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C.P.R. Grade Revision in the Rockies.

Plans have been approved for the grade revision on the C.P.R. main line between Hector and Field in the Rocky Mountains. Between these two points the controlling gradient has been 4.5 or 4½ ft. of rise in every 100. This has been a great drawback in the handling of traffic, for in order to take a passenger train over this hill it has been necessary to attach two or three heavy locomotives. With freight trains, too, it has been impossible to handle more than half a dozen loaded cars with a single locomotive, adding great delays and a heavy cost to the shipping of goods. During the past few years traffic over this line has grown tremendously, and for the last year the company's engineers have been looking over the ground in an endeavor to find some means of making the grade lighter at this point. A number of surveys have been made, all with this object in view.

The only way in which the gradient can be lessened is by lengthening the line between Hector and Field, and this is a most difficult and expensive proposition. With Mount Selkirk on one side and the Kicking Horse river on the other, there is little room for operations of this sort, for the pass is narrow and crooked up to the summit. In order to get the requisite length of line, two loops will be built, the railway doubling back on itself. There is no room to make the loops in the open and to get the turn they will be cut in the solid rock of the mountains. The two tunnels will be 5,880 and 3,400 ft. long respectively, giving a total tunnel of 9,280 ft. in length. The additional distance gained will permit the company to reduce the gradient to 2.2 or 2 1-5 ft. in every 100. The work on this section will be begun at once, though it will probably take a couple of years to complete. The accompanying plans show the loca-

SION OF C.P.R. MAIN LINE BET

9-1907

economizes in other particulars, as
by the comparative statement in fig. 1.

The construction of this tunnel was through very difficult material, mostly wet blue clay, with small quantities of sand, gravel, hard pan and other materials, as indicated in fig. 2. The method of excavation, illustrated by successive stages, is shown in fig. 3. First two parallel headings were driven on the grade of the wall plates, and next a crown drift for the placing of the crown bars. After this the material between the side and crown drifts was removed, and the remaining crown bars placed in position. After placing the arch timbers the core between the side drifts was excavated, and then post trenches were excavated to grade and the posts placed in position under the wall plates. The removal of the bench completed the work of excavation. Logs 30 to 40 ft. long were used as crown bars and 8 by 10 in. timbers for wall plates. Ordinary cordwood was used for lagging. Other details regarding the timbering are made clear in fig. 3. This work had to be done under heavy pressure of the superincumbent material, making it necessary to follow the timbering closely with the lining, which consists of concrete reinforced with bars, as illustrated in fig. 4. Generally it is 3 ft. thick at the springing line and 2 ft. thick at the crown. At the base of the side walls the thickness is 4 ft. 4 ins., and the bottom of the tunnel is an invert.

The proportion of the concrete mixture was varied to suit conditions at different points. At the east portal the wing walls are built of 1:3:6 plain concrete, faced with 4 ins. of cement mortar. For a short distance from this end the tunnel arch and walls are not reinforced, the lining being 3 ft. thick and side walls 2 ft. thick. In other parts of the tunnel the arch was made of 1:2:4 and 1:2½:5 concrete, as conditions varied. The work of construction was begun in Oct., 1905, and the tunnel was completed July 31, 1906.—Railway and Engineering Review.

