CANADIAN PACIFIC RAILWAY

SELKIRK

2-10-4

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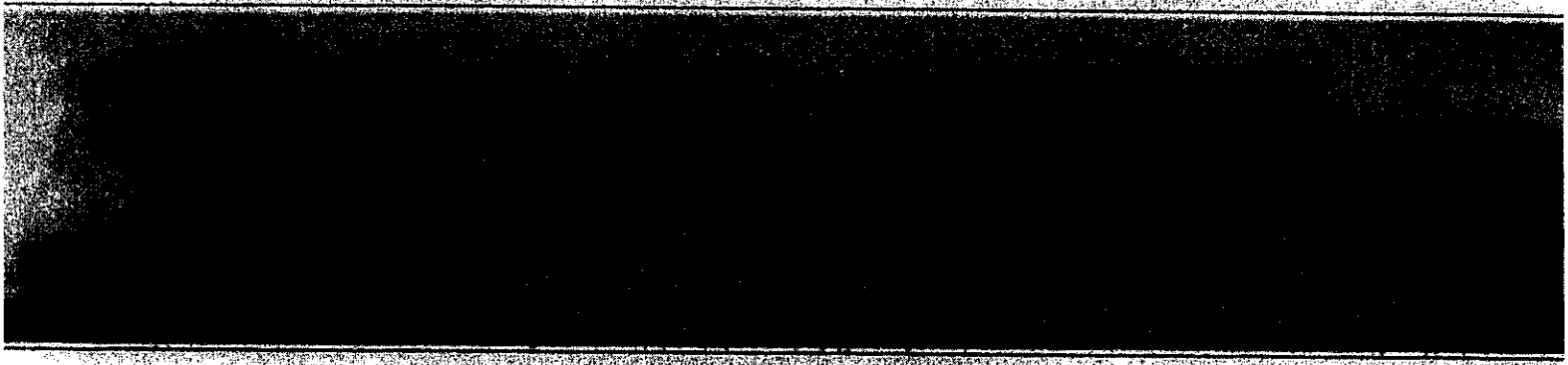

Oil Burning Locomotive, Canadian Pacific Railway.

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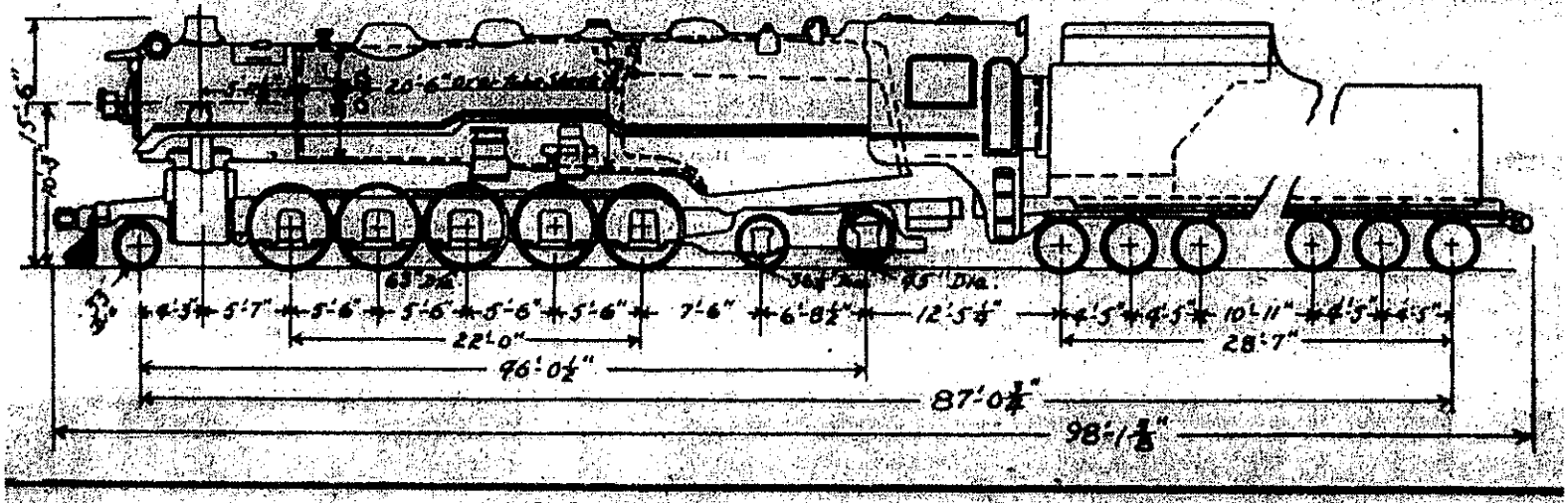

Oil Burning Locomotive, Canadian Pacific Railway.

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drivers and also on the pins of both intermediate pairs of drivers.

superheated steam for auxiliaries. T

Canadian Railway and Marine World

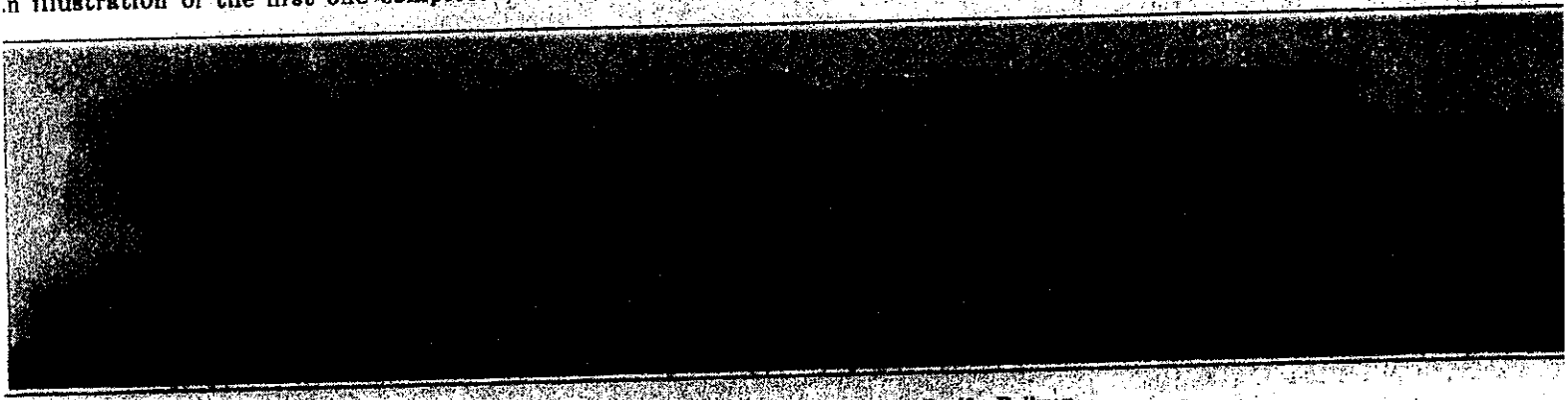
November, 1929

Oil Burning Locomotives, 2-10-4 Type, Canadian Pacific Railway.

The ordering by Canadian Pacific Ry. rom Montreal Locomotive Works of 20 il burning locomotives, with a 2-wheel eading truck, 5 pairs of drivers, and a 4- wheel trailing truck, for service on the British Columbia District, was mentioned n Canadian Railway and Marine World or February, pg. 85, and some preliminary letails were given in subsequent issues, n illustration of the first one completed, in the elastic limit. One of the indications of these inherent characteristics is the surprising impact value of nickel steel compared with that of carbon steel or other alloy steels.

As a result of experiments made during the past few years with various grades of alloy steels, the crank pins and main and side rods of these locomotives are constructed of low carbon nickel steel, which

The boiler pressure is the same as of the 8100 class locomotives, viz., 27 which is 25 lb. higher than used i C.P.R.'s G8d Pacific type passenger motives. This high boiler pressur only secures greater economy, but c livelier and faster locomotive perform and enables cylinder and piston dia to be kept down well in relation t large tractive effort developed.



Oil Burning Locomotive, Canadian Pacific Railway.

