BALDWIN

WESTINGHOUSE

STEAM TURBINE LOCOMOTIVE

TYPE 6-8-6

GEARED STEAM a strainer and filter

d by boiler feed

The more important dimen of this

ng and gear

locomotive are tabulated on the followi boiler, frame, trucks and driving wheels are of conventi mo. fi d by the elimination of cylinders and their accompanying parts and adapted to a new type of propulsion equipment, i. e., a turbine geared to the third and fourth pairs of driving wheels.

The propulsion equipment comprises a forward turbine, a double reduction gear for each of the two middle driving axles, a flexible cup drive element between the final gear and the two middle driving axles and a reverse turbine and gear unit clutched to the high speed pinion. Both turbine units are supported from the gear case which, in turn, is supported from the main locomotive frame, making the power unit a complete assembly in itself.

Steam enters the forward turbine through four inlet pipes, each of which admits steam over 25% of the periphery of the turbine and rotor. Admission of steam is under control of the engineer who opens the throttle valve in series as he manipulates the control lever.

Reversing is accomplished by engaging the dog clutch and admitting steam to the reverse turbine. The ahead turbine is never disengaged and must therefore operate in a direction of rotation opposite to normal when the locomotive is moving in reverse.

All portions of the propulsion equipment are lubricated from a common source. The oil is pumped from the gear case sump

by a centrifugal pump through a strainer and filter, to a lubricating oil cooler which is cooled by boiler feed water. After being cooled, the oil enters the bearing and gear sprays to lubricate the turbine and gear bearings and the tooth contacts.

Control of the locomotive from the cab is from a single lever, the position of which determines the steam flow to the ahead or the reverse turbine. A protective device prevents clutching of the reverse turbine unless the locomotive is at rest. Overspeed protection for both turbines is provided to prevent damage from high speed slippage or overspeeding from any source. The throttle control of the locomotive utilizes a pneumatic system and the overspeed protection operates by means of an hydraulic system.

The ahead, or forward turbine is of the impulse type and consists of a Curtis Stage followed by five Rateau Stages. In order to obtain favorable tractive effort values when starting and at low speeds, the turbine is over bladed and the maximum efficiency and horsepower occur at about 70 miles per hour.

The reverse turbine consists of a single Curtis impulse element. The rotor disc is mounted on the end of the pinion shaft and carries two moving rows of blades. Inlet nozzle blocks and a single stationary row of guide blades are mounted in the cylinder base and cover, providing approximately 50% of full peripheral admission.

GENERAL DIMENSIONS AND WEIGHTS

Gauge 4' 8-1/2" Fuel - Bituminous Coal
Drivers, 68" diameter over tires.
Boiler working pressure - 310 pounds per square inch.

WHEEL-BASE:

Driving	19' 6"
Rigid	13' 6"
Total engine	53' 0"
Total Engine and Tender	108' 0"

Boiler - Type, Modified Belpaire, 102" diameter - largest course
Firebox - 180" long and 96" wide.
Combustion Chamber 120" long.

Tubes - 49 - 2-1/4" diameter, 18' 0" long.
Flues - 235 - 3-1/2" diameter, 18' 0" long.
Gas Area 11 sq. ft.

HEATING SURFACE:

Firebox	340 sq. ft.
Combustion Chamber	190 " "
Circulators - (6 in firebox)	84 " "
Tubes - 2-1/4"	518 " "
Flues - 3-1/2"	3,860 " "
TOTAL	4,992 sq. ft.

Grate Area 120 sq. ft.
Ratio - Grate Area to Total Heating Surface 1 to 41.5.
Superheating Surface - 2050 sq. ft.

Weight in Working Order (approximate)	(Front Truck	143,000 lbs.
	(Drivers	260,000 "
	(Trailing Truck	177,000 "
	(Total Engine	580,000 "
	(Tender	412,900 "
	(Total Engine and Tender ...	992,900 "

Tractive Effort - Forward, 70,500 pounds; Reverse, 65,000 pounds.
Ratio of Adhesion - Forward 3.69; Backward 4.

TENDER:-

Water Capacity	18,000 gallons.
Fuel Capacity	75,000 pounds.

TURBINE CHARACTERISTICS

Steam Conditions

Pressure at Turbine Inlet	285 psi gauge
Steam Temperature at Inlet	750° F. T. T.
Back Pressure at Turbine Exhaust	15 psi gauge