9-1907

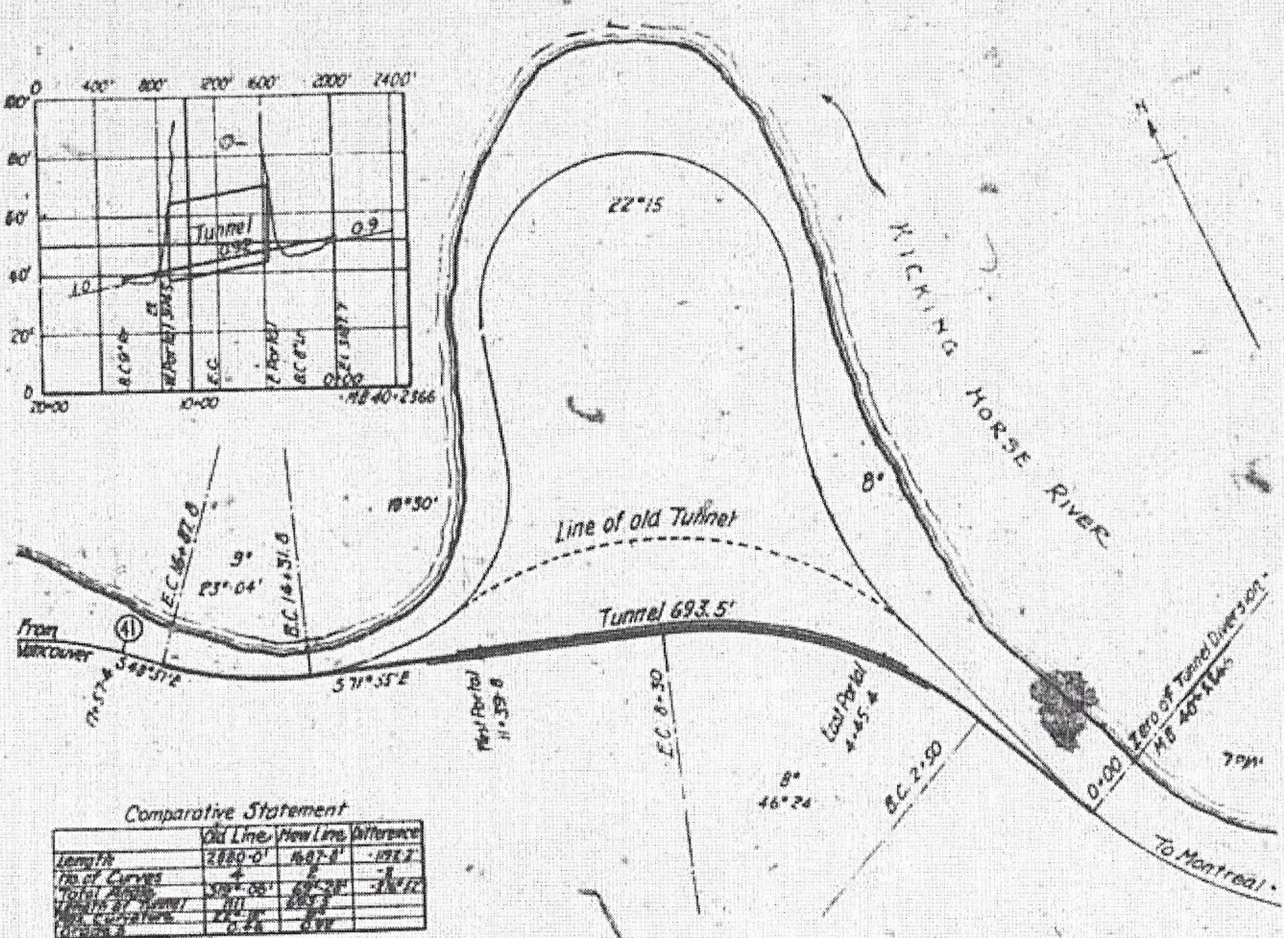
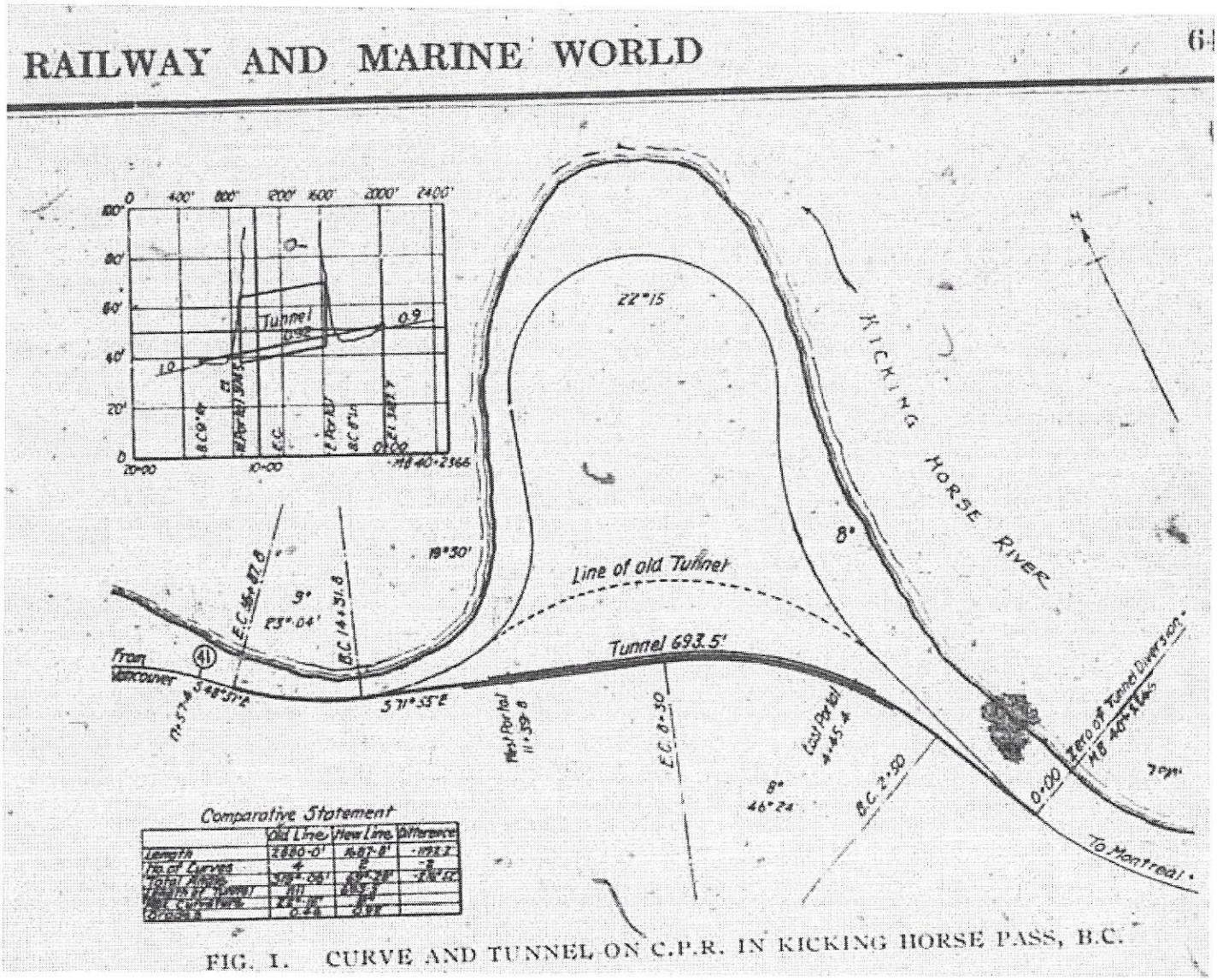


FIG. 1. CURVE AND TUNNEL ON C.P.R. IN KICKING HORSE PASS, B.C.