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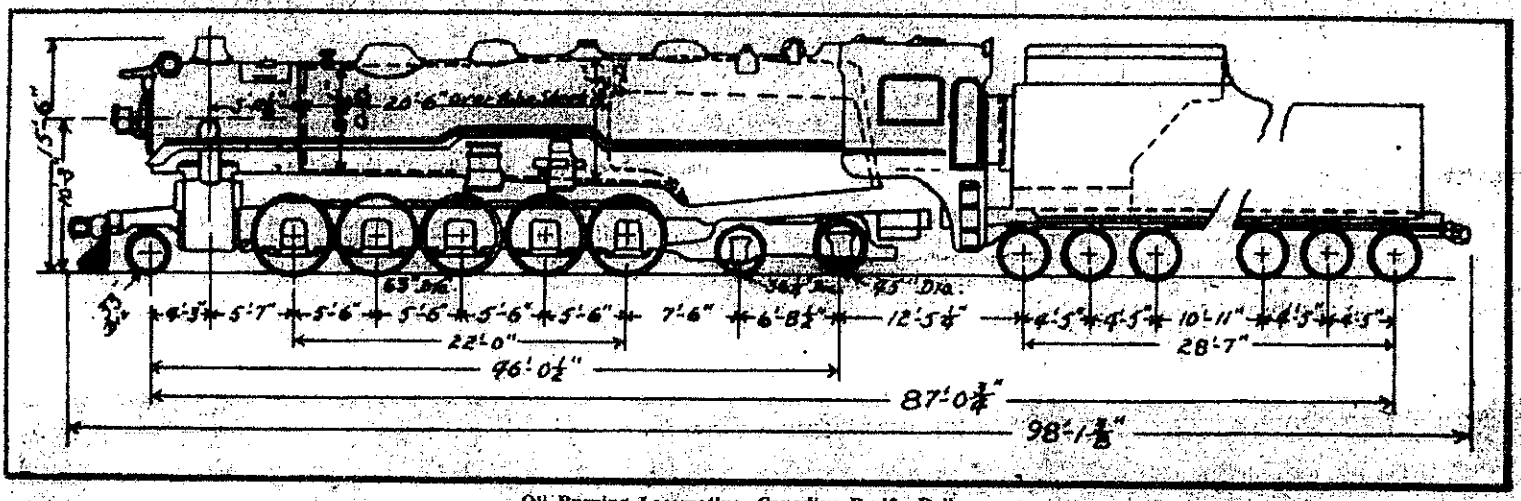
The same superheater and throttle installation is made on these locomotives as on the 3100 class, viz., a type E superheater and smoke box throttle combined with the superheater header, the advantages of this arrangement being a quicker response from the locomotive following throttle opening, the ability to carry out throttle repairs by merely closing a shut-off valve in the dome, thus saving the necessity of blowing down the boiler, and the opportunity presented to employ



Oil Burning Locomotive, Canadian Pacific Railway.

last year, and described and illustrated in Canadian Railway and Marine World for Oct. 1937, pg. 478. Two of the oil burning locomotives have been equipped with a booster; the others may be easily equipped with boosters if desired in future.

As in the 3100 class locomotives referred to, the boilers for the 5900 class locomotives are of nickel steel, not only the shells, but the boiler material throughout, including the staybolts. The presence of the nickel in the steel used has its greatest value in forming one of the very few alloys which permits a reduction in carbon content, with an approach to the toughness and ductility of iron, and with an increase in tensile strength, and particularly

drivers and also on the pins of both intermediate pairs of drivers.

Like the 3100 class locomotives, these 2-10-4 locomotives have the Commonwealth one-piece locomotive bed, made by General Steel Castings Corporation, Commonwealth Division. This large steel casting, extending all the way from the deck support members at the rear, forward to the bumper beam, replaces the two conventional main frames with cross ties and braces, and, in addition to creating maximum rigidity, effects a material saving in weight. In addition, the cylinders and valve chests are integral with the locomotive bed, replacing the usual bolted pair of saddle castings.

superheated steam for auxiliaries. The throttle is of the multiple type.

The first 15 of the locomotives built were equipped with Detroit hydrostatic lubricators, the others having Nathan mechanical lubricators. Air compression is by a Westinghouse 8½ in. cross-compound compressor, mounted on the left side of the locomotive alongside the feedwater heater pump, the running board being elevated a few inches to clear. A Hancock type LNL non-lifting injector is applied on the right side.

The leading truck is of the Commonwealth type, with 33 in. diam. wheels, and is fitted with outside bearings. The trailing truck, a Commonwealth cast steel 4-

wheel type, is also fitted with outside bearings. The leading wheels of the trailing truck are 36¼ in. diam., and its rear wheels, through which the booster drives, are 45 in. diam. The journals of the rear axle of the truck are 1 in. larger in diameter than those of the leading axle.

The reverse gear applied to the locomotives is of the C.P.R. standard screw type, the same as on the 3100 class locomotives. The cab is of the short vestibule type, with the sides sloped in toward the top to provide maximum clearance in tunnels. Air and steam gauges are mounted on panels on the boiler back head. A valve in the cab controls a device applied to the top of the stack to deflect smoke back over the top of the locomotive when it is going through tunnels. The accompanying illustration does not show the smoke deflector in operative position; on turning the valve in the cab, an air-operated piston working in a cylinder near the stack rotates the deflector forward, leaving the only exit for the smoke through the opening in the deflector at the back of the stack. Two sand boxes are placed on the top of the boiler, and are equipped with Never-clog sanders with Hanlon operating valve. Bell, whistle and electric generator are placed well back toward the cab. The boiler is fed through top check valves. The headlight is at the smoke box center, and above it is a triangular number plate case. The driving boxes are of standard type, but Grisco boxes are applied at main and intermediate wheels. Driving box wedges are of the C.P.R. standard cast iron type. The fire door, firebox arrangement, etc., are the C.P.R. standard for oil burning locomotives. The arch tubes are of nickel steel.

The main drivers are the middle pair of the five, the journals are 12½ in. in diameter, as are also the front intermediate and back intermediate driving journals, the front and back driving journals being 1 in. less in diameter. Driving wheel centers are of cast steel. The total driving wheelbase is 22 ft., driving journal centers being uniformly spaced at 5½ ft.

The valve gear is of the Walschaert type, the valves being set to provide 1 1/8 in. lap, 3/16 in. lead, and 1/8 in. exhaust clearance. Franklin special wedge type E radial buffer is applied, and Barco flexible connections are provided between locomotive and tender for air, steam and oil. The steam heat reducing valve is the Leslie

Oil Burning Locomotive, Canadian Pacific Railway.

500 lb. and the water capacity of the Diameter of driving wheels 80 in.

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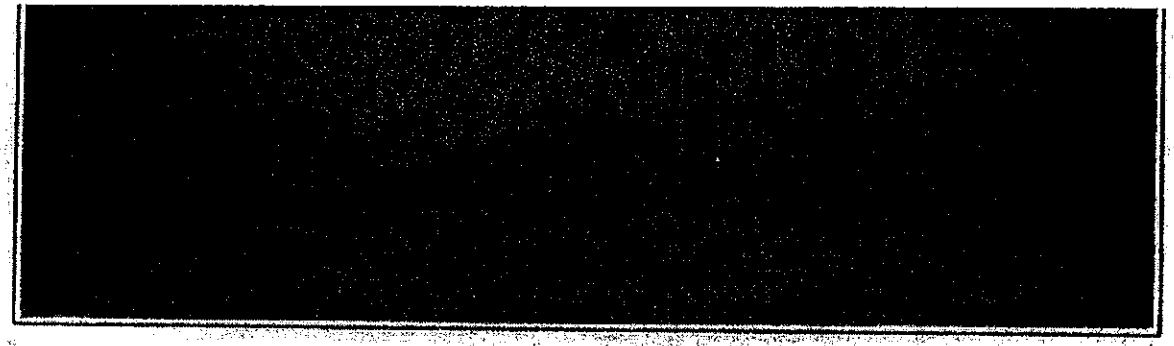
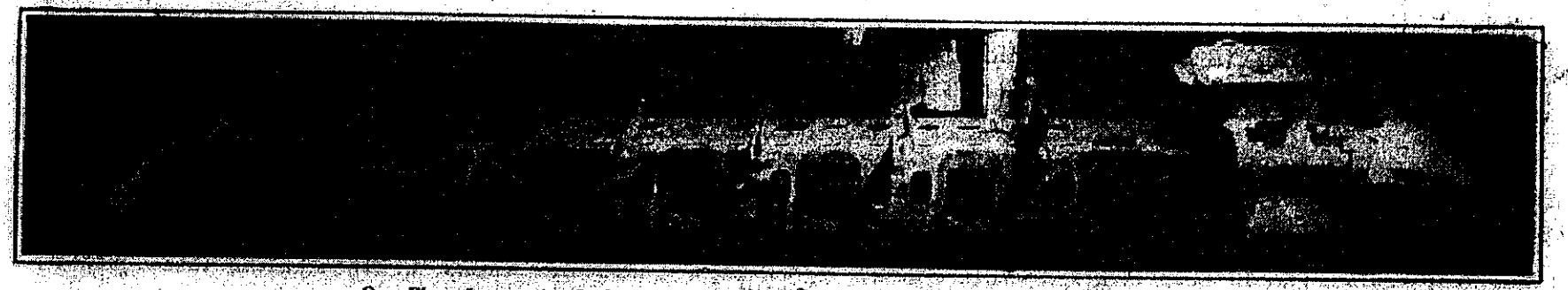


Oil Burning Locomotive, Canadian Pacific Railway.