Ahead Turbine

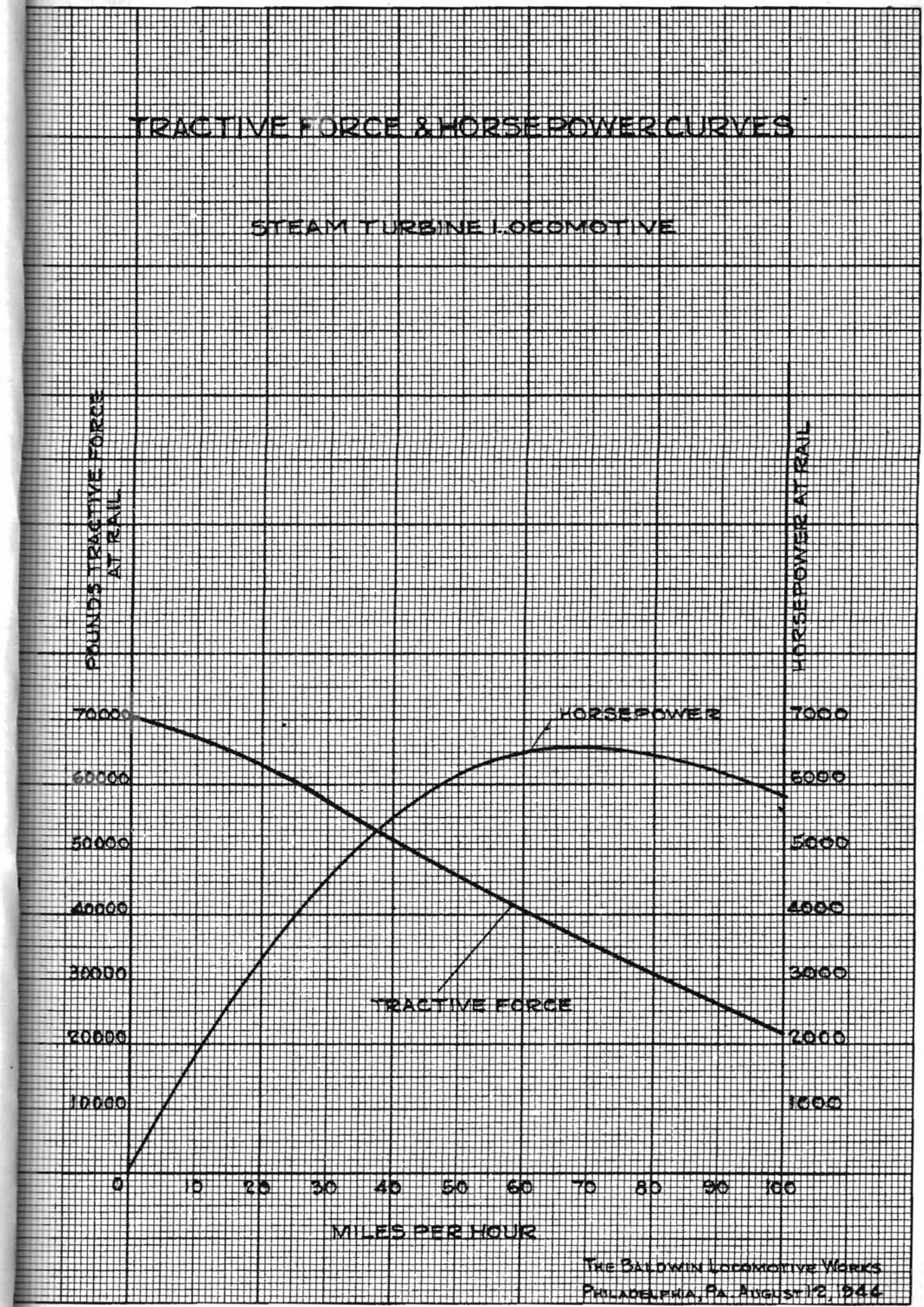
Nominal Rated Capacity	6900 hp.
Maximum Turbine Operating speed	9000 rpm.
Overspeed Governor Controlling Speed	10000 rpm.

Reverse Turbine

Nominal Rated Capacity	1500 hp.
Maximum Turbine Operating Speed	8300 rpm.
Overspeed Governor Controlling Speed	9100 rpm.

Main Reduction Gear

High Speed Ratio	31:160
Low Speed Ratio	31:111
Total Reduction	18.5:1


TRACTIVE FORCE & HORSEPOWER CURVES
STEAM TURBINE LOCOMOTIVE
POUNDS TRACTIVE FORCE AT RAIL
HORSEPOWER AT RAIL
70000
60000
50000
40000
30000
20000
10000
7000
6000
5000
4000
3000
2000
1000
HORSEPOWER
TRACTIVE FORCE
0
10
20
30
40
50
60
70
80
90
100
MILES PER HOUR
THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA, PA. AUGUST 12, 1944

CHARACTERISTICS OF VARIOUS TYPES OF POWER

In order to make clear the characteristics of the steam turbine type of motive power as compared with reciprocating steam and Diesel-electric locomotives, the following curves have been drawn.

TORQUE:-

Curve 1 shows that with a turbine as a prime mover the locomotive has a uniform torque at all speeds, similar to the electric and Diesel-electric. The reciprocating steam locomotive has a varying torque throughout a wheel revolution as shown by the wavy line.

TRACTIVE POWER:-

Curve 2 shows a comparison of the tractive effort at rail of the steam turbine locomotive, a conventional two-cylinder reciprocating steam locomotive having equal boiler capacity and weight on drivers, and a 6000 horse-power Diesel-electric passenger locomotive.

The tractive power of the turbine locomotive exceeds at practically all speeds that of the conventional steam locomotive, the gain at start being possible with the constant torque of the turbine, while at the higher speeds the gain is due to reduced steam consumption per unit of power developed by the turbine.

The tractive power of the turbine also exceeds that of the Diesel-electric at speeds above 40 miles per hour, there being a considerable gain at speeds above 50 miles per hour. At speeds below 40 miles per hour, gradually decreasing to start, the Diesel-electric has an inherent advantage due to its greater adhesive weight, that is, weight on drivers.

HORSE-POWER:-

Curve 3 shows a comparison of the horse-power available at rail of the steam turbine locomotive, a conventional two-cylinder reciprocating steam locomotive having equal boiler capacity and weight on drivers, and a 6000 horse-power Diesel-electric passenger locomotive.

The horse-power curves bring out more strongly the advantages of the turbine locomotive over the other types of locomotives considered than do the tractive effort curves.

STEAM PER HORSE-POWER AT RAIL:-

Curve 4 shows the steam consumption per horse-power delivered at rail by the steam turbine locomotive as compared with a conventional two-cylinder locomotive having equal boiler capacity and weight on drivers. The decreased steam consumption at speeds above approximately 30 miles per hour results in a corresponding increase in horse-power available at rail for a given weight of steam delivered by the boiler. At starting and very low speeds the steam consumption of the turbine is relatively high, but with modern high speed, main-line schedules, with few stops and very little operation at the low speeds, the influence of this feature will be small and more than overcome by the advantages at the higher speeds.

