



FRIDAY, MARCH 27, 1903.

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Contributions

Why Automatic in Preference to Controlled Manual?

Swissvale, Pa., March 20, 1903.

TO THE EDITOR OF THE RAILROAD GAZETTE:

In Colonel Yorke's report on American railroads (lastly made public by the Board of Trade) I find the following sentences:

"Automatic signaling does not of itself introduce greater safety of operation. It is merely a labor-saving device. No doubt it eliminates the risks due to mistakes of signalmen, but it introduces other risks peculiar to itself, due either to inefficient maintenance, to failure of the mechanism, to weather, and to accidents of various sorts. Moreover, the chief object of a system of automatic signaling must be to enable more trains to pass over a given section of the line in a given time, and more trains under such conditions necessarily involve increased chances of accident."

It is quite obvious that Colonel Yorke has not stated his thought very completely or with much care. It is not likely that he would deliberately suggest running fewer trains as a means of safety. Nor is it likely that he would deliberately suggest that automatic signals enable us to run more trains. Manual blocking permits the running of just as many trains as automatic blocking. It is merely a question of the length of the blocks, and that in turn is a question of wages. No doubt we could find denser traffic on main line steam railroads in England than in America.

We have in this country some very perfect automatic blocking, that has stood well the tests of time and weather and heavy traffic; but the controlled manual "eliminates the risks due to mistakes of signalmen," has the advantage of the constant presence of signalmen and will pass just as many trains. It is only a question of money.

BLOCK.

Economy of Different Types of Engines Using Superheated Steam.

TO THE EDITOR OF THE RAILROAD GAZETTE:

There has appeared in the *Railroad Gazette* a number of articles on superheated steam. None, however, has shown its relative effects when used in the several types of engines.

The various results given herewith should not be compared with each other on the basis of water per horse power per hour, as pressures and other conditions are different, but the economy arising from the use of superheated steam over the use of saturated steam in the same engine can properly be compared by one percentage diagram.

The following tests [A. S. M. E., Vol. 21, p. 788] were made by Mr. E. H. Foster on a Worthington duplex direct acting triple expansion pumping engine having six cylinders arranged in tandems of three on each side. The engine was fitted with the Schwoerer patented superheater.

Test No. 1. 2. 3. 4. 5.
I.H.P. 106.3 106.8 103.1 105. 105.1
Superheat, deg. F. 0 0 118.6 122.5 117.7
Steam per pump h.p. per hr. lbs. 21.8 21.2 18.9 18.5 18.0

The average economy as shown by the above tests in using steam superheated 119.6 deg. F. is 14.1 per cent. over that of saturated steam.

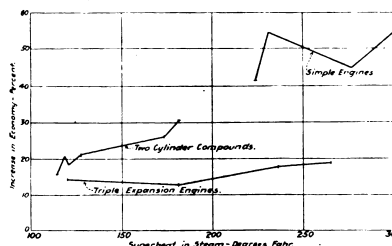
Perry in the "Steam Engine" gives the results of sev-

eral tests on a Corliss compound engine with steam jacketed cylinders when developing about 500 h.p. With saturated steam at 96 lbs. pressure the steam consumption was 19.8 lbs. per indicated horse power per hour, but when the steam was superheated 118 deg. F. the steam consumption dropped to 15.6 lbs., a gain of 20.8 per cent. Other tests on a single expansion engine equipped with a Schmidt superheater gave, when using saturated steam, an economy of 38 lbs. per i.h.p. per hour. When using steam with 300 deg. superheat the steam consumption was 17 lbs., showing 55.3 per cent. increase in favor of the latter method.

In a paper read before the Society of German Engineers in 1900, Oscar Hunger reported a test of a vertical cross compound pumping engine with 23.6 in. and 37.4 in. x 31.5 in. cylinders and running at 40 r.p.m. At 75 lbs. pressure the steam consumption was 20.5 lbs. with saturated steam. With steam superheated 180.5 deg. and a pressure of 150 lbs., the steam consumption became 12.9 lbs., or a gain of 30.7 per cent. over saturated steam at the lower pressure.

Again, tests of a 3,000 h.p. vertical triple expansion engine at the Berlin electric light works (*Engineering Record*, Vol. 42, p. 345) show that a gain of 12.5, 17.9 and 18.7 per cent. results from superheating the steam 181, 235 and 264 deg. F. respectively.

Other tests in Bavaria, with a Sulzer compound engine (*Engineering News*, Vol. 41, p. 213) give a gain of 16 per cent. with steam superheated 114 deg., 18.5 per cent. when superheated 121 deg., and 25.9 per cent. when superheated 173 deg. F.