500 lb., and the water capacity of the rectangular tank is 12,000 imp. gall. Oil capacity is 4,350 imp. or 5,220 U.S.A. gall. The tender is carried on Commonwealth 6-wheel trucks, the wheels, 36¼ in. diam., being steel tired and having rolled steel centers, and journals are 6 x 11 in. The

Diameter of driving wheels	63 in.
" leading truck wheels	33 in.
" trailing truck wheels	t.-36¼ in.; r.-45 in.
Diam. and length of driving journals:—	
Main and front and rear intermediate	12½ x 14 in.
Front and rear	11½ x 14 in.
Diam. and length leading truck journals	6 x 11 in.
" " " trailing truck journals	7 x 14 and 8 x 14 in



One Piece Locomotive Bed, Oil Burning Locomotives, Canadian Pacific Railway.

Pyle National. Safety valves are McAvity World Consolidated type, and King metallic piston rod and valve rod packing is applied.

Just as the locomotive has a Commonwealth locomotive bed replacing the usual frame assembly, so the tender has a Commonwealth water bottom casting replacing the usual built up tender frame. The weight of tender in working order is 297,-

locomotives' chief dimensions, etc., are as follows:—

Limiting height	15 ft. 7 in.
" width	10 ft. 8 in.
Service	Freight and passenger
Weight in working order on drivers	312,800 lb.
" " " " leading truck	87,000 lb.
" " " " trailing truck	102,700 lb.
" " " loco.	452,500 lb.
" " " loco. and tender	750,000 lb.
Wheelbase, driving	22 ft.
" loco.	46 ft. 0½ in.
" loco. and tender	87 ft. 0¼ in'

Boiler, type	Conical
" outside diam	96½ in. max., 84¼ in. min.
" working pressure	275 lb.
Tubes, no. and diam	7-3½ in. and 50-2¼ in.
Flues, no. and diam	186-2¼ in.
Distance between tube sheets	20 ft. 4 7/8 in.
Heating surface, firebox	377 sq. ft.
" " arch tubes	45 sq. ft.
" " tubes and flues	4,509 sq. ft.
" " total	4,931 sq. ft.
Superheating surface	2,112 sq. ft.
Fire box length and width	140 5/16 x 96 in.
Grate area	93.5 sq. ft.

Valves, type	Piston
" travel	7 in. min.
" diam.	14 in.
" lap and lead	1 1/8 in. and 3/16 in.
" exhaust clearance	1/8 in.
Cylinders, diam. and stroke	28½ x 32 in.
Tractive effort, loco	77,200 lb.
" " loco. and booster	89,200 lb.
Factor of adhesion, loco	4.05

The 20 locomotives were designed by C.P.R. mechanical officials. An idea of their size and efficiency as prime movers may be derived from the accompanying illustration of one of them and from the foregoing figures; a further idea of their magnitude is given by the fact that the boiler of one of them contains over two miles of piping. Each locomotive and tender weighs 80 times as much as Stephenson's historic Rocket. With its power output of 4,800 h.p., each locomotive will develop about 85 times as much power as the Rocket, and at a capital cost of about 45 times as much.

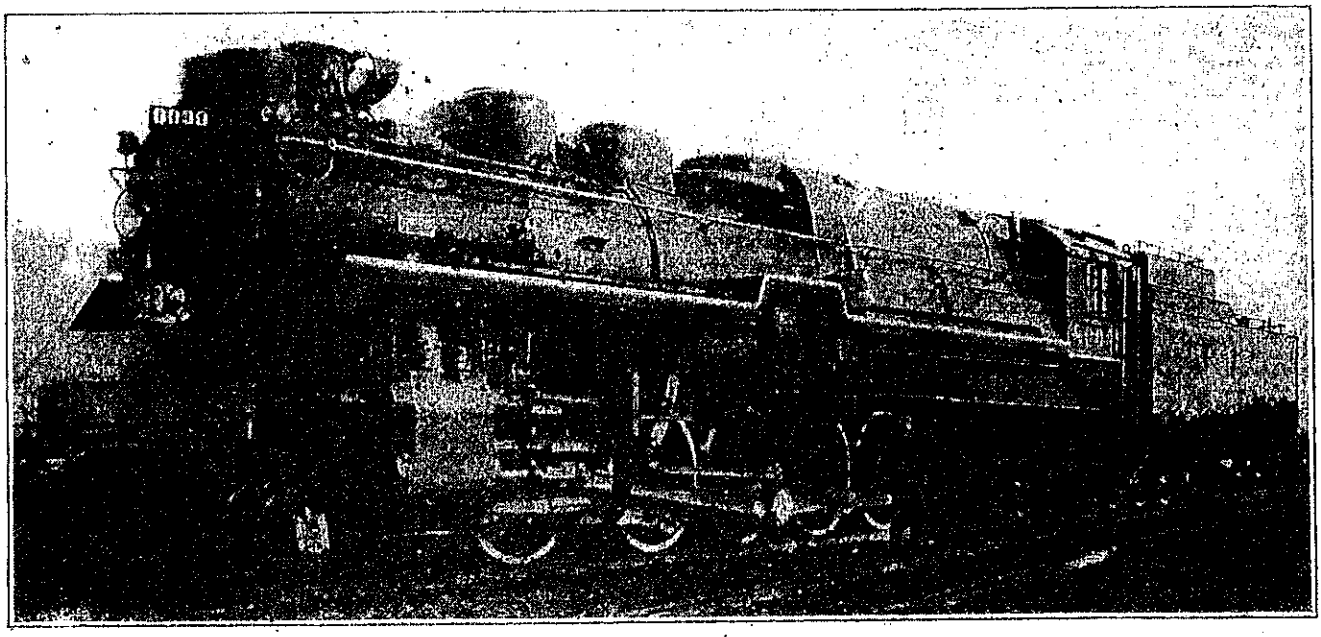
CANADIAN PACIFIC RAILWAY MULTI-PRESSURE 2-10-4 No. 8000

Multi-pressure, Oil-burning, Three-cylinder Locomotive, Canadian Pacific Railway.

The Canadian Pacific Ry.'s intention to build a locomotive to operate with steam pressures greatly exceeding any utilized heretofore in Canadian railway service was first dealt with in Canadian Railway and Marine World for June, 1929, pg. 364, where it was pointed out that such a locomotive would be the first in Canada to make use of the indirect method of steam generation, and that, in turning to the high boiler pressures proposed to be employed, the Canadian Pacific was blazing the trail so far as the North American continent is concerned. We had published, previously, descriptions of the Delaware and Hudson Co.'s first two high pressure locomotives, viz., the Horatio Allen, described in our May, 1925, issue, pg. 232, and the John B. Jervis, described in our June, 1927, issue, pg. 334A. Our April issue of this year contained, on pg. 191, an illustrated description of the D. and H. third high pressure locomotive, the James Archbald. The Canadian Pacific new locomotive is, however, equipped with a boiler operating on principles differing same type as the 8000, as regards the system of steam generation employed, in Europe, which are showing excellent savings in fuel ranging from 25 to 35%, in comparison with the conventional design of steam locomotives, but the largest of the European locomotives is only 42% of the weight, and develops only 36% of the power, of the 8000. In this connection, it was stated in the article in our Aug., 1929, issue, that the many and great dissimilarities between European and Canadian conditions, particularly as regards the weight and tractive effort of locomotives, would mean that the C.P.R. mechanical officials and their associates would probably have to provide for many conditions which were not vital factors in similar locomotives then constructed and experimented with.

The 8000 is the first locomotive of its type on this continent, and is attracting much interest in railway and other mechanical circles, on account of the radical departure in boiler design and the high steam pressures utilized with the object of securing economy in

The 8000 has a 2-10-4 wheel arrangement, the same as the C.P.R.'s 5900 series locomotives, hitherto the largest and most powerful steam locomotives in the British Empire, which, built two years ago, are in Rocky Mountains service, and were described and illustrated in Canadian Railway and Marine World for Nov., 1929, pg. 667. The weight of the 8000 type locomotive is 485,000 lb. and the tender weighs 300,000 lb., a total of 785,000 lb., or 392½ tons; the overall length of the two is 99 ft. 3⅝ in., an increase in weight of 44,800 lb. and an added length of 1 ft. 2 in. over the 5900 series locomotives. The 10 driving wheels are each 63 in. diam. The two low pressure cylinders, located outside the frames, and using superheated steam at 250 lb. pressure per sq. in., are 24 in. diam. by 30 in. stroke. The high pressure cylinder, situated between the frames, and using superheated steam at 850 lb. pressure per sq. in., is 15½ in. diam. by 28 in. stroke, and transmits its power through a piston and a connecting rod to a crank axle at the second pair of driving wheels. The



Multi-pressure, 3-cylinder, Oil-burning Locomotive, Canadian Pacific Railway.