STEAM DEMAND:-

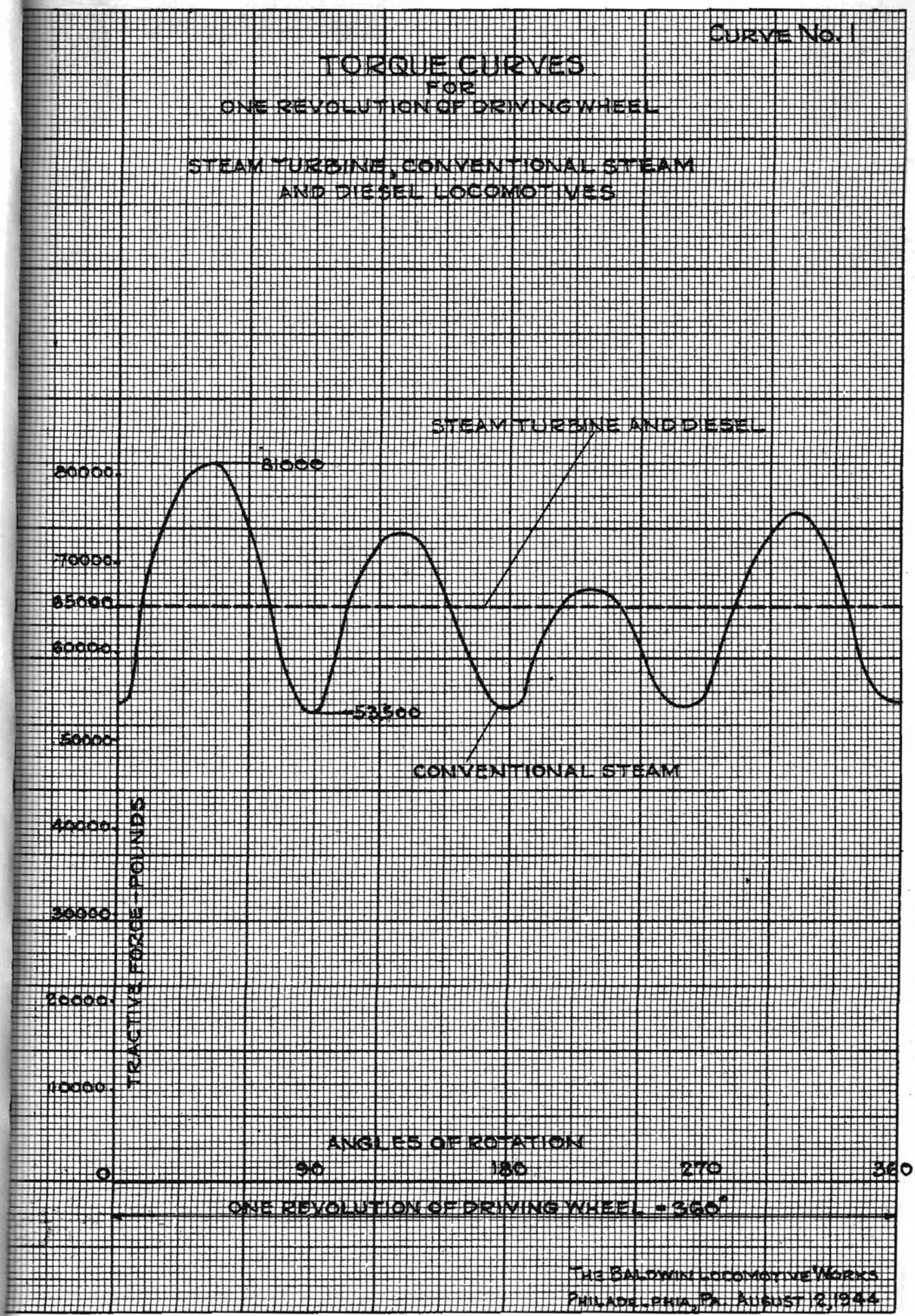
Curve 5 shows the total amount of steam required by the turbine engine as compared with the demands upon the conventional two-cylinder locomotive having equal boiler capacity and weight on drivers Beyond about 30 miles per hour both engines will consume the total output of the boiler, while below that speed the demands of the conventional

reciprocating steam locomotive upon the boiler gradually decrease and become quite low at starting. The characteristics of the turbine engine are such as to require the maximum flow of steam at starting and throughout the full range of speeds.