9-1907



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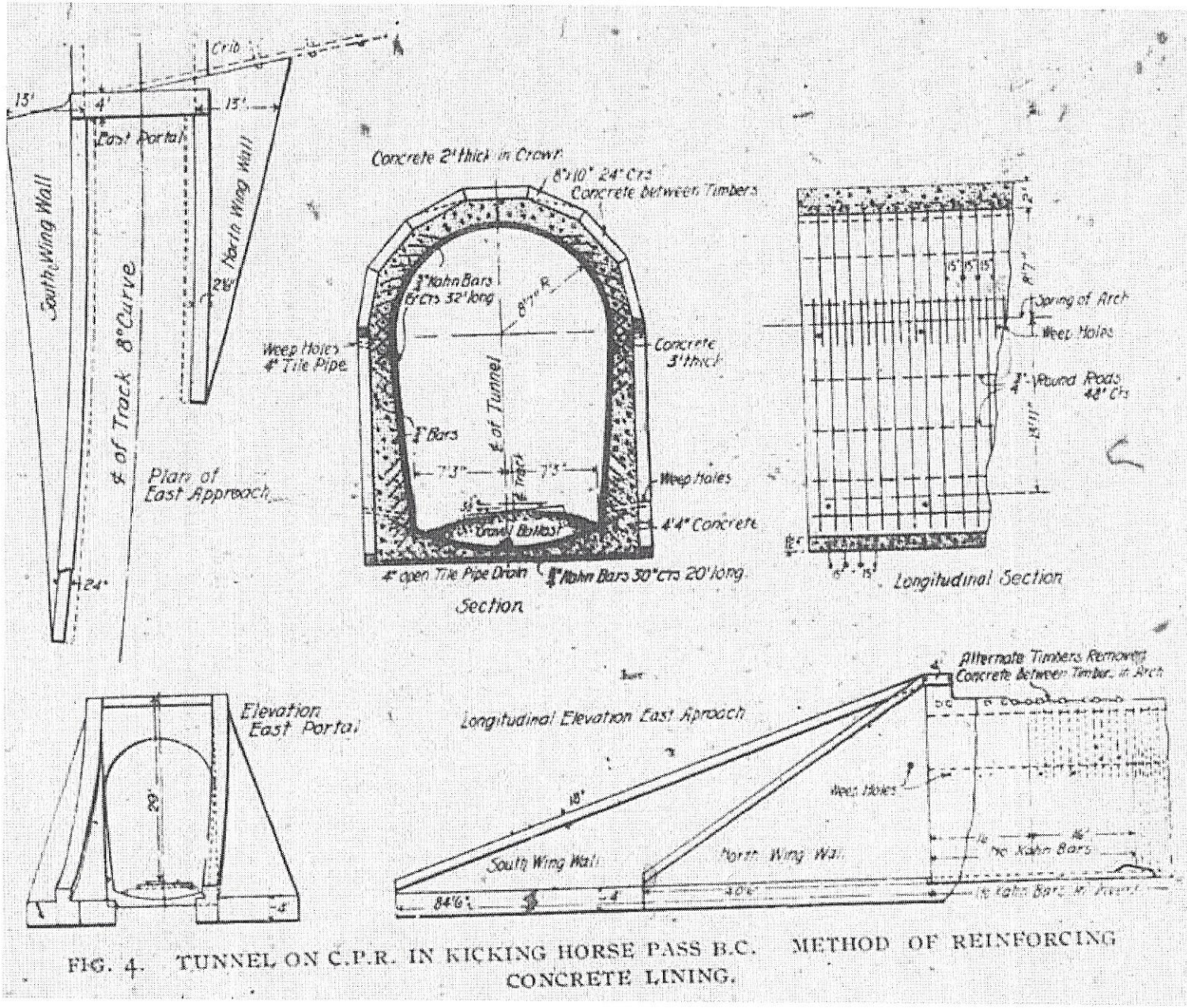

FIG. 4. TUNNEL ON C.P.R. IN KICKING HORSE PASS B.C. METHOD OF REINFORCING CONCRETE LINING.

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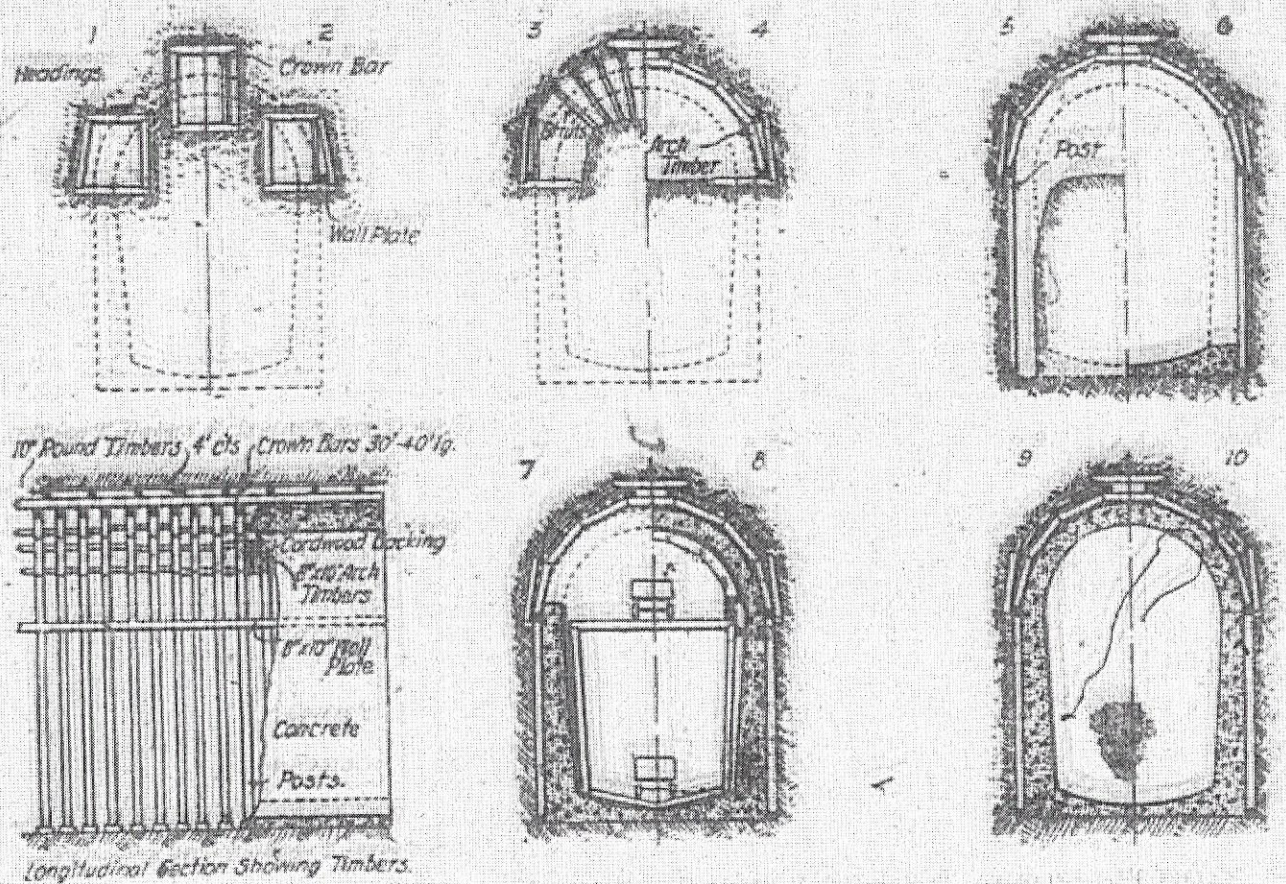

FIG. 3. TUNNEL ON C.P.R. IN KICKING HORSE PASS B.C. CROSS SECTIONS SHOWING SUCCESSIVE STAGES IN CONSTRUCTION.