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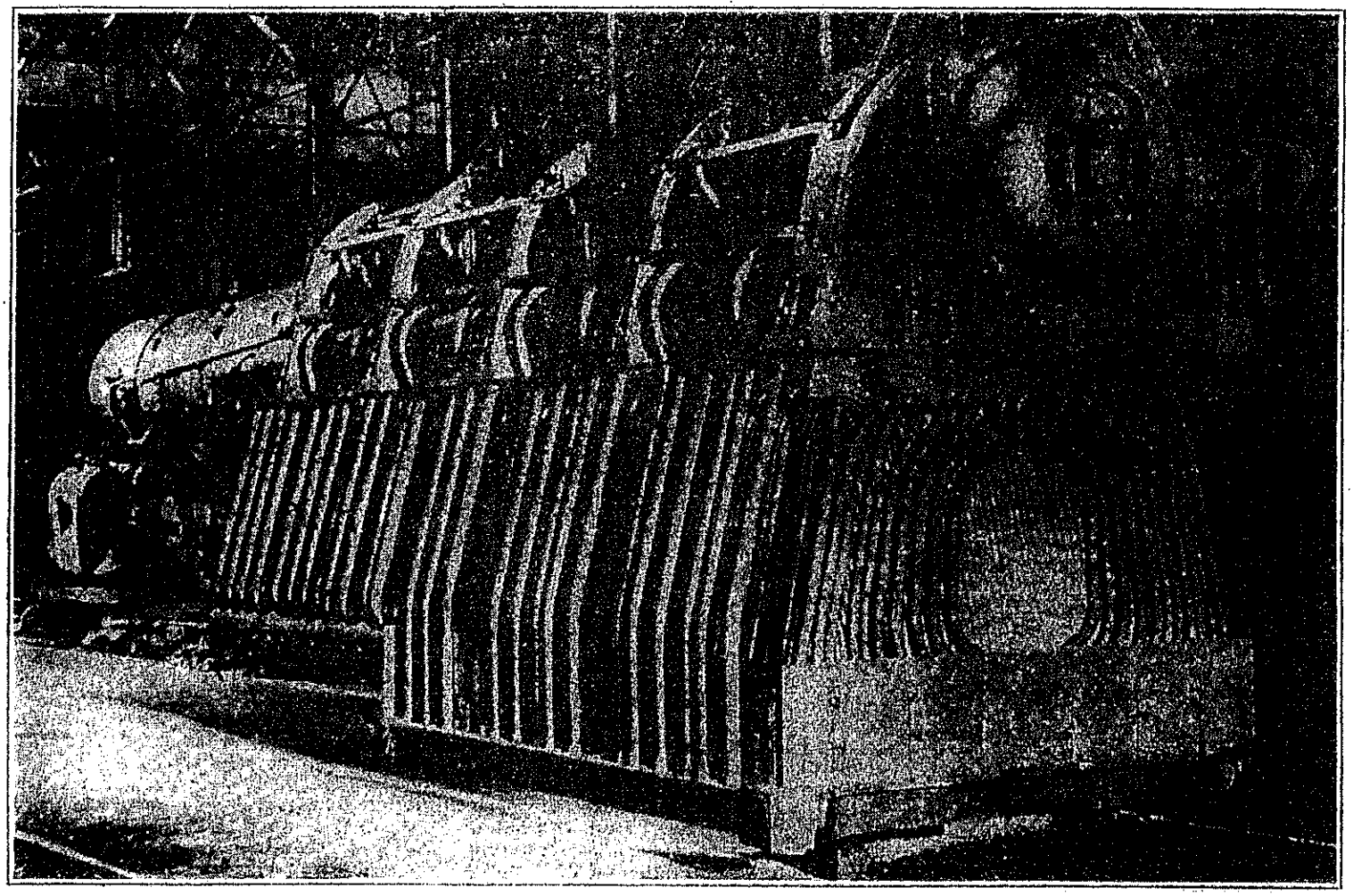
The locomotive, which has been mbered 8000 and which was built the C.P.R. Angus shops, Montreal, s been completed, and was made availle for inspection by the public on Ap- 24, when it was placed on a track in indsor Street station, Montreal.

There are three locomotives of the its type on this continent, and is attracting much interest in railway and other mechanical circles, on account of the radical departure in boiler design and the high steam pressures utilized with the object of securing economy in fuel consumption without addition to the cost of boiler maintenance. It represents a new era in the advancement of steam motive power of greater efficiency and higher sustained capacity. The rapid adoption of higher steam pressures, not only for locomotives, but for ships and stationary power plants, has been world-wide. As steam pressures have increased, the conventional type of locomotive boiler, which in its essential features is the same as originated by George Stephenson, a century ago, becomes less well-suited because of the fact that the firebox and combustion chamber contain flat surfaces which are supported by staybolts. In the most recent addition to the Canadian Pacific's locomotives, these flat surfaces have been replaced by a tubular form of firebox and combustion chamber, thereby securing a greater insurance against operating troubles.

high pressure cylinder, situated betw the frames, and using superheated ste at 850 lb. pressure per sq. in., 15½ in. diam. by 28 in. stroke, and tra mits its power through a piston an connecting rod to a crank axle at second pair of driving wheels. tractive effort of the locomotive is 000 lb., an increase of about 17,000 over the 5900 series. This means t on a level track the locomotive will able to haul a freight train made of 150 forty-ton freight cars, a t weight of 6,000 tons, or a train ove mile long. The tender has capacity 12,000 gall. water and 4,350 gall. f oil, which will enable the locomotive make long hauls without replenishin

The principal feature of this locor tive is the steam generating syst composed of three units, as follows (1) The low pressure boiler, of conventional fire-tube type, loca ahead of the firebox, carrying a pr sure of 250 lb. per sq. in. It is constr ted of nickel steel plates. It conta 214 3½ in. diam. flues, in which superheater pipes are located. (2) T

MAY 1931



Firebox unit and high pressure drum of boiler, Multi-pressure Locomotive, Canadian Pacific Railway. Low pressure portion of boiler is shown in left background.

MAY 1931

high pressure boiler, which is a seamless forged nickel steel drum 41½ in. diam., 1¼ in. thick, made from a single ingot of steel weighing 32½ tons and in its finished condition weighing 8 tons. This drum is 25 ft. 2 in. long and is located centrally above the entire length of the firebox. It is designed for a working pressure of 850 lb. per sq. in. (3) The firebox unit, made up of six small diam. forged nickel steel drums, a hollow forged nickel steel firebox ring and 254 seamless steel tubes of various shapes and sizes, is designed for 1700 lb. pressure per sq. in. The average working pressure will, however, be around 1350 lb. This unit is really a closed circuit containing approximately 300 gall. of distilled water. The use of distilled water is to prevent accumulation of sludge and scale, so common in water tube boilers. The closed circuit, or firebox unit, extends into the high pressure boiler drum in the form of 16 coils, called heat transfer coils.

The foregoing boiler features of the 8000 form the basis for the designation multi-pressure locomotive, because steam is generated in three separated portions and at three different pressures. The water in this system, heated by the furnace gases, is converted into steam which passes through coils located inside the high pressure drum. The heat from this steam passes through the walls of these tubular coils and is absorbed by the water in the high pressure drum. The condensate flows downward to the bottom of the firebox and is again re-circulated through the tubes without loss. The water in the high pressure drum is heated, as has been described, and is converted into steam

H. B. Bowen,
Chief of Motive Power and Rolling Stock, Canadian Pacific Railway.

at 850 lb. pressure. From the high pressure drum this steam passes through a type E superheater, an M
tle and to the high pressure
The low pressure boiler, which
the barrel portion of the conve
comotive boiler, generates stea
lb. pressure per sq. in. Th
flows through a second type
heater, an MV throttle, and int
pipes which join the exhaus
pipes from the high pressure
The steam exhausted from
pressure cylinder joins with t
from the low pressure boiler
to two low pressure cylinder
in normal position outside the

The locomotive is equipped v
water heater to heat the wa
the tender before it enters
pressure boiler. The low pres
er acts as a feedwater heater
fier for the high pressure boil
by keeping the heat transfer co
high pressure boiler clean, so
high heating efficiency will n
duced, which, experience show
result if raw water were used

A large amount of seaml
tube is used in the constructi
boiler units alone. In the fir
there are 2,961 ft. of tube, rang
2 in. outside diameter to 3 in.
the heat transfer coils requi
ft. of 1¼ in. o.d. tube. The 3
flues in the low pressure boile
090 ft., and there are 8,735 ft.
in. o.d. and 1 5/8 inch o.d. tu
superheater units. The aggreg
th of all tubes is 18,695 ft., o
over 3½ miles.