CURVE No. 1

TORQUE CURVES
FOR
ONE REVOLUTION OF DRIVING WHEEL

STEAM TURBINE, CONVENTIONAL STEAM
AND DIESEL LOCOMOTIVES



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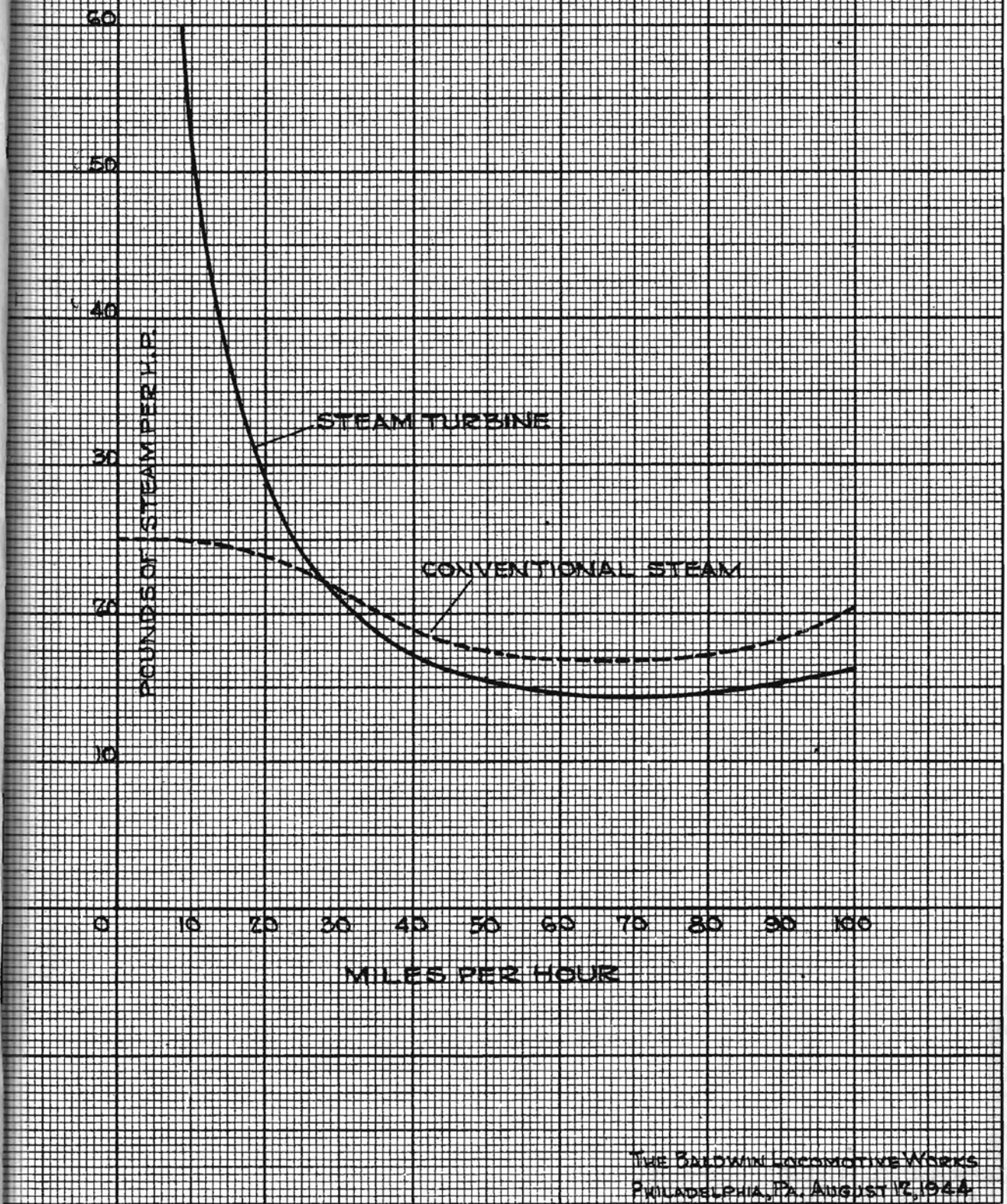
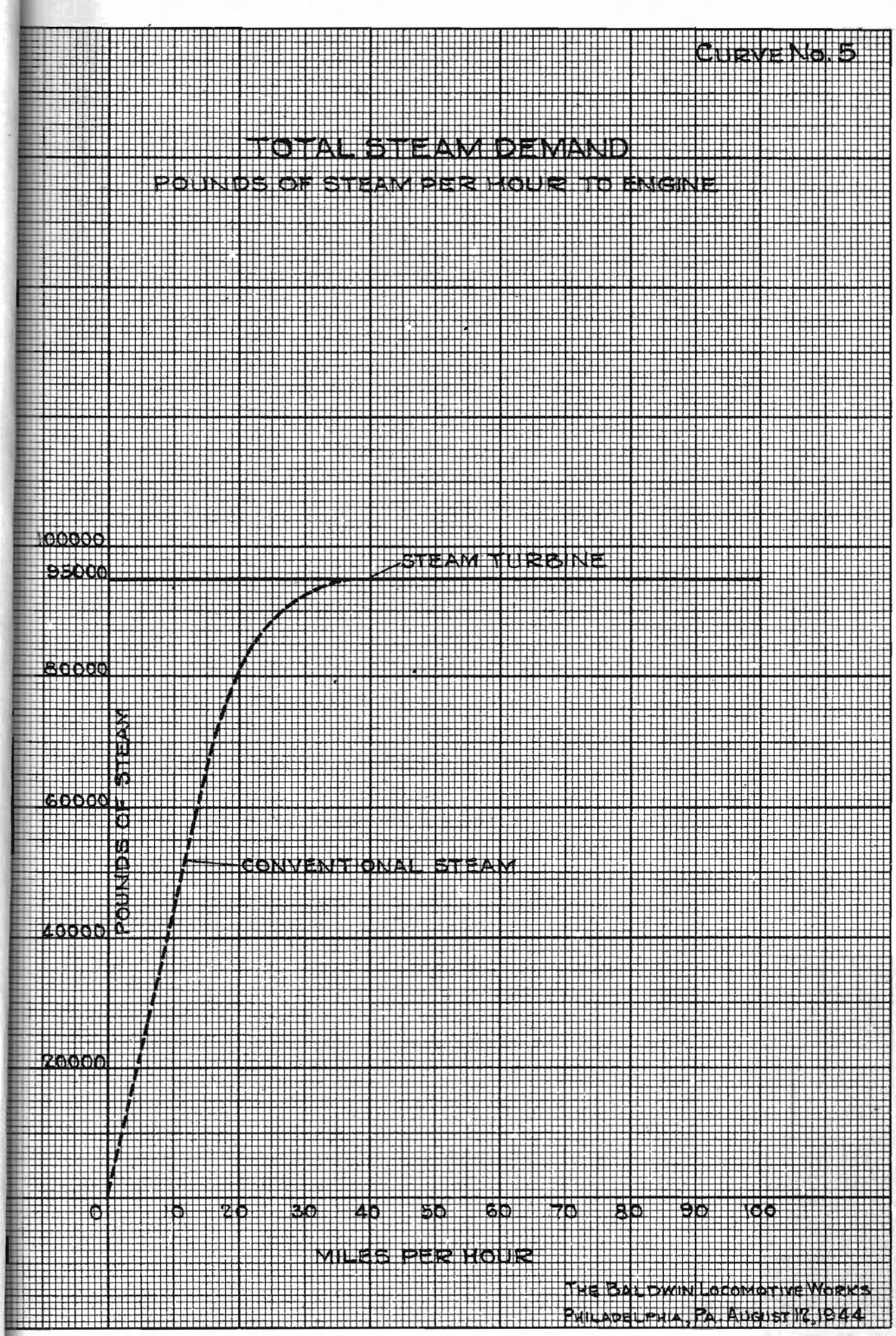
CURVE No. 4