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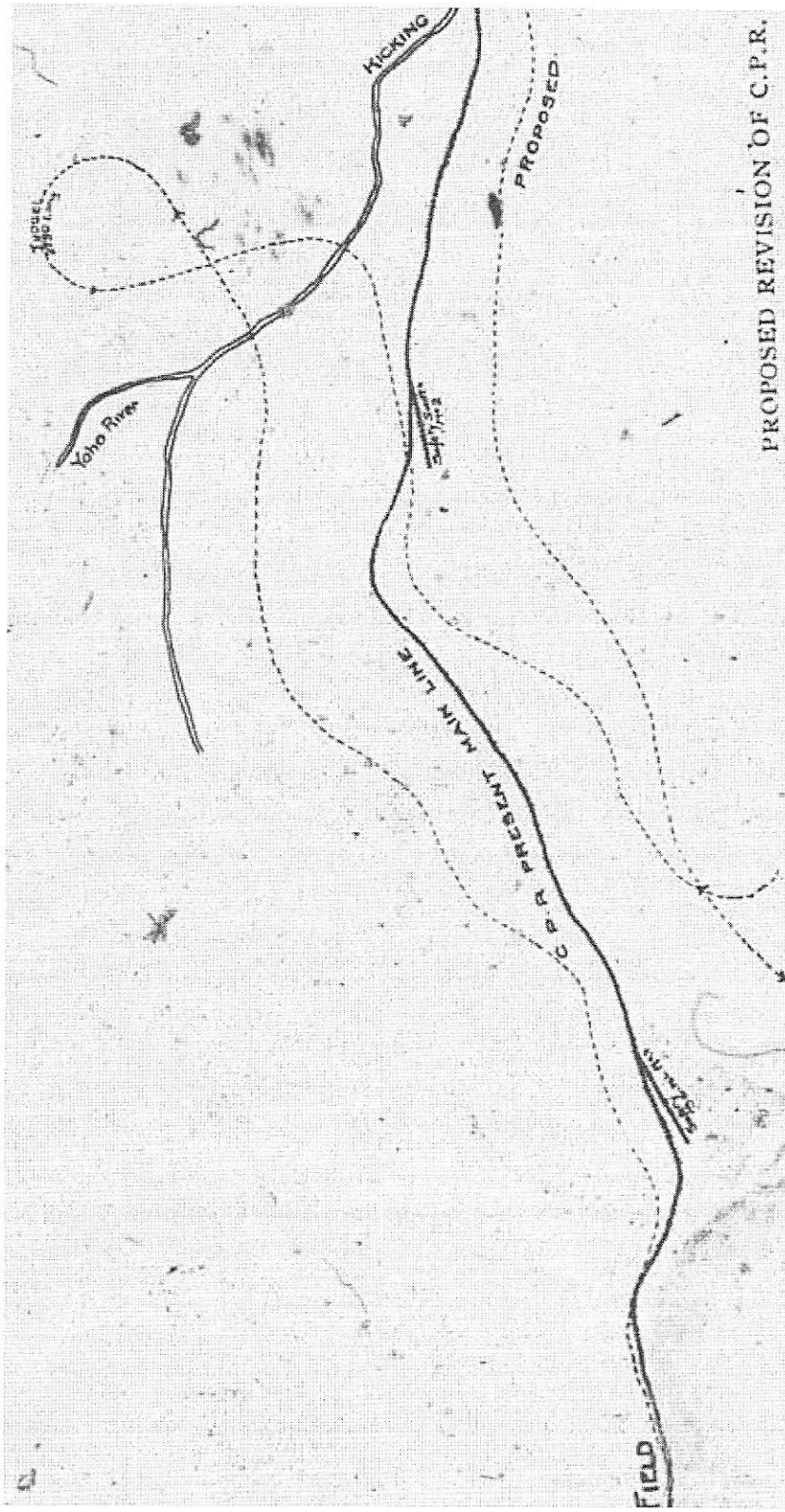

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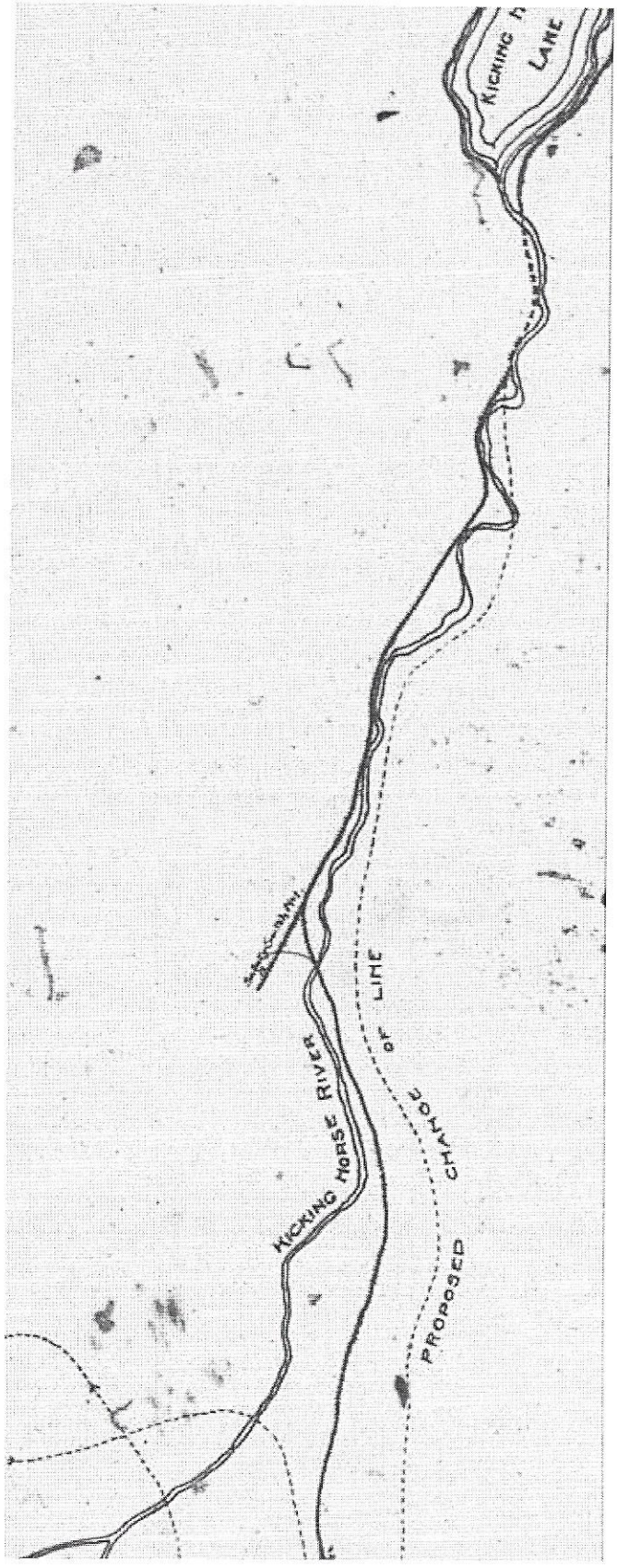