The control of the locomoti
a single throttle lever in the c

MAY 1931

actuates the two throttles as one. The control of the cutoff is by a single wheel in the cab, which governs the steam distribution to the three steam chest valves. The locomotive is fitted with the usual steam gauges and water level indicator, as well as the additional instruments required with the new type of steam generating which is used.

H. B. Bowen, Chief of Motive Power and Rolling Stock, Canadian Pacific Railway, designed locomotive 8000, after he had made a trip to Europe in 1929 to study various types and evelopments of locomotives there, and the American Locomotive Co. and the Superheater Co. co-operated in the work of design and construction. The construction of the locomotive was under the supervision of J. Burns, Works Manager, Angus Shops, Montreal, and T. Donald, of the C.P.R. mechanical staff.

The 8000 was on exhibit at Windsor Street station, Montreal, for about a week, and was later subjected to a series of extensive tests on C.P. Eastern Lines, prior to being placed in heavy freight and passenger service in the company's Rocky Mountains territory.

MAY 1931

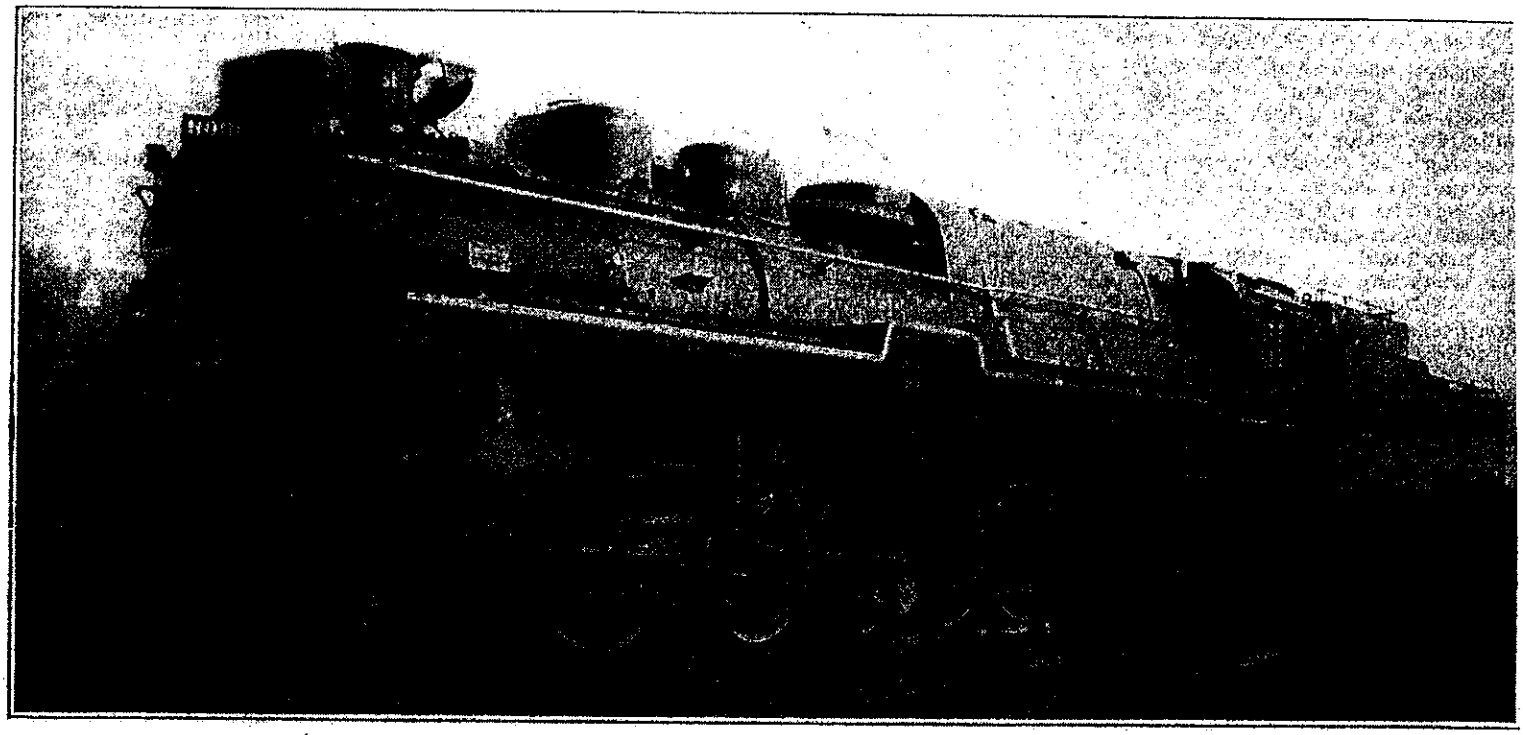
Canadian Railway and Marine World

October, 1932

Operation and Maintenance, Multi-Pressure Locomotive 8000, Canadian Pacific Railway.

By R. B. Bowen, Chief of Motive Power and Rolling Stock, Canadian Pacific Railway.

Increasing steam pressures and temperatures have to a great extent been the measure of the progress made in the development of greater power at reduced cost. While locomotive development has made marked advances, it has nevertheless lagged behind stationary practice in utilizing the manifest advantages of higher pressures. Conventional locomotive design, with a large diameter fire-tube boiler construction, definitely restricts the maximum pressure that can be used, and the Canadian apparatus. Subsequently, further conferences with the American Locomotive Co. and the Superheater Co. resulted in the decision by the railway to construct a heavy freight locomotive suitable for service on its severe mountain divisions, and its 2-10-4 type locomotive no. 8000, is the result. This locomotive is termed the T-4-A class, and is, so far as its running gear is concerned, a close duplicate of the T-1 class locomotives which are now the standard locomotive for the service referred to. While the T-4-A tractive force. This loss, however, reduced as the pressure rises, givir greater proportionate tractive force Higher pressure means smaller cylinder removing some of the restrictions du to large cylinders as determined by cu tomary boiler pressures. The highe density also provides for the use c smaller pipes for feeding both cylinde and auxiliaries, which is a most gratefu relief to those who have struggled i trying to fit in the maze of complicate piping required by even the compara



Multi-pressure Locomotive 8000, Canadian Pacific Railway.

Pacific Ry. has gone nearly as far as practical in the increasing of steam pressures with the conventional form of locomotive boiler construction.

All obtainable information concerning new types of locomotives has been studied, and such designs as had been transformed into reality have been investigated thoroughly. In 1929 the writer, during a trip to Europe, investigated carefully all of the available examples of new and improved types of locomotives. Conferences with the Superheater Co., Ltd., and its associate organizations, both in the United States and abroad, resulted in further investigations being made of locomotives in England and on the Continent, which utilized the multi-pressure system of steam generation.