Economy of Superheated Steam.

The accompanying diagram has been obtained from the above tests by plotting the degrees F. of superheat as abscissae and the per cent. of economy as ordinates. Inspection of this diagram shows that the greatest economy results in the use of superheated steam in simple engine, as might be expected. On the other hand, marked economies are shown for compound and triple expansion engines, but the percentage of gain decreases as the number of expansions increase.

W. W. CHRISTIE.

Improvements on the Pennsylvania Railroad.*

BY S. WHINERY, C.E.

Improvements at Philadelphia.

As all roads led to Rome, so all the railroads of the Pennsylvania System may be said to center at Philadelphia. It might therefore be expected that the problem of handling its vast business in that city would be one of the largest and most difficult that the management must deal with. Some conception of the magnitude of this business may be formed from the following statistics. The total length of single track owned and controlled by the Pennsylvania in the city of Philadelphia is approximately 450 miles. The distance by the Pennsylvania Railroad from New York to Pittsburgh is 445 miles, so that the trackage in Philadelphia is sufficient to build a single track road between those cities.

The number of passenger trains that use the Broad Street station every week-day is, according to current schedule:

Trains outbound	268
Trains inbound	262
Total	530

A census of the passenger business handled at this station in a single day was taken on June 1, 1901, with the following results:

Passenger trains arrived	260
Passenger trains departed	264
Total	524
Cars arrived	1,245
Cars departed	1,300
Total	2,545
Number of passengers arrived by trains	30,168
Number of passengers departed by trains	30,121
Total	60,289
Single tickets sold (exclusive of commutation)	39,906
Pieces of baggage handled, outbound	2,968
Pieces of baggage handled, inbound	2,262
Total	5,230
U. S. mail pouches, in and out	5,101
P. R. R. cab service in and out, trips	901
Number of meals served in restaurant	1,658
Number of letters and packages handled through station branch post office	1,600,570
Express packages handled	1,397
Information bureau, No. of questions answered	4,337
Information bureau, No. of time-tables given out	1,774

The records show that during the year 1902, 8,443,603 passengers arrived at, and 8,383,729 departed from the station—a total of 16,827,392 for the year. As the Sun-

*Continued from page 180.

day business is comparatively light, the above figures indicate that the average number of passengers in and out of the station on week-days was in the neighborhood of 50,000. This great station is itself worth our attention. Built in 1880 for the use alone of what was then the Pennsylvania Railroad, it was called upon to accommodate the other lines that have since been absorbed. It was enlarged in 1890, but has become so crowded that further enlargement is absolutely necessary, and the train shed, now 600 ft. long, will be extended 200 ft. This train shed is still one of the most remarkable structures of its kind. Its roof and sides are formed by a great steel elliptical arch having a clear span of 306 ft., with a rise at the center of 104½ ft. When it is recalled that the clear span of the arch of the Reading Terminal station in the same city is 250 ft. 8 in., that of the Pennsylvania station in Jersey City is 252 ft. 8 in., and that of the noted St. Pancras station in London is 243 ft., some idea of its comparative size may be formed. It shelters 16 tracks, and when extended, will be 800 ft. long.

The statistics of freight movement at Philadelphia would be even more impressive than those of the passenger service, but I am not able to give them complete.

During the month of January last, the records show the car movement for two of the lines to be as follows:

Main Line West—	Loaded.	Empty.	Total.
No. of cars arriving	23,190	893	23,883
No. of cars leaving	9,494	14,156	24,109
Totals	32,684	14,849	47,983

Schuylkill Valley Division—	Loaded.	Empty.	Total.
No. of cars arriving	5,635	285	5,900
No. of cars leaving	2,226	1,236	3,462
Totals	7,861	1,501	9,362

The total number of cars arriving and leaving over the above two divisions Feb. 7, 1903, was 2,431. These with the engines necessary to move them would form a train over two miles long.

All the Pennsylvania's roads at Philadelphia may be said to enter the city through West Philadelphia. This is true even of the New Jersey coast lines since they reach the Broad Street station over the Delaware River bridge and the tracks of the New York division. An enormous amount of business is therefore concentrated in West Philadelphia, and it is to facilitate the handling of this business, both passenger and freight, that improvements upon so large a scale in that section of the city have been planned. The principal objects it has been sought to accomplish may be stated as follows:

- (1) To provide for the safe and expeditious handling of incoming and outgoing passenger trains, by eliminating all crossings at grade of both tracks and streets.
- (2) To provide facilities for running passenger trains through between New York and Washington and between New York and the main line west (called the Philadelphia division), without taking them into the Broad Street station, as is done at the present time.
- (3) To provide better and more extensive facilities for handling through and local freight.
- (4) To provide facilities for handling the large amount of coal used in the city and supplied to vessels, and, incidentally, to provide for the rapid transit of fast or perishable freight through the city.