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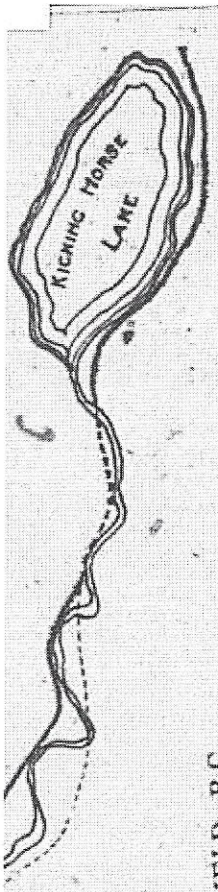

MAIN LINE BETWEEN HECTOR AND FIELD, B.C.

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Plans have been approved for the grade revision on the C.P.R. main line between Hector and Field in the Rocky Mountains. Between these two points the controlling gradient has been 4.5 or 4½ ft. of rise in every 100. This has been a great drawback in the handling of traffic, for in order to take a passenger train over this hill it has been necessary to attach two or three heavy locomotives. With freight trains, too, it has been impossible to handle more than half a dozen loaded cars with a single locomotive, adding great delays and a heavy cost to the shipping of goods. During the past few years traffic over this line has grown tremendously, and for the last year the company's engineers have been looking over the ground in an endeavor to find some means of making the grade lighter at this point. A number of surveys have been made, all with this object in view.

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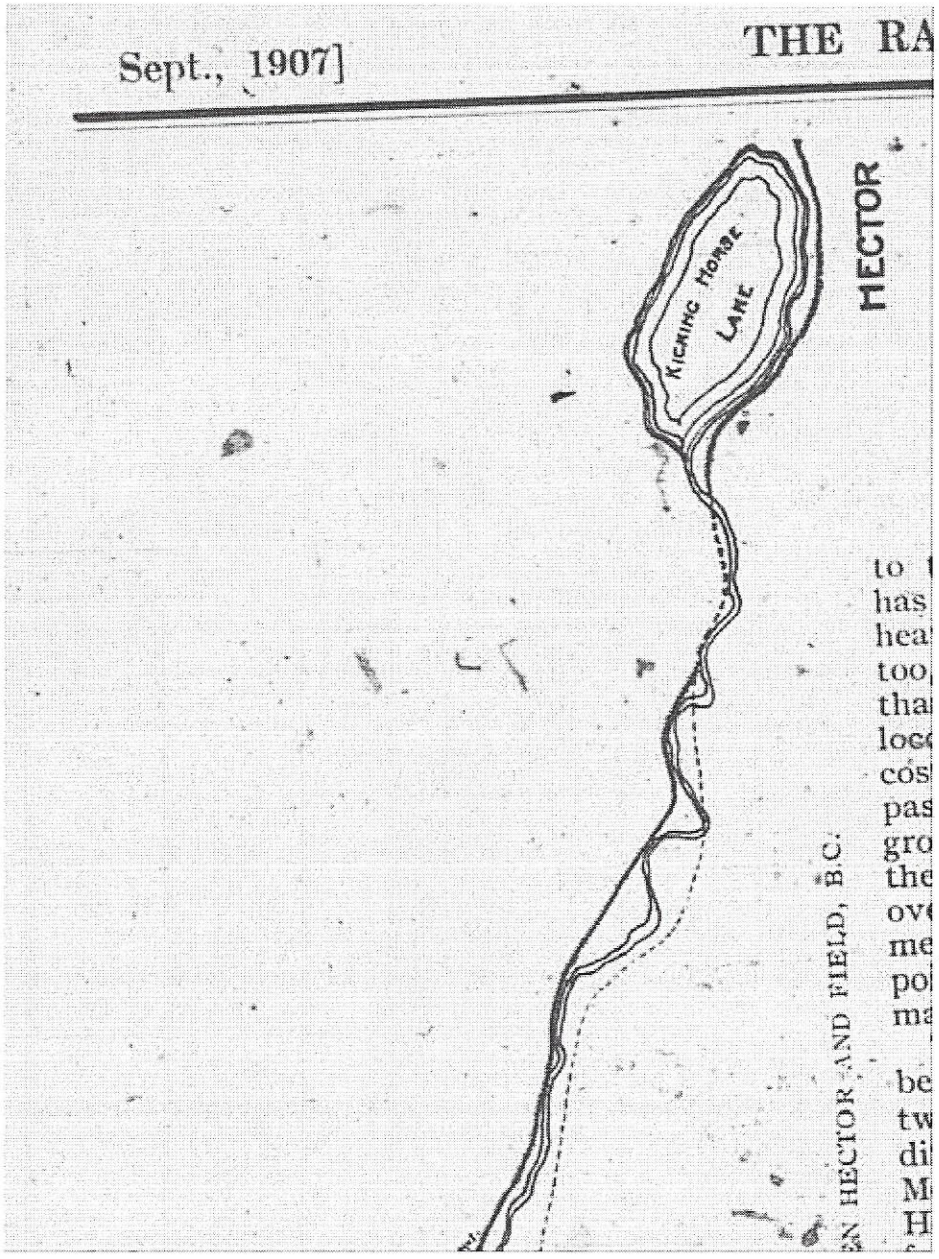

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Reduction of the Kicking Horse Pass Grade on the C.P.R.

By J. E. Schwitzer, Assistant Chief Engineer C.P.R. Western Lines.

Two great engineering triumphs have been achieved this year by the C.P.R. Co., in the reduction of the steep grade in the Rocky Mountains, and the construction of a huge viaduct on its Crow's Nest Pass branch. Both are works of considerable magnitude, and both have been successfully completed in a remarkably short time. Although only separated by less than 200 miles as the crow flies, these engineering feats are essentially different in every aspect, even in their surroundings and conditions, the one being located in mountain recesses, and the other on the broad plains of a ranching and grain-growing region.