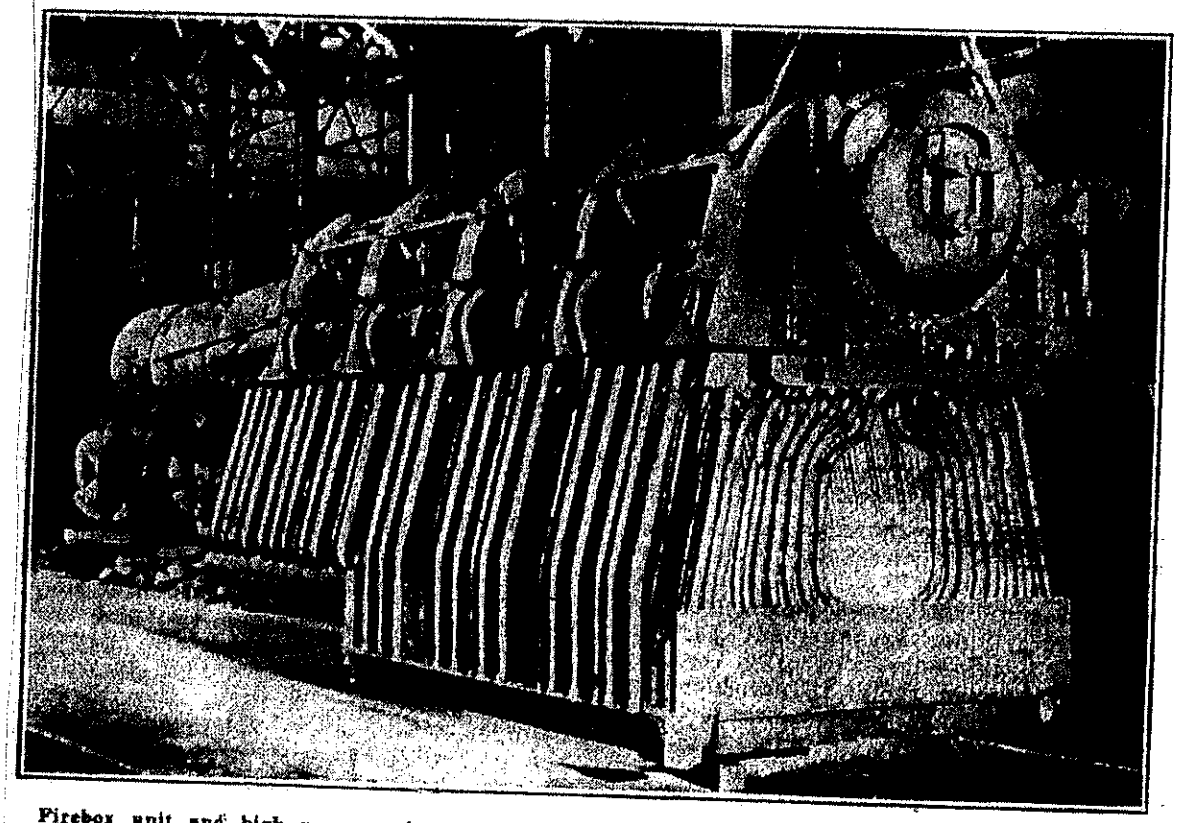
Conferences with officers of the German State Railways, the London, Midland & Scottish Ry. in England, and the Paris, Lyons & Mediterranean Lines in France, had served to focus attention upon this type of steam-generating class is slightly heavier as to total weights, it is, nevertheless, very closely the same as the T-1 class so far as weight on the drivers is concerned.

The 3-cylinder arrangement has permitted satisfactory operation with a somewhat lower factor of adhesion and, consequently, has a somewhat larger tractive force. High pressures and temperatures are not only attractive from the standpoint of improved thermodynamic performance, but, in themselves, bring about desirable changes in construction and performance. For example, higher pressures necessitate multi-cylinder construction to fully utilize the steam expansively. This immediately gives a more uniform torque, and permits lowering the adhesion factor between the driving wheels and the rails, which in turn provides for the better utilization of weight. Higher pressures give a better steam flow and reduce proportionate pressure drops. It is customary to allow a 15% drop in boiler pressure in figuring the maximum tively simpler conventional type of locomotive.

Multi-pressure locomotive 8000 is the joint production of the Superheater Co., the American Locomotive Co. and the Canadian Pacific Ry., which are, respectively, responsible for the high-pressure steam generating system, the three-cylinder arrangement, valve motion and the general locomotive proportions, and the design and construction, which was done at the C.P.R. Angus shops, Montreal. It was turned out for operation in July, 1931, and during the ensuing few months was used in freight service between Montreal and Smiths Falls, Ont., to determine its operating characteristics, and, particularly to develop the arrangement of oil burners which it was anticipated would have to be somewhat different from the standard burner arrangement used on C.P.R. western lines.

Construction was commenced in Nov., 1930. The machinery, together with the low-pressure boiler and firebox framework, was erected in a complete unit,

high-pressure boiler. Full pressure of



Firebox unit and high pressure drum of boiler, Multi-pressure Locomotive 8000, Canadian Pacific Railway. Low pressure portion of boiler shown in left background.

850 lb. per sq. in. was reached on final test.

Various features show excellent examples of how metallurgical developments have permitted constructions that would not have been possible with the materials of construction available only a few years ago. Stainless steels for valves and valve seats have surmounted the limitations of bronze and the corrosion defects of ordinary steels. Stain-

kept in mind in all controls for locomotive 8000, and in spite of there being two superheaters and two throttles for the high- and low-pressure cylinders, the throttle mechanism was worked out so that only one throttle lever is used for opening both throttles.

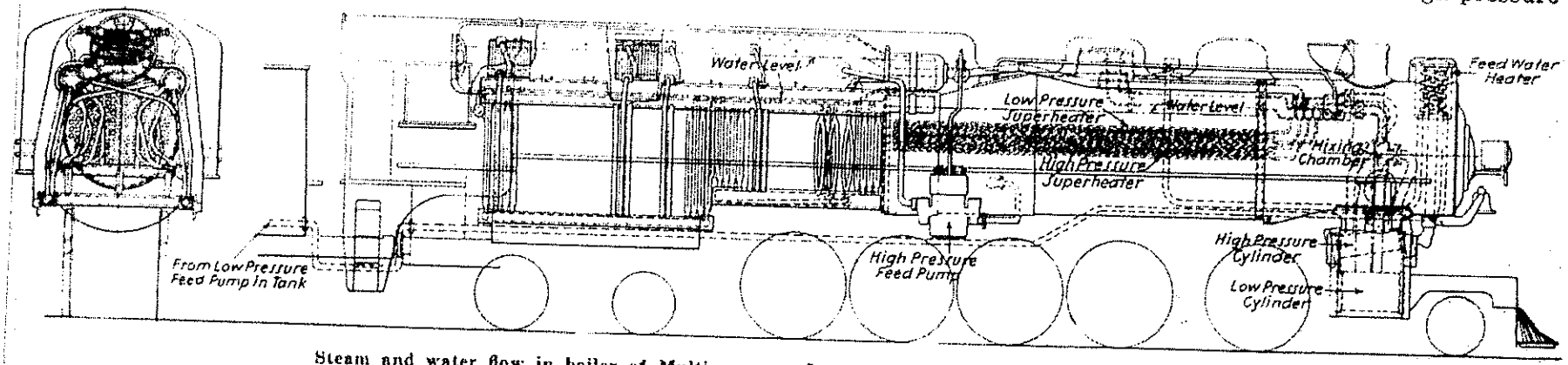
The operation is identical with that of an ordinary locomotive. The low-pressure boiler is fed with a standard Elesco CF-1 feed pump and is provided with a Hancock inspirator as an auxil-

there are other features that require periodic checks by the locomotiveman, but these have all been so simplified that it has not constituted any objection from the standpoint of simplicity of operation. In fact, after the initial period the locomotive was turned into the regular pool and is now handled by any locomotiveman who may be assigned to it on any individual run. There has been keen interest on the part of the locomotivemen and a desire to be assigned to locomotive 8000.

The most difficult operating problem on the Canadian Pacific is the movement of both freight and passenger traffic over the Mountain Sub-division in British Columbia. Numerous heavy grades are encountered, the worst of which is 22.5 continuous miles of almost uniform 2.2% grade. In 1929, 20 new locomotives were put in service on this sub-division, of the 2-10-4 wheel arrangement, using 275 lb. boiler pressure and two simple cylinders. These locomotives immediately introduced new standards of economy and performance, and by no means the easiest problem was selected when the Canadian Pacific decided to construct for direct comparison a multi-pressure locomotive of substantially the same weight, wheel arrangement and proportions as the T-1 class locomotives now handling traffic on this sub-division.

Locomotive 8000 burns oil as fuel and the proportions of the flash pan, size, number and location of oil burners constituted a real problem, as there was practically no precedent on which to base the design. When the locomotive was originally turned out, several experiments were made with location of a single burner and a double burner, and after a considerable amount of experimenting, proper locations for two burners were decided upon, one of which

while the closed system and high-pressure boiler were assembled on a jig especially constructed for this purpose in the boiler shop. Work on these separate units progressed simultaneously, and on April 10, 1931, the closed system and high-pressure unit being completed were subjected to a hydrostatic test, each being found tight under the required test pressure. On April 13 the closed circuit and high-pressure unit were released from the jig and transferred to the machinery and low-pressure boiler unit. With the addition of cab, fixtures, fittings and piping, the locomotive was ready for steam test. The steam test involving the closed circuit, high-pressure and low-pressure boilers, was carried out in two stages, i.e., it was thought desirable to work gradually to the maximum. Accordingly, the first test was discontinued when a pressure of 500 lb. per sq. in. was reached in the high-pressure boiler. Full pressure of



Steam and water flow in boiler of Multi-pressure Locomotive 8000, Canadian Pacific Railway.