STEAM RATE POUNDS PER H.P. AT RAIL

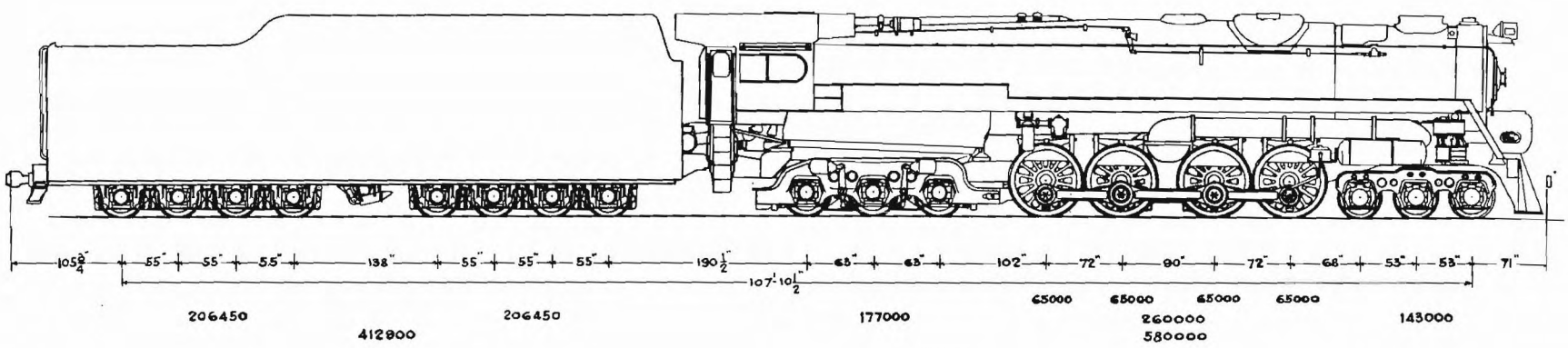
STEAM TURBINE AND CONVENTIONAL STEAM LOCOMOTIVES



THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA, PA. AUGUST 1, 1944


CURVE No. 5
TOTAL STEAM DEMAND
POUNDS OF STEAM PER HOUR TO ENGINE
100000
90000
80000
60000
40000
20000
0
POUNDS OF STEAM
STEAM TURBINE
CONVENTIONAL STEAM
0
10
20
30
40
50
60
70
80
90
100
MILES PER HOUR
THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA, PA. AUGUST 12, 1944