The original C.P.R. line between Field and Hector, was constructed for about 4.1 miles with 4.5% grade, which was the heaviest grade on the main line of the railway; this, however, answered all purposes until the increasing traffic during the past few years necessitated the consideration of a grade revision at this point, more especially owing to the large amount of passenger traffic and the danger of operating this 4.5% grade, although

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October 1909

le to haul 882 tons. The engines
ed in operating over the old
ide are what are known as 180%
gines, having a total tractive
rce of 46,900 lbs., the weight on
e drivers being 173,700 lbs., the
tal weight of the engine and ten-
r loaded being 154 tons.

The amount saved on account of
ducing this grade at the time the
timate was prepared was not in
elf sufficient to warrant the ex-
nditure; but, taking into account
e question of handling passenger
affic so much more safely, as well
allowing longer trains to be
erated, besides doing away with
e terminal at Laggan, the ter-
inal of the Western division being
oved to Field, it was decided to
o on with the work.

The work was started on this
revision in September, 1907, and
finished in August, 1909. The
n the tunnels was started from
nds, the contractor at first using
-style Jumbo, but steam-shovels
ater substituted in these tunnels,
e work progressed a little quicker.
eat difficulty was experienced in
nnel work, as it is through med-
rd limestone, with a dip of about
. A large quantity of timber was
d in both the large tunnels on
t of striking slides in the rock,
a little trouble was experienced
water, but this was kept under

October 1909

steam-pumps. The two headings in the tunnels met on May 22, the levels checking in tunnel 1 within two-hundredths of a foot, and tunnel 2 within one-hundredth of a foot.

The question of ventilation was investigated, but it was not considered that any would be required in either of these tunnels until the traffic increases to such a degree that it will be necessary to double track outside the present tunnels. On account of the tunnels being on a spiral, and the portals being in such close proximity to each other, there will practically be the same atmospheric conditions at the portals of each of the tunnels, and the tunnel should have a complete change of air in about 2½ minutes.

On account of the nature of the rock, which appears to slack after being exposed to the air for some little time, the greater part of the tunnels were taken out, so that they might be lined with concrete when that may be necessary. This will give a maximum grade of 2.2% through the mountains, of which there will be 12.7 miles east bound and 5.1 miles west bound.

As a comparison between other tunnels it may be stated that the present tunnels have an area of 376.9 sq. ft. of section through the longest tunnel, the actual grade being 1.6%.

Elkhorn tunnel, on Norfolk and Western Rd., is 3,000 ft. long, with an area of 235 sq. ft., and a grade of 2 and 1.4%. It was found necessary to instal a ventilating plant in this tunnel, as the train movements were about 100 per 24 hours. Cascade tunnel on Great Northern

October 1909

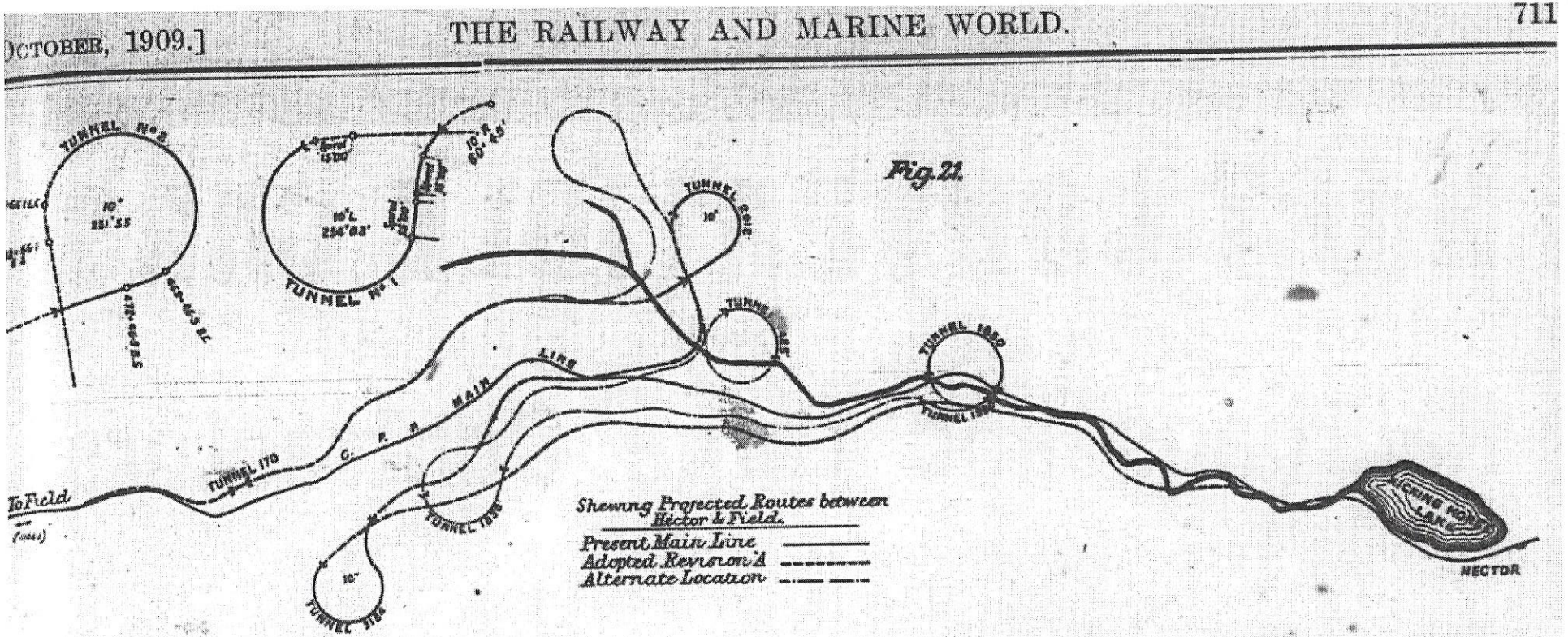

Fig. 21.

ntrol at the upper ends with two small grade, 0.6% ascending from east portal, 300 sq. ft.. No ventilating plant installe

October 1909

control at the upper ends with two small steam-pumps. The two headings in the tunnels met on May 22, the levels checking in tunnel 1 within two-hundredths of a foot, and tunnel 2 within one-hundredth of a foot.

