance of the turbine engines, in other words, did not surpass that of conventional locomotives enough to compensate for the turbine's higher cost.

But U.S. locomotives are very heavy, and the question of track pound is very important. As we have noted, the Diesel-electric does not pound the track. The Baldwin people reasoned that if U.S. railroads were now willing to pay twice as much for a Diesel-electric as for a comparable steam locomotive, they would welcome a steam turbine costing less than a Diesel-electric. Together with Westinghouse Electric Corp., Baldwin and Pennsylvania Railroad built the nation's first direct-connected turbine. It was completed last fall and turned over to the Pennsylvania, which numbered it 6200 and runs it between Harrisburg and Altoona.

The 6200 (on the left) is the simplest locomotive of any kind in the U.S. The engineer opens the throttle, steam shoots against the turbine blades, and the turbine drives the wheels. The 6200 was designed to be at least as efficient on sustained runs as a modern steam locomotive, its low steam consumption at high speed compensating for high consumption at low speed. More important (since coal is very cheap), the 6200 was designed to perform as well as a modern conventional steam locomotive of comparable size up to thirty miles an hour, to develop 6,500 hp at seventy miles an hour, and to outperform both a conventional steamer and a 6,000-hp Diesel at all speeds above forty miles an hour. Conclusive data on tests and trial runs has not yet been released, but in the seven months that the 6200 has been operating it apparently has not disappointed its designers. Some engineers were worried about whether its gears would hold up under the jerk and vibration of road service, but so far they have given little trouble. If they stand up and the engine proves as efficient and effective as a conventional steam locomotive of the same size, the question remains whether its simplicity, smoothness, and performance at speed will be worth the additional cost (from 10 to 50 per cent depending on the size of the order). Apparently the Pennsylvania Railroad, surely not a company to go off the deep end, thinks the question is at least debatable. For last March 20, four months after the 6200 had gone into service, it announced that it would build the most powerful locomotive ever—a 9,000-hp machine with two turbines.

ONE BOILER, TWO TURBINES: Unlike the turbine locomotive on the opposite page, the Pennsylvania's projected "Triplex" turbine locomotive shown below will not resemble a conventional engine very much. To provide enough weight on its drivers, one of the two turbines will be geared to a driving-wheel assembly under the coal bunker—placed up front. To maintain a constant weight on the drivers as the coal pile goes down, water from the tender will be piped into tanks in the coal compartment. The engine is styled by Raymond Loewy Associates.





THE ENGINE illustrated above is one of three 6,000-hp locomotives being built by Baldwin & Westinghouse to haul an elegant postwar Chesapeake & Ohio streamliner between Washington and Cincinnati. Like the Pennsylvania engine on the previous page, it is powered by a steam turbine; unlike the turbine of the Pennsylvania's engine, its turbine is not geared directly to the driving wheels but runs a generator that powers an electric drive, just as the Diesel engines in a Diesel-electric do. The C. & O. decided it wanted an electric-drive engine, but since it derives about 60 per cent of its revenues from hauling coal, it avoided the oil-burning Diesel-electric and chose instead a coal-burning turbo-electric. This is not the first turbo-electric locomotive in the U.S. Several years ago General Electric constructed one (for the Union Pacific) with a forced-circulation type boiler and condenser, but it developed so many bugs it was scrapped. The C. & O. engines will have a conventional boiler without condenser, and the company's engineers predict it will be cheaper to maintain than Diesel motors.

At the same time nine coal-carrying roads (including the C. & O.) have put $1,500,000 into and are working on an experimental 6,900-shaft-hp turbo-electric whose steam is generated by a Babcock-Wilcox water-tube boiler.

All of which does not mean that simple reciprocating steam engines like those below are out of the *road*-engine race (Diesels have made a clean sweep of the switch-engine field). Practically all the advantages enjoyed by the Diesel-electric road engines a few years ago have been or can be largely offset. Roller bearings on rods eliminate lubrication stops, and high-capacity water plugs and coal chutes permit refueling in a minute or two at regular station stops. Steam locomotives are running 20,000 miles and more a month. The price of the steam locomotive has been rising steadily while that of the Diesel has remained stationary or declined, but a steamer still costs around half as much as a comparable Diesel. Whether Diesel or steam is cheaper to operate still provokes hot arguments, but the evidence suggests that steam advocates have a case. The Santa Fe has the biggest fleet of Diesels in the country. "Repairs and expense per locomotive mile," testified a Santa Fe motive-power official before the National Railway Labor Panel Emergency Board two years ago, "are slightly higher for the Diesel than for the steam locomotive." The Diesel-electric has undeniably accelerated progress in steam engines. Locomotive builders used to lament that the hardheaded railroads valued simplicity too highly, and did not give adequate attention to the unconventional engines. Now that they have got used to spending a lot of money for complicated Diesel-electrics, they seem more willing to spend money on unusual steam engines. And the coal-carrying roads naturally tend to favor engines that burn coal.