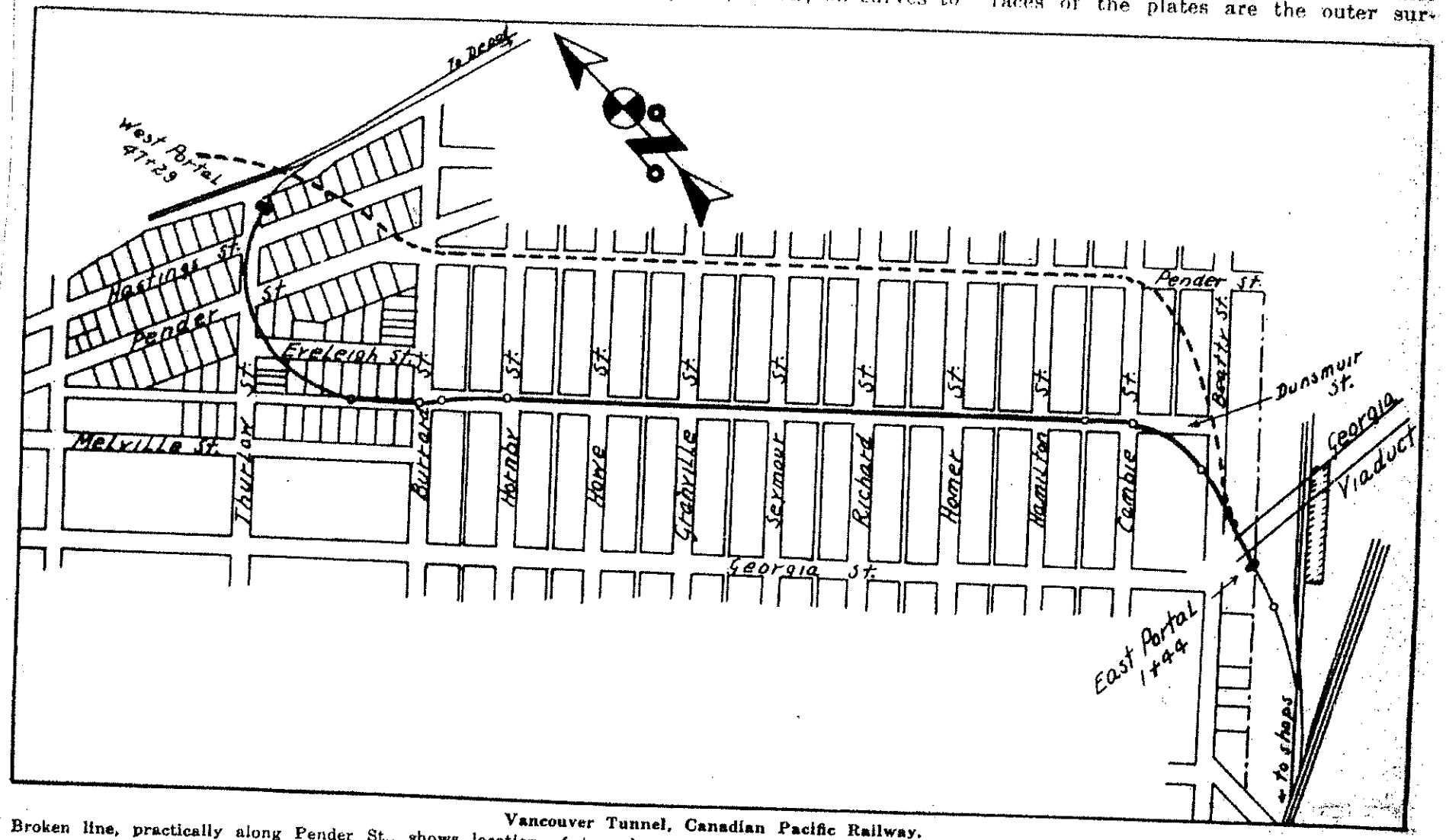
strength with approximately 30% reduction in weight. Nickel-steel forgings have provided toughness and resistance to abuse and impact with minimum weight in various driving and motion parts.

It is customary on the Canadian Pacific to operate locomotives by the pool system. Naturally, it is desirable to make the operation of all locomotives as simple and as uniform as possible. This was kept in mind in all controls for locomotive less-steel plates have provided a direct baffle for the oil flame, to prevent the flame coming in direct contact with the drums. These plates, while resistant to high temperatures, have given some trouble on account of expansion, which necessitated some changes in clearance. Low-carbon nickel steel for seamless drum construction has permitted high factors of safety with reduced weight. Nickel-steel boiler plate in the low-pressure boiler has also given the requisite

iary. Incidentally, the CF-1 pump for the low-pressure boiler is located within a compartment provided in the tender tank, a location that we had previously tried with considerable success and advantage. The high-pressure boiler is pumped with a specially designed CF-1 boiler feed pump adapted to high-pressure service. A duplicate of this pump is also provided as a standby and auxiliary in connection with feeding the high-pressure boiler. The high-pressure water pumps are located one on either side of the boiler.

The cut-off control in the valve motion is a straight duplicate of that of an ordinary locomotive. The oil-burner control is also identical, and the only deviation is the two varying water levels for the high- and low-pressure boilers, respectively, and the two boiler-feed pumps for feeding these two boilers. The cross-over valve is an addition, and there are other features that require periodic checks by the locomotiveman, but these have all been so simplified that it has not constituted any objection from

...from yard, near the end of Thurlow St., were:—on tangents, 16 ft.; on curves to ... faces of the plates are the outer sur-



Vancouver Tunnel, Canadian Pacific Railway.

Broken line, practically along Pender St., shows location of tunnel as projected originally; solid line, practically along Dunsmuir St., shows location as built.

engineers to give line and grade at the inner end of the drifts.

In order to limit as far as possible annoyance by the blasting, shooting was prohibited between 23 o'clock and 8 o'clock. The work was carried on in three shifts per day, from midnight Sunday to midnight Saturday. The drifts and heading were shot at 8, 12, 16 and 23 o'clock, and the bench at 8 and 16 o'clock. All dynamite used was 40% and fired by fuse. The amount of dynamite used per hole of drifts and heading was seven sticks. The shooting in the drifts and heading caused practically no vibration. The powder fumes were drawn out through a 24 in. wire wound wooden pipe, by a fan located at the portal. The pipe was hung on the wall about 10 ft. above grade. Ten minutes after shooting the workmen could return to the face. As soon as the fumes were gone the damper system in the pipe was reversed and

Vancouver Tunnel. Heading, with shovel moved away so that photograph could be taken. At the top on either side are shown the drifts which were carried ahead for the wall plates.

buildings along the route and for at least a block on each side. Notes and sketches were made of all defects in the buildings, so that if any claims were made for damages it could be determined whether they were new defects.

From the point at which rock was first encountered, to the front yard end, the tunnel is all in rock, either shale or sandstone. The depth from the street level to the outer surface of the concrete arch is from 20 to 60 ft. Through practically all the rock section the cover is about half rock and half earth. The same system of timbering as described for the earth section obtained throughout. The average rate of progress through the rock section was 16 ft. per day.

In advance of the concrete lining, inch boards were spiked to the inner faces of the wall posts, up to 2 ft. below the wall plates. The spaces between the posts and outside of them were filled with tunnel spoil. A concrete footing was also poured, 2½ ft. wide and to the level of subgrade. In the footings were inserted 16-in. lengths of 45 lb. railway rails at 3½ ft. centers and projecting 8 in. out of the concrete. They were put in to increase the bond and strength between the footings and the side walls when the latter were poured. Six inches of the footings projected inside the inner surface of the concrete walls. The side walls of the concrete lining form rested on the 6 in. projections when in position for pouring. The form was a wooden structure 52 ft. long and permitted a 50-ft. length of tunnel to be concreted when set in position. The form was collapsible, so that it could be withdrawn from the concrete and moved ahead. Each side wall could be extended or withdrawn 6 in. by a number of heavy bolts top and bottom working

Multi-Pressure Locomotive 8000, Canadian Pacific Railway.

W. A. Newman, Chief Mechanical Engineer, Canadian Pacific Ry., addressed Toronto Railway Club, Oct. 7, at a meeting at which the President, R. McKillop, Special Representative, Canadian Pacific Ry., presided, on the Canadian Pacific Ry. multi-pressure locomotive 8000, his address having been illustrated by moving pictures and animated diagrams. His description of the theory underlying steam generation and use in the locomotive, of the principles employed in applying the theory, and of the locomotive itself, and the motion pictures and animated diagrams, combined with his lucid explanations, gave his hearers a clear understanding of the locomotive's design and operation. His address was similar to that given to the Canadian Railway Club in Montreal, April 4, which was published in Canadian Railway and Marine World for June, pg. 293, with illustrations of the locomotive, the firebox unit, the high pressure drum and low pressure portion of the boiler, and of the arrangement of the firebox closed circuit, heat transfer coils and high pressure boiler.—Mr. Newman read a paper on the locomotive before the Engineering Institute of Canada's Montreal branch, Oct. 13, H. B. Bowen, Chief of Motive Power and Rolling Stock, C.P.R., who was to have read it, being unable to be present.

mply provides for ordinary demands, ne second one being cut in when re-uired by abnormal conditions.