BALDWIN - WESTINGHOUSE STEAM TURBINE LOCOMOTIVE

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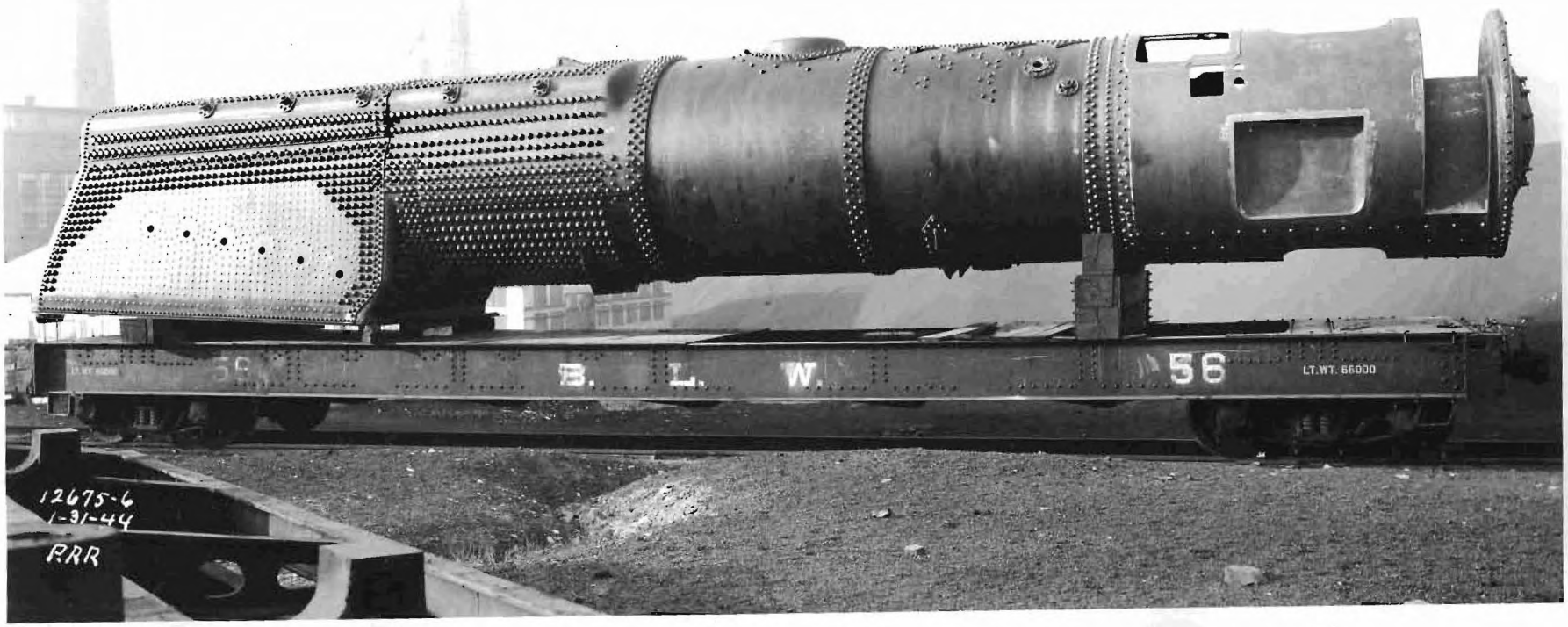