We can only briefly describe in a general way, in this article, the methods by which these results are to be secured.

At present nearly all the passenger trains entering Philadelphia go to the Broad Street station. Until very recently all these trains used a single three-track bridge over the Schuylkill River just above Market street. The main shops, roundhouses, and storage yard for passenger cars being on the west side of the river not only all schedule trains, but all the empty trains to and from the storage yard and shops, must cross this bridge, which has for many years been over-crowded. A second double track bridge was therefore built just above and nearly parallel to the first bridge and this is now, and will continue to be used for trains of the Philadelphia, Baltimore & Washington Railroad. This new bridge is a through truss structure with two spans of 160 ft., one span of 153 ft. and one of 61 ft. It was completed and put in service Aug. 1, 1902. To provide still greater bridge capacity, and particularly to accommodate the trains of the New York and the Philadelphia division, a third double-track bridge has been built just below the original bridge. It is a deck truss bridge with two spans of 160 ft. each, one span of 150 ft. and one of 85 ft. From the west end of this bridge a steel viaduct 730 ft. long carries its tracks over the freight tracks and yards on the bank of the river. The whole structure is just about completed. The east end of all three bridges lead into the main line of tracks to the Broad Street station on the east side of the river, but each of the new bridges diverges somewhat from the line of the old bridge in a fan-like formation. The old or central bridge is to be used hereafter exclusively for empty trains and engines in transit from the shops and storage yards to the Broad Street station.

A commodious passenger station, now approaching completion, is being erected at 32nd street and Market street. The location of this station is shown on Fig. 3, and further details, with the arrangement of tracks about it are shown by Fig. 4. It is a two-story structure to accommodate the two sets of tracks on different levels which it is to serve. The general arrangement of these tracks may be traced on Fig. 3, remembering that each line represents a double track. P. B. & W. trains en route to or from Broad Street station cross the upper bridge over the river, and following the lower level, curve to the south, and passing first through a tunnel, 163 ft.

long, then through an open, walled cut 440 ft. long and 50 ft. wide, then by a covered cut 95 ft. long, reach the lower level of the 32nd Street station. Over the tunnel and the open cut, the tracks from the middle bridge to the storage yards and shops as well as various connecting tracks, are carried. Passing the station the P., B. & W. tracks enter a tunnel along and under 32nd street. This tunnel begins at the north line of Market street and extends southward for a distance 750 ft. The tracks then proceed toward Washington.

Trains to and from Broad Street station over both the Philadelphia and the New York divisions will cross the lower or southerly bridge over the river, and will approach the new station on a rising grade passing over the tracks of the P., B. & W. as described above, and will be served by the upper floor of the station.

In order that trains of the New York division may reach the tracks of the P., B. & W. road at this station they will be switched from the main line to New York at some distance northward, as will be described later, and, dropping below the main lines will cross under them through a tunnel or arched way and connect with the P., B. & W. tracks at the station. Over these connecting tracks through fast trains between Washington and New York will pass without going to the Broad Street station, passengers for Philadelphia being landed at the 32nd Street station, whence they can reach the Broad Street station by local trains.

The 32nd Street station is an artistic stone structure with extensive train sheds and shelters. The arrangement of tracks gives it a great train capacity, as eight

ing from the tunnel the tracks continue to curve to the right around the Zoological Gardens, and proceed toward New York, with connections to be later described.

At a point about 4,000 ft. west of the 32nd Street station the tracks connecting the New York division with the P., B. & W. diverge from the New York tracks just described, which at this point are a sufficient distance apart to allow these connecting tracks to be located between them. The connecting tracks at once begin descending southward on a grade of 74 ft. per mile, and at a point nearly in the line of Mt. Vernon street enter a walled cut which extends for a distance of 1,750 ft. At the south end of this cut they have dropped sufficiently below the plane of the main lines to permit them to pass under the outbound main line tracks through a tunnel 400 ft. long, where they enter another walled cut 785 ft. long north of the main lines. At the end of this cut they enter the tunnel, 305 ft. long, at the 32nd Street station, previously described, and are led into the main line tracks of the P., B. & W. at the station. These depressed connecting tracks are also provided with connections with both the inbound and outbound tracks of the Philadelphia division so that trains between Pittsburg and Washington may avoid going into the Broad Street station.