It will be appreciated just how difficult nis problem was when it is understood nat three separate boilers—the closed ystem, the high-pressure boiler and the w-pressure boiler—are all supported y the one firebox and combination of rners, and that a balance in the heat stribution must be maintained between ose three heat-absorbing units through wide range in steam demands of the comotive. This has been partially off-t by introducing a by-pass valve from e high-pressure to the low-pressure iler, so that excess steam can be by-ssed without losing it through the fety valves. Even as yet this by-pass rangement is used to some extent, but, course, the ideal solution to be accom-ished is the final adjustment and bal-ce of component features of operation as to obviate entirely the necessity any by-passing. This can, of course, ly be accomplished by close observa-n and adjustment of the locomotive operation until the final proportions d adjustments are definitely deter-ned. Originally, the cross-over valve ve trouble, as it caused severe dis-rbances of the water, due to by-pass-g the high-pressure steam, which was ercome by a change in design of the lve outlet into the low-pressure boiler. Proper draft adjustments and boiler nditions are somewhat more difficult to ure with locomotive 8000, as the ex-usts are secured at uneven intervals. e uneven effects of the exhaust on the aft conditions of the locomotive are re noticeable at low speeds. This has en greatly improved, with better com-stion and increased superheat tem-ratures, by installing baffle plates in smokebox with apertures to more nly diffuse the draft, a change in ck diameter and changes in the ex-ist nozzle. While great improvements have been effected, the problem is so different from an ordinary locomotive that still further improvements can be expected.

In operation the locomotive has thoroughly lived up to expectations in the matter of uniform torque, marked advantage in hauling heavy loads at low speeds due to more even torque, smooth running development of maximum tractive force and slipping far less than the T-1 locomotives under adverse rail conditions.

At present there is no doubt as to the increased maintenance cost of the multi-pressure locomotive over that of the conventional simple locomotives operating over the same division. This is generally true of locomotives radically different in design and construction, as the shop men lack experience on this type of locomotive and must become acquainted with the various details, which are different from those on the locomotives they have been maintaining. Many experimental changes are also continually in progress at present which are apt to be mistaken for regular maintenance. Boiler men, not acquainted with the new boilers, require more time to wash out the two systems than they will when thoroughly acquainted with this work.

The safety valves presented a difficult problem as their dimensions were strictly limited and as they must operate under conditions of vibration and exposure not met with in stationary practice. The valves applied originally were not altogether successful. The valves on the closed circuit system gave trouble, largely on account of the actual details of construction which has been overcome by rebuilding the valves in the railway shops by the use of a new form of seat and valve. The high-pressure safety valves also required a change in form of construction, but it appears that these difficulties are largely eliminated.

The check valve in the water-delivery line to the high-pressure boiler ga trouble on account of the very high cc centrated load in the valve being almc impossible to maintain it in a tight cc dition for any length of time, due the pounding it received. The soluti was a twin check valve with the prop capacity provided by two valves side side in the same body, so that the to load on each valve of reduced diamet was little greater than the load on t single valve used in conventional pra tice.

Although over a year has elapsed sin the locomotive was first put into servi the breaking in period on Eastern Lin its transfer in knocked-down conditi and re-assembly on the Western Lin and the various adjustments requir while the locomotive was in regul operation on its assigned location on t Mountain Sub-division has not made possible to give a complete summary the operating performance of the loc motive over the entire period since was built. The engine performance h been closely followed by observers, a results show that a fuel saving of 14.8 has been effected on the division, und regular service conditions, at slow spee on 2.2% grades between Albert Canyc and Glacier, eastbound, and Beave mouth and Glacier, westbound. Tes conducted on the Eastern Lines over tl level Winchester Sub-division betwee Montreal and Smiths Falls, showed fu economies of 25% under higher spee and heavy tonnage.

The accompanying table shows tl performance of locomotive 8000, con pared with locomotives of the 5900 (T- class), on the heavy grades of the Mou tain Subdivision both east and we bound.

Mr. Bowen's foregoing paper was rea before the American Society of Mechan cal Engineers' Railroad Division, at meeting at Bigwin Inn, Lake of Bay Ont., recently.

ABITIBI TRANSPORTATION AND NAVIGATION COMPANY

August, 1922.

Railway Development, Proj

Abitibi Transportation & Navigation Co., Ltd.—Canadian Railway and Marine World for June stated that it had been officially advised that the Abitibi Power & Paper Co., had let a contract to build, this year, a standard gauge logging railway from Iroquois Falls, Ont., to a junction with the National Transcontinental Ry. at Hughes, Ont., 16 miles, that Iroquois Falls is the terminus of the Timiskaming & Northern Ontario Ry's 7-mile branch from Porquis Jct., Ont., 225.7 miles north of North Bay, and that Hughes is 29 miles east of Cochrane. This meagre information was only obtained after we had written two letters to the company. We then wrote again, asking the usual information we obtain in regard to such matters, including the name and address of the contractor; what the contract included; section and weight of rails to be used; name of engineer who made the survey; a blue print showing the routes; who would be in charge of construction for the company, and what rolling stock it was intended to acquire. The company's Secretary replied, repeating that a contract for all the work had been let, and the equipment purchased, or under agreement to purchase, but declined to give any further information. We wrote him again, pointing out that such information is invariably furnished us in regard to railway contracts awarded and urged that it be supplied, but our request was ignored and our letter was not even acknowledged. In Canadian Railway and Marine World's 24 years history, its Editor cannot remember having been similarly treated before, railway officials and projectors being almost invariably willing to furnish full information. However, in spite of the company's refusal, we are able to give considerable information about the matter, and shall give more from time to time in our readers' interests.

The Abitibi Power & Paper Co. has a large pulp and paper plant at Iroquois Falls and extensive timber limits in the surrounding districts. Press reports state that the company wanted to build a railway from Iroquois Falls, via Hughes, to ultimately reach James Bay, or navigable waters flowing into it, and to do business thereon as common carriers. The question of the construction of such a line was considered by the Ontario Government in June, when a deputation from the company waited on Hon. M. Doherty, then acting Premier, and other members of the cabinet, the Chairman and other members of the Timiskaming & Northern Ontario Ry. Commission being present. The commissioners objected to the company's application, on the ground that the projected line would interfere with the T. & N. O. Ry's business, and that it would parallel the extension of that line now under construction from Cochrane northerly. As a result, it was decided that the company may build a railway from Iroquois Falls to Hughes, but that it shall be used for logging purposes only. The Ontario Government, on June 28, issued letters patent of incorporation under the Ontario Companies Act, for the Abitibi Transportation & Navigation Co., Ltd., for the following purposes: To carry on a lumber, timber and pulpwood business; to construct, purchase or otherwise acquire, steamers, scows, tugs and booms or any other kind of crafts or appliances for inland navigation and to employ and operate the same; to improve and develop rivers, streams and lakes and to construct and

August 1922

Abitibi Transportation & Navigation Co.—We are advised that the railway built by this company from the terminus of a Timiskaming & Northern Ontario Ry. branch at Iroquois Falls to Hughes, Ont., on the National Transcontinental Ry., is 15.76 miles long, and was opened for traffic Dec. 23, 1922. A spur line from mile 8, which extends for some 5 miles into the bush, is probably of a temporary character, and will be extended or moved from time to time as logging operations demand. (Jan., pg. 8.)

MARCH 1922

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Abitibi Railway & Navigation Co. —We were advised recently that the grading, trestle-building, track laying and ballasting on the 16 miles standard gauge logging railway from Iroquois Falls, the terminus of a branch of the Timiskaming & Northern Ontario Ry., to Hughes, Ont., where a junction is effected with the National Transcontinental Ry., had been practically completed, and that a 5-mile spur line had been built from mile 8, into the bush. (Nov., pg. 568.)

JANUARY 1923

Abitibi Transportation and Navigation Co.—A press report states that the operation of this railway, which extends from the terminus of the Timiskaming and Northern Ontario Ry. branch at Iroquois Falls, to Hughes, Ont., on the National Transcontinental Ry., 15.76 miles, together with an 8-mile logging branch, is enabling the Abitibi Pulp and Paper Co. to operate its plant more efficiently and economically. It is expected that the newsprint output, which now runs from 18 to 20 cars a day, will be maintained all winter. (March, pg. 118.)

September 1923