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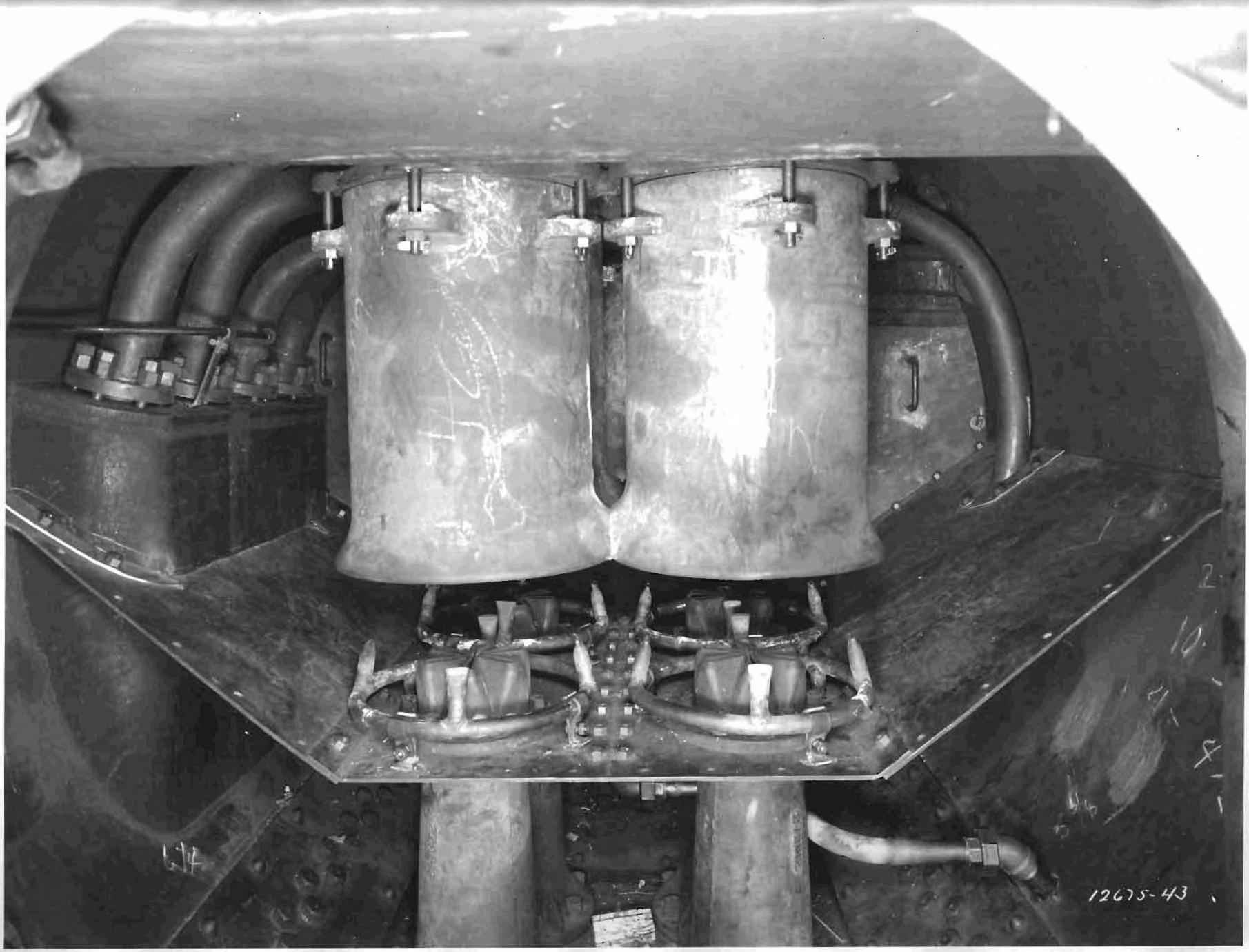
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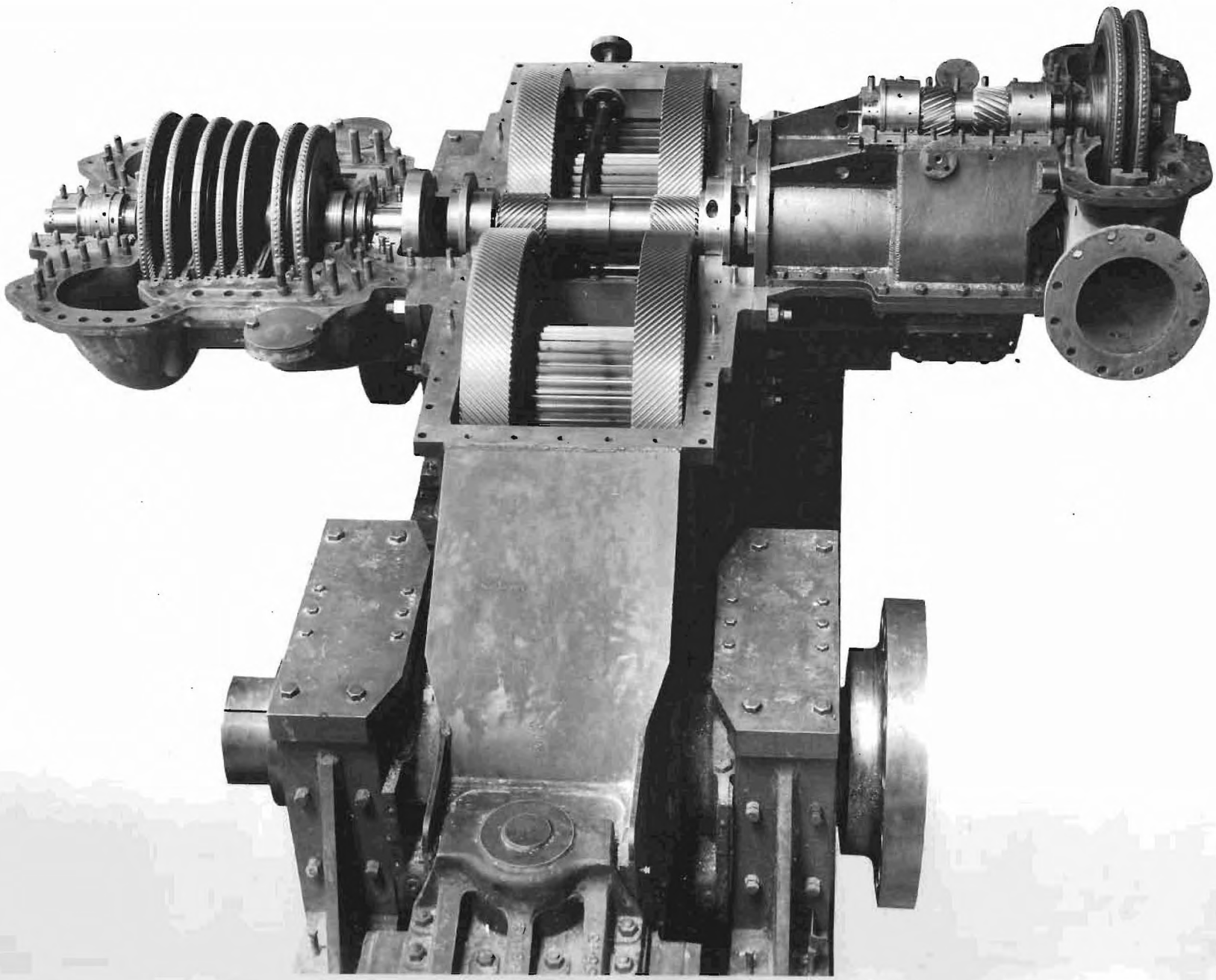

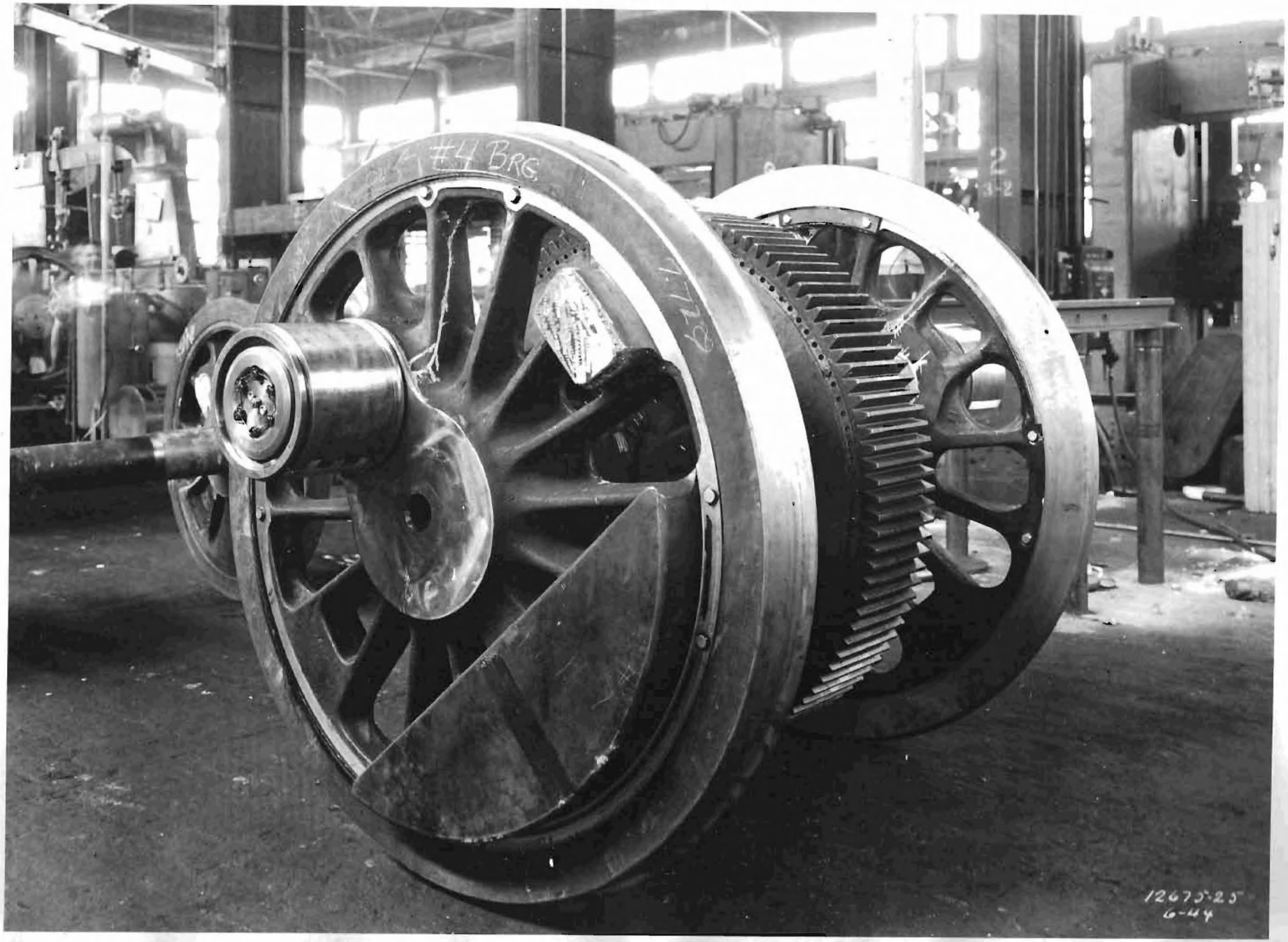
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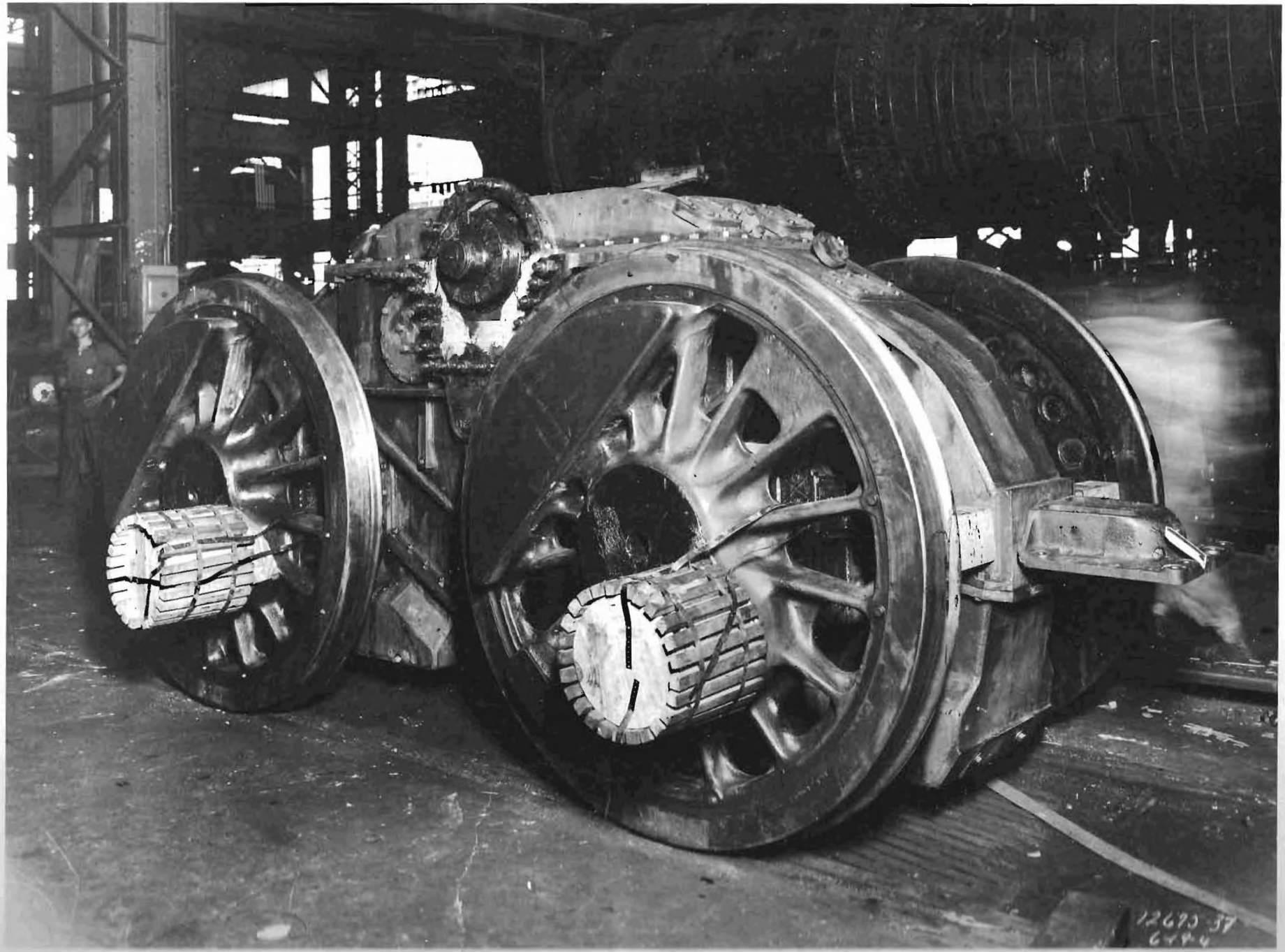
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