The two main line tracks of the Philadelphia division, after parting company with the New York tracks continue westward on a rising grade and at the same elevation until a point just west of the crossing of Belmont avenue, after which the outbound track begins to rise above the inbound with an ascending grade of 1.5 per

on a rather sharp curve, switches into the inbound Philadelphia division track east of the 52nd Street station.

It remains to describe the connections between the New York division tracks and the Philadelphia division tracks which enable passenger trains to be run through between the West and New York without going to either the 32nd Street or the Broad Street stations. These connecting tracks switch off from the Philadelphia division tracks at a point about 4,500 ft. east of the 52nd Street station, near the crossing of Belmont avenue, and descend eastward on a grade of 1½ per cent, through a walled cut 1,070 ft. long between the Philadelphia division tracks, and curving to the north, pass under the outbound track of the Philadelphia division through a tunnel 1,000 ft. long, the western end of which is about 150 ft. west of the 40th street crossing. Emerging from this tunnel, the tracks are carried through a walled cut about 600 ft. long toward the main line tracks of the New York division. But if the junction of these connecting tracks with the New York division main tracks were made with all the tracks on the same plane it is evident that there would be a crossing of one track at grade. To avoid this, the inbound main track of the New York division, which is the extreme right-hand track approaching Philadelphia, is swung outward and depressed until it can be passed under the connecting tracks just described, as well as the freight tracks, through a tunnel 485 ft. long. The situation at this point is still further complicated by the fact that a double-track connection with the Philadelphia & Reading must be taken care of. These tracks are carried through a tunnel 390

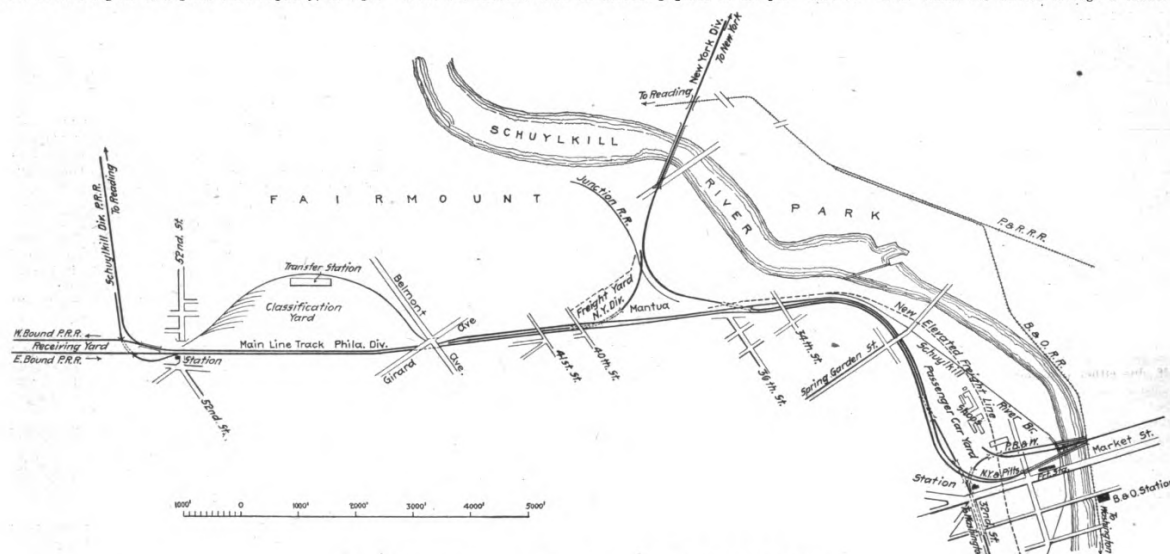


Fig. 3.—General Arrangement of Passenger Tracks, West Philadelphia.

trains may be served at the same time. It has been carefully designed and is very complete in all its details. Separate platforms are provided for inbound and for outbound passengers. The platforms for its lower tracks extend into the arched or covered tunnels through which pass the lower tracks. Commodious stairways connect the two levels, and passenger elevators and baggage lifts are also provided. A covered walk extends to Market street and a commodious cab stand is provided.

Fig. 4 shows the plan of this station and of the tracks about it. The cost of the station and its appurtenances will be about \$125,000.

It is difficult, in a brief description, to convey an adequate idea of the improvements in progress in the West Philadelphia yards. Simple and complete as will be the whole arrangement for operating purposes, it is structurally so extensive and complicated as to impress the unfamiliar student as a gigantic Chinese puzzle. Perhaps we may best obtain some idea of it by following each set of main line passenger tracks from the 32nd Street station to its emergence from the labyrinth, and then describing briefly the arrangement of tracks for the freight service. Fig. 3 will assist in following this programme, bearing in mind that each line on the sketch represents a double track.