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October 1909

Devoted to Steam and Electric Railway, Marine, Street, Telephone and Contractors' inte

TORONTO, CANADA, OCTOBER, 1909.

Kicking Horse Pass n the C.P.R.

er, Assistant Chief En-
R. Western Lines.

ineering triumphs have is year by the C.P.R. tion of the steep grade ountains, and the con- ge viaduct on its Crow's h. Both are works of gnitude, and both have completed in a time. Although and dash line required running parallel to the bed of the river at several points in order to secure the gradient; this would require the railway and the river to be carried through the same cuts, and on account of the danger of ice blocking the river, besides being a very expensive project to divert the river, this line was abandoned, and the dotted line adopted as a general location. After having further surveys made, and in order to save length of tunnel,

December 1909

several snow-slides to contend with, which would endanger the operation of the line. It was decided by the management to undertake this work in 1907, the contract being let to McDonnel and Gzowski for the construction work.

There was no work of any particular interest outside of the ordinary grading except the tunnels. The tunnel known as no. 1 is 3,255 ft. long, on a reverse curve; tunnel no. 2, 2,921 ft. long, being partly on a 10 deg. curve radius 573.7 and partly on a tangent. Each of these curves have 300 ft. of spiral at each end. The grade is 2.2%, compensated at 0.04 per degree of curvature throughout, except in the tunnel, where 0.06 is used, and on the tangents in the tunnels an allowance of 0.02 was made for slippery rails.

As already stated, the maximum grade on the original line was 4½% for a distance of 3.71 miles, and the balance of 0.2 mile varies from 3.5 to 4%. On the old line it required four engines to handle a train of 700 tons over this grade, while it is estimated that on the new line with two engines of the same class the company will be able to haul 982 tons. The engines used in operating over the old grade are what are known as 180% engines, having a total tractive force of 46,900 lbs., the weight on the drivers being 173,700 lbs., the total weight of the engine and tender loaded being 154 tons.

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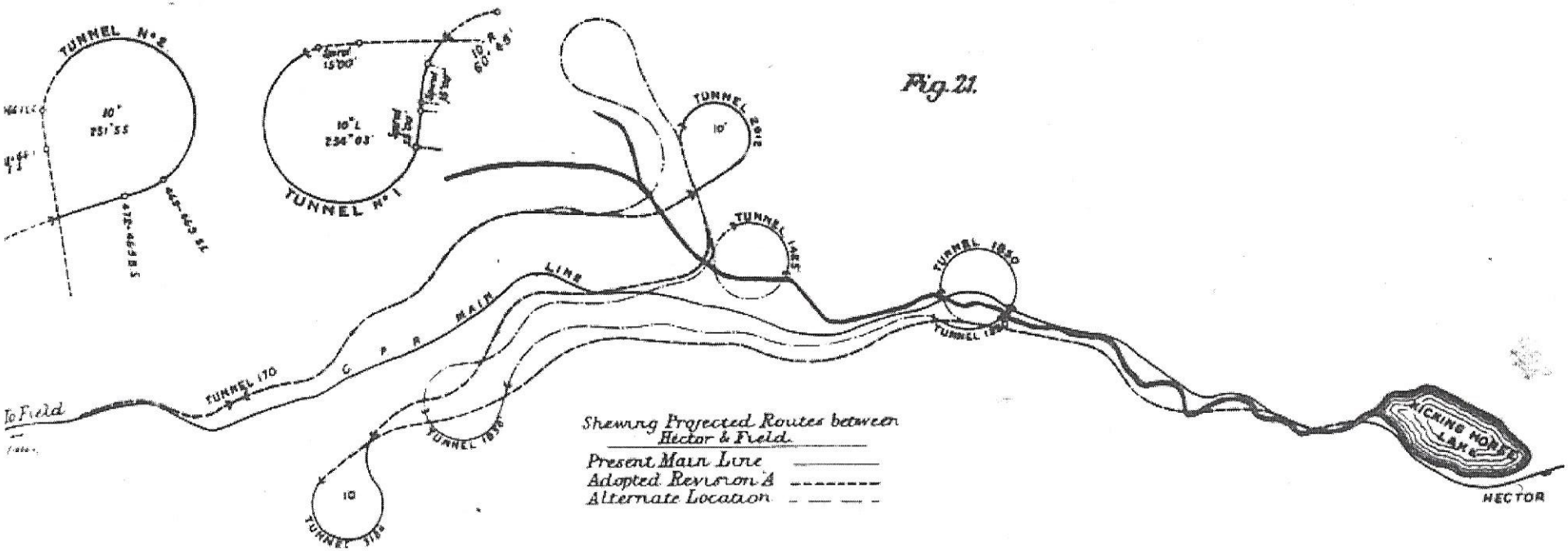

Fig. 21.

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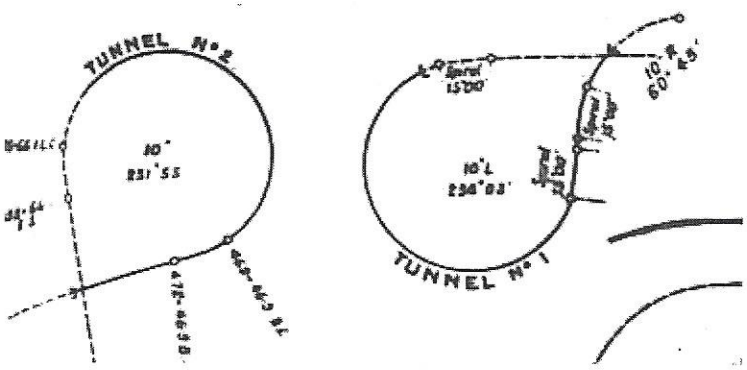