The greatest threat to the steam engine may not be the Diesel-electric, but the gas-turbine locomotive (FORTUNE, June, 1944), which consists merely of a geared turbine revolved by hot gases. Theoretically simpler even than the steam turbine because it needs no boiler, more compact and more efficient than either steam or Diesel-electric, it may be ready for trial in a few years, depending on progress in turbine-blade metallurgy. Six coal-carrying railroads and three coal producers, working with Bituminous Coal Research, Inc., are putting more than $1 million into studying the gas turbine. When and if it is built to burn coal, it should give both steam and Diesel a run for their money.

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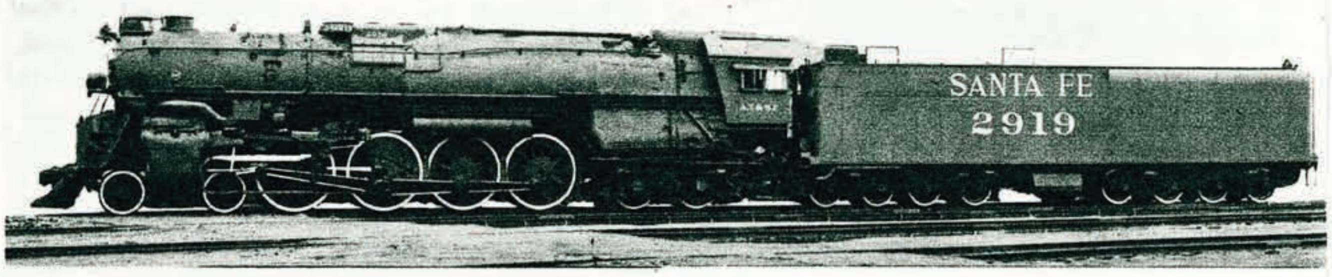
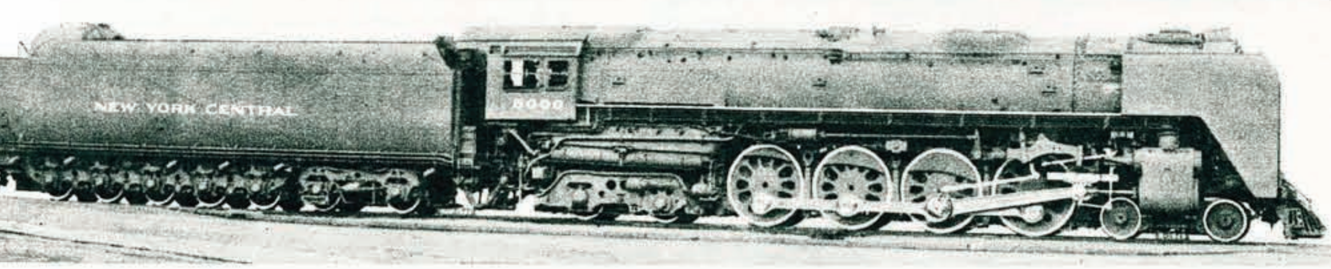
**THE SHAKEDOWN RUN** for No. 6195, one of the Pennsylvania's twenty-five new freight engines, the world's most powerful steamers at speeds above 20 mph. Much bigger than the record-breaking T-1 described on pages 144 and 145, they resemble it in principle. They too have four cylinders. The front pair is connected to two pairs of drivers but the rear set to three.

**OLD RELIABLE:** The 4-8-4 wheel arrangement is the U.S. standard in both freight and passenger service. The Santa Fe assigns engines like the one at the right, the largest and heaviest 4-8-4 ever built, to haul passenger trains between Kansas City and Los Angeles, 1,776 miles, without change. They not only can handle heavy tonnage, but can run 100 miles or more an hour.




**THE "NIAGARA":** (Left) One of twenty-seven 4-8-4's being built by American Locomotive for freight and passenger service on the New York Central, which calls them the Niagara type. Only one will be equipped with poppet valves like those on the Pennsylvania's T-1; despite the Pennsylvania's success with them, the N.Y.C. wants to test them itself before deciding on more.

*END*