The main line tracks, four in number, of the New York division and the Philadelphia division (which later are used here also by the trains of the Schuylkill Valley division), leading to and from the Broad Street station, are on the higher level at the 32nd Street station and their arrangement at that station is shown by Fig. 4.

It will be observed that the inbound and the outbound tracks of the Philadelphia division are the inner and outer of the four tracks, the two tracks of the New York division being between them. From this station the four tracks run almost parallel with each other to 34th street. In this vicinity the tracks spread further apart, the New York tracks dip downward and, curving to the right, pass under the outbound track of the Philadelphia division, through a tunnel 550 ft. long. The tunnel is preceded by a walled open cut about 500 ft. long. Emerg-

cent, so that when the 52nd Street station is reached, it is on the level of the third floor of the station, at a height of 35 ft. above the grade of the street. This track is supported upon an embankment between masonry walls for a distance of 2,170 ft.—the walls gradually rising in height westward—and then upon a viaduct constructed with masonry piers and plate girders of 35 ft. span, 1,750 ft. long, ending at the east end of a through truss bridge with a span of 385 ft., after crossing which the tracks reach the natural surface of the ground over an embankment. The freight tracks connecting the receiving and the classification yards of the Philadelphia division pass under this bridge.

The inbound Philadelphia division track is parallel to the outbound, but with a lighter ascending grade, so that when the 52nd Street station is reached, the grades of the two tracks are separated by a vertical distance of 24.6 ft., and it is served by the second floor of the station. It is carried for a distance of 700 ft. east of that street upon an embankment supported by a masonry retaining wall. Westward from the 52nd Street station, the outbound and inbound tracks begin to diverge so that the receiving freight yard mentioned hereafter may be located between them.

The main line tracks of the Schuylkill Valley division use the main line tracks of the Philadelphia division from the 52nd Street station into the city, and the connections between the two divisions are arranged as follows: The Schuylkill Valley tracks approach the Philadelphia division tracks almost at right angles, from the north, on a line that would cross the outbound Philadelphia division track about 300 ft. west of the 52nd Street station.

The outbound Schuylkill Valley track switches off to the right from the outbound Philadelphia division track just west of the west end of the bridge described above. The inbound track is depressed by a grade of 3½ per cent., so that it passes through a tunnel 325 ft. long under both the outbound and the inbound Philadelphia division tracks as well as the freight tracks connecting the receiving and the classification yards, and turning to the left

ft. long, located alongside of and nearly parallel to the tunnel last described, and these junction tracks, as they are called, are then carried to a connection with the freight and yard tracks of the Pennsylvania Railroad.

If the above description has been made clear, it will be seen that as a result of the arrangement of the tracks, passenger trains, either in or out, on the New York division, the Philadelphia division and the Schuylkill Valley division can proceed to or from either the Broad Street station or the 32nd Street station, and the tracks of any division connected with those of either of the other two, without a single crossing of passenger tracks at grade; and as will appear later, without crossing a single freight or yard track at grade. Considering all the complications that exist and the great number of tracks that it was necessary to deal with this is a most remarkable result, and one cannot but admire the genius and skill of the engineer who worked it out.

The 52nd Street passenger station, which has been mentioned above, merits a passing notice. It is a three-story structure. The first floor is upon the level of 52nd street. There are no passenger tracks on this level. The second floor is at the level of the inbound tracks of the Philadelphia and the Schuylkill Valley divisions, and the third floor is at the level of the outbound tracks of the same divisions. Each floor is provided with ample platforms, waiting rooms and all usual station conveniences; and the floors are connected by ample stairways, passenger elevators and baggage lifts.

It is hardly possible to give a satisfactory description of the arrangement for handling freight trains in the West Philadelphia yards without going into details that cannot be attempted in this article. The very large area of property owned by the Pennsylvania Railroad is literally crowded with tracks, and their arrangement in all their details has been worked out with the same care and skill as that of the passenger tracks.

The freight business of the Philadelphia division—the main line to Harrisburg and the West—is of enormous volume and requires a vast amount of yard and track room. West of the 52nd Street station there has been

laid out and constructed a receiving yard about 3,000 ft. long, and 200 ft. wide, between the inbound and outbound main line passenger tracks. At its eastern end the level of this yard is sufficiently below the grade of the passenger tracks to allow the tracks connecting this yard with the classification yard, to pass under the bridge west of the 32nd Street station, and at the same time to cross 32nd street over the grade of the street.

The great classification yard, lying between the main line passenger tracks and Fairmount Park, has a length of about 4,000 ft. and a width of over 1,200 ft., covering an area of some 85 acres. It embraces a large transfer station, roundhouse, cooling station and other necessary appurtenances. This yard as well as the tracks to the receiving yard is designed to be operated by gravity.

The freight yard of the New York division lies in a space north of the main lines and west of the passenger train tracks connecting the New York division with the Philadelphia division west, and is connected with the classification yard of the Philadelphia division by a large number of tracks. It is as large and as advantageously arranged as the space available will permit.

The yards described are but a small part of the freight trackage in West Philadelphia, as every available bit of

line. This connection with the P. B. & W. road is a very important one, as will be explained later. The cost of this new Greenwich line will be about \$2,000,000.

The great new coal pier at Greenwich is 735 ft. long and has a capacity for a very large quantity of coal. The arrangements for handling and delivering the coal to it are very complete and interesting. Loaded coal trains arriving over the new Greenwich line are delivered to a special set of five tracks about 600 ft. long. These tracks have a descending grade of 1 per cent. toward the pier, and all lead into the single inclined track up which the cars are elevated to the top of the pier. Cars to be unloaded on the pier are dropped by gravity to the foot of the incline up which they are then hauled by a wire rope actuated by a stationary steam engine. The grade of this incline, is $17\frac{1}{2}$ per cent., and its crest is 75 ft. above mean high water. From this summit the tracks descend on a grade of 1 per cent. to the outward end of the pier, where they are 65 ft. above high water, so that a car, when detached from the cable, runs by gravity, first into one of three tracks for temporary storage, and then out upon the pier.

There are two discharging tracks, 50 ft. apart, center to center, upon the pier. Between them is located the

Philadelphia to New York.

The principal work that has recently occupied and continues to occupy the attention of the management on the lines between Philadelphia and New York is the elevation of tracks through the several cities, and work incidental thereto.

Proceeding north from Philadelphia the first important improvement is found at Frankford Junction, where the location of the main line is to be materially changed to reduce grades and to secure easier curvature. On the present line the grade against southbound traffic is 31.7 ft. per mile, and this is accentuated by a $4\frac{1}{2}$ deg. curve, making it the controlling grade between Philadelphia and New York. The change to be made will be something over two miles in length, the grade will be reduced to 21 ft. per mile, and the degree of curvature to 19 min. Owing to the great value of property through which the new line will run, it will be a very expensive improvement. The estimated cost, including an elevated connection with the Delaware Bridge track to the Jersey seacoast resorts, is about one and a quarter million dollars. This improvement will be completed by the end of this year.

The next important improvement is at Bristol, Pa., where the tracks are to be elevated to avoid grade crossings, and the location changed for a distance of slightly over two and one-half miles. The new line will be about one-fourth mile shorter than the present line, and will have 49 deg. of curvature of 40 to 45 min. curve, while the old line has 107 deg. of curvature varying from 20 min. up to 1 deg. 40 min. curve. The work is in progress and will be completed this year. The total cost of the improvement will be about \$600,000.

At Trenton, N. J., an important change of route is now being made for the purpose of straightening the line, throwing out some objectional curvature and elevating the tracks through Morrisville and Trenton. The length of line changed is about 10,000 ft., but the track elevation extends over a considerably greater distance, to avoid eight street grade crossings. The most notable feature of this improvement is the new stone arch bridge over the Delaware on the new line. The total length of this bridge is 1,220 ft., and the elevation of the tracks above mean low water is 40 ft. The bridge consists of 18 arches of stone masonry, each arch having a clear span of 90 ft. The width under the parapet is 54 ft., and the bridge will carry four tracks.

The Trenton cut-off, which connects with the main line just south of Morrisville, must also be elevated at its junction with the main line. The cost of this work at Trenton will be about \$600,000, and it will be completed in July, this year.

The next important improvement in progress is at New Brunswick, where the tracks are being elevated from 16 to 22 ft. through the city to avoid all street crossings at grade, and a new stone arch bridge is being constructed over the Raritan River. The elevation begins about two miles south of the south abutment of the Raritan River bridge, and extends to a distance of three miles north of that point before joining the old grade line, a total length of about five miles. The alignment is not changed. The new bridge over the Raritan River, and the manner in which it is being erected upon the same line as the old truss bridge, presents many points of engineering interest. The total length of the new bridge extending over the river, the Delaware & Raritan Canal and over Water and Neilson streets, is 1,455 ft. Beginning at its north end there are 10 arches of 66 ft. clear span, then two arches of 56 ft. span followed by eight arches of 51 ft. span, and finally one ribbed skew arch of 72 ft. span, over Neilson street. This last is a segmental circular arch with a radius of 39 ft., and a rise of 24 ft. All the others are plain semi-circular arches. The piers are founded upon rock throughout, the bottom of the masonry in the river being 65 ft. below the crown of the arch (intrados) and about 73 ft. below base of rail of the new tracks. The bridge is 55 ft. wide under the parapet and is intended to carry four tracks.

The general plan of the track elevation through the city is to build masonry retaining walls on each side of the road, and to fill the space between the walls with earth to the proper grade. At the street crossings stone abutments joined to the retaining walls are built on each side of the street, and plate girders are used to carry the tracks over the street. This work will be completed this year and its cost will be about \$1,500,000.

Arrangements are being made to elevate the tracks through the town of Rahway and the work will begin as soon as the necessary authority is granted by the municipality. The change of grade will be about 6,000 ft. long, and 21 street crossings at grade will be avoided.

The work of elevating the tracks through Newark and its suburb, Harrison, is now in progress and will be completed during this year. The total length of this track elevation will be two and eight-tenths miles, and as a result no less than 23 street crossings at grade will be eliminated. The character of the work is similar to that at New Brunswick, but some special difficulties are met with and the work is more expensive. The elevation of the tracks through Elizabeth and through Jersey City was completed some years since, and when the work is completed in all the cities referred to above, all grade crossings in every considerable town between Philadelphia and New York will have been eliminated.

The effect of these improvements upon the economy and safety of operation and upon the speed attainable will undoubtedly be very marked. It should be possible to shorten materially the already fast time made by through

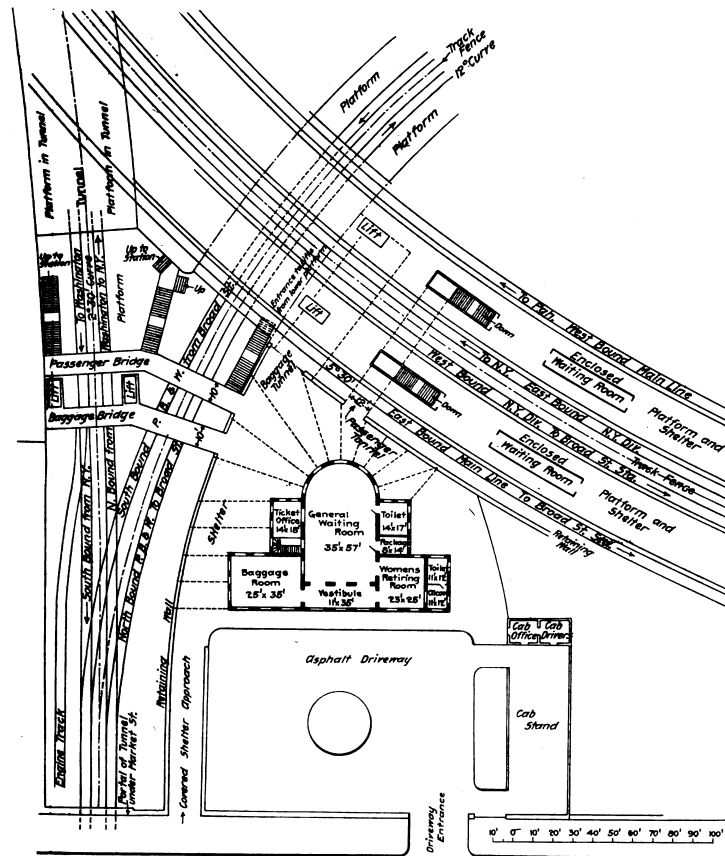


Fig. 4.—Arrangement of Tracks at Thirty-second Street Station—West Philadelphia.

space for a distance of $3\frac{1}{2}$ miles out from the 32nd Street station is now or will be closely occupied. The yard for storage of passenger trains and cars, located directly north of the 32nd Street passenger station and alongside the West Philadelphia shops is of large capacity and admirably arranged. It is connected directly with the three tracks of the middle or old bridge.

One of the most important improvements at Philadelphia is a new elevated double-track freight line connecting the West Philadelphia freight yards with the great coal piers at Greenwich. This line begins near 36th street, with connections to the Philadelphia division classification yard, and to the freight tracks of the New York division. Continuing southward it begins to rise above the general level of the adjoining tracks, passes under the 34th street highway bridge, but attains a sufficient elevation to pass by an elevated steel structure over the Spring Garden Street bridge, and thence, curving southward, and passing over the roofs of the shops and over all the main passenger lines, crosses Market street just east of the 32nd Street station at an elevation of 42 ft. above the street and continues southward to the "Arsenal Bridge" over the Schuylkill River. Thence it will follow the existing tracks to Greenwich. The elevated structure will be 7,000 ft. long, ending at South street. It is of the ordinary steel viaduct type, but stone piers and deck plate-girders are used at the street crossings. Just before reaching the Arsenal bridge connecting tracks lead to a junction with the freight tracks of the P. B. & W. main

single return track for empty cars. The car is stopped and unloaded at any point upon the pier, and then dropped by gravity to the outer end of the pier, where it is switched into the central "empty" track. This track descends with a uniform grade of 1.54 per cent., passing under the incoming track near the inner end of the pier, and continuing to a junction with the storage yard for empty cars. Thus, with the exception of hauling them up the inclined plane, the cars are handled entirely by gravity.

The elevation of the storage bins of the pier is such that vessels lying alongside may be loaded by gravity. The cost of the pier and its adjuncts has been \$316,000.

The elevated Greenwich line is intended to be used almost exclusively for two important purposes. One of these is the delivery of coal to Greenwich. The other is the unobstructed and rapid transit through Philadelphia, of fruit, vegetables and other perishable freight, en route from the South to New York. "Berry trains" (the railroad vernacular for this class of freight) will be switched from the P. B. & W. to and over this elevated route to the tracks of the New York division, and on to New York, practically without a stop in Philadelphia, and the time in transit for this class of freights will thus be materially shortened.

This description of the improvements at Philadelphia is necessarily inadequate. Some idea of their magnitude may be gained when it is stated that their estimated cost when completed is over four and one-half million dollars.

trains between the two cities. When all the work in progress and projected is completed the road between New York and Philadelphia will have no equal in America if in the world. With no curves exceeding 2 deg., and the total amount of curvature reduced to a minimum, with maximum grades of 21 ft. per mile, with four passenger tracks throughout, of the best modern construction and supplied with the most approved appurtenances, and with a signal system as nearly perfect as human ingenuity and skill can devise, the line may be accepted as a model of the most advanced railroad practice of the age.

Improvements at New York.

If the magnitude and importance of the improvements we have noted between Pittsburg and New York impress one as stupendous, no word short of colossal will fitly characterize those now under way and projected in the vicinity of the last named city.

New York is becoming every day, in a larger sense, the Commercial Metropolis of America. Recognizing this and forecasting the demands that the wonderful growth of the city will, in the near future, make upon the transportation capacity of all the railroads entering it, the Pennsylvania Railroad Company is preparing, in its broad-minded and courageous way, to meet them. The problems it finds itself called upon to solve are peculiarly difficult. Its present terminus at Jersey City is separated from New York by a wide and deep river, or arm of the sea, across which all its New York business, both passenger and freight, must be handled by boats.

The number of passengers carried daily by the road between Philadelphia and Jersey City is very great, and in addition to this through travel, the road does a very large commutation business between New York and the

determined upon, the details have not been entirely worked out and no accurate estimates of the probable cost have been made public. The first tunnel is to be completed within five years.

The object of this great tunnel is not alone, however, for the accommodation of local New York business. The geographical location of the Pennsylvania Railroad and its terminal in Jersey City is not at present favorable to a satisfactory connection with the New England Railroad System, involving, as it does, a ferry transfer at New York. Through train service between New England points and the west via New York and the Pennsylvania Railroad is not possible except to a limited extent by cars transferred between the present terminals by boats.

It is therefore contemplated, in conjunction with the tunnel system under New York, to build a connecting line between the Long Island Railroad and the New York, New Haven & Hartford system, thus providing an all rail connection for this class of business. The details of this project are not yet available for publication.

The two improvements referred to have for their object the accommodation of the passenger business at New York. The handling of the freight business is to be provided for upon an equally broad and liberal basis. It is probably unknown to more than a few New Yorkers, that a work of very great magnitude has been for some time in progress at their very doors, which is nothing less than the reclaiming of a large area of submerged land in New York Bay to be used for the construction of freight yards for the Pennsylvania Railroad.

The company secured control, some years since, of a large tract of submerged land on the New Jersey shore opposite Greenville, about three and one-half miles south of its Jersey City station. This tract has a frontage on

the Long Island Railroad will be directly across New York Bay, and but two and a half miles from these piers, and the conditions for transferring cars between these points will be unusually favorable.