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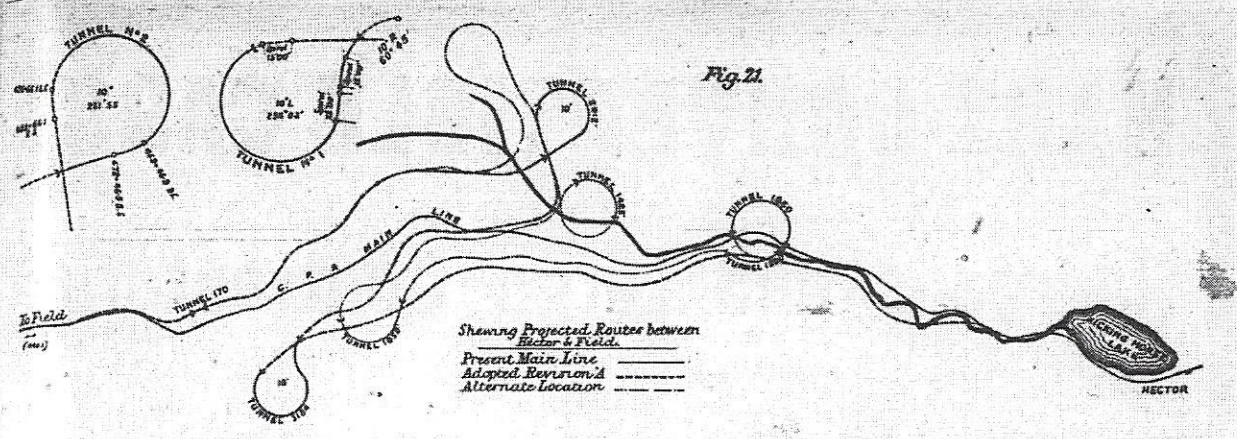
Fig. 21.



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Cascade tunnel, on Great Northern Ry.—Length, 13,280 ft.; grade, 1.74%. There has been no ventilating plant used at this point, and it is proposed to operate this by electricity, the installation for which was to be completed about the end of June of the present year.

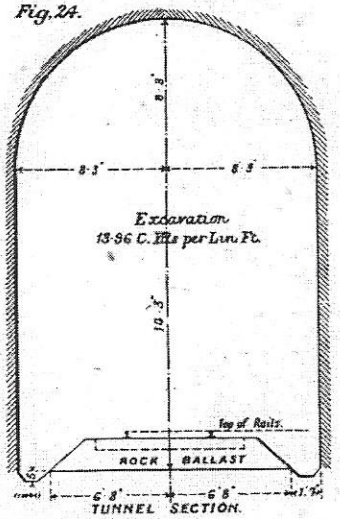
Stampede tunnel, on Northern Pacific Rd.—0,844 ft. long.; area, 333.7 sq. ft.; grade, 0.74% for 5,000 ft., then 0.2% to east portal. Completed 1888. No ventilation.

Boulder tunnel, on Montana Central Ry.—6,139 ft. long; area, 239 sq. ft.; grade, 0.6% ascending from east portal, thence 0.02% descending to west portal.

Busk tunnel, on Colorado Midland Ry.—9,400 ft. long; area, 275 sq. ft.; grade, 1.41%. Built 1893. No ventilation.

Hoosac tunnel, on Boston and Maine Rd.—Double track, 4.7 miles long; area, 572 sq. ft.; grade 0.5% from each end to centre, at which point there is a shaft. This was operated without mechanical ventilation till 1899, though in 1890 it was considered to have reached its limit with 65 trains a day without mechanical ventilation.

Fig. 24.



Big Bend tunnel, Chesapeake and Ohio Rd.—6,500 ft. long; area, 250 sq. ft.; grade ascending, 0.4% for 4,300 ft., thence, descending, 0.08% for balance. It was divided in three sections of about 2,000 ft. by two shafts. These were found to be insufficient for proper ventilation when traffic reached 45 trains a day.

St. Clair tunnel, Grand Trunk Ry.—Built 1901; 6,000 ft. long; grades 2%, descending, each way to centre of section of 2,000 ft., which is on 1% grade. Area, 300 sq. ft.. No ventilating plant installed till at least 1904, when train movement became so heavy that it was necessary to install electric locomotives. [These were placed in operation in 1908.—EDITOR.]

Arlberg tunnel, on Arlberg Ry.—Completed 1883; 6.4 miles long; area, 442.6 sq. ft.; double track; grade, 0.2% for 2.6 miles, ascending from east end, thence 1.5% descending to west end. Owing to increased traffic it began to give trouble in 1885, when the company began to use coke. In 1888 the traffic increased to 31 two-engine trains per 24 hours, but no abnormal effects were noticed till Sept., 1890, when some workmen were overcome by gases, but recovered on removal to air. In 1894 started to use petroleum for fuel, and in 1896 all locomotives were equipped to burn petroleum, which has been satisfactory ever since.

St. Gothard tunnel, St. Gothard Ry.—9½ miles long; construction completed 1882; grade practically level, being only sufficient to provide drainage. The ventilation was natural till about 1899, when Saccardo system was installed. At this time the traffic was 61 trains per day. The approaches to the St. Gothard has seven spiral tunnels of the following lengths:—5,000 ft., 3,670 ft., 3,605 ft., 5,100 ft., 5,019 ft., 4,000 ft., and 5,010 ft. with grades of 2.5%, with natural ventilation only; besides a straight tunnel of 5,150 ft.

Tangevard tunnel, on Bergen and Christiania Ry.—Length about 5 miles; no ventilation; grade, about 1.5%.

Khojak tunnel, India.—Double track, 3 miles long. Was originally divided into three sections by two shafts, but on account of these shafts it was found that there was a dead section between the two shafts. These were then closed up, and till 1900 it was not found necessary to ventilate same.

[The half-tone illustration on page 713 gives what is really a bird's eye view of the Kicking Horse Valley and the old and new C.P.R. lines. The old line is shown by the barred white line, and that which has taken its place by the single and longer line. EDITOR.]

Fig. 22.

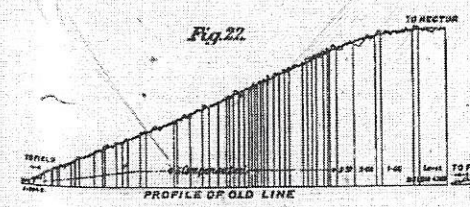
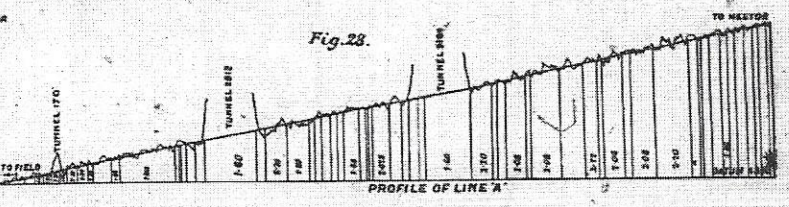


Fig. 23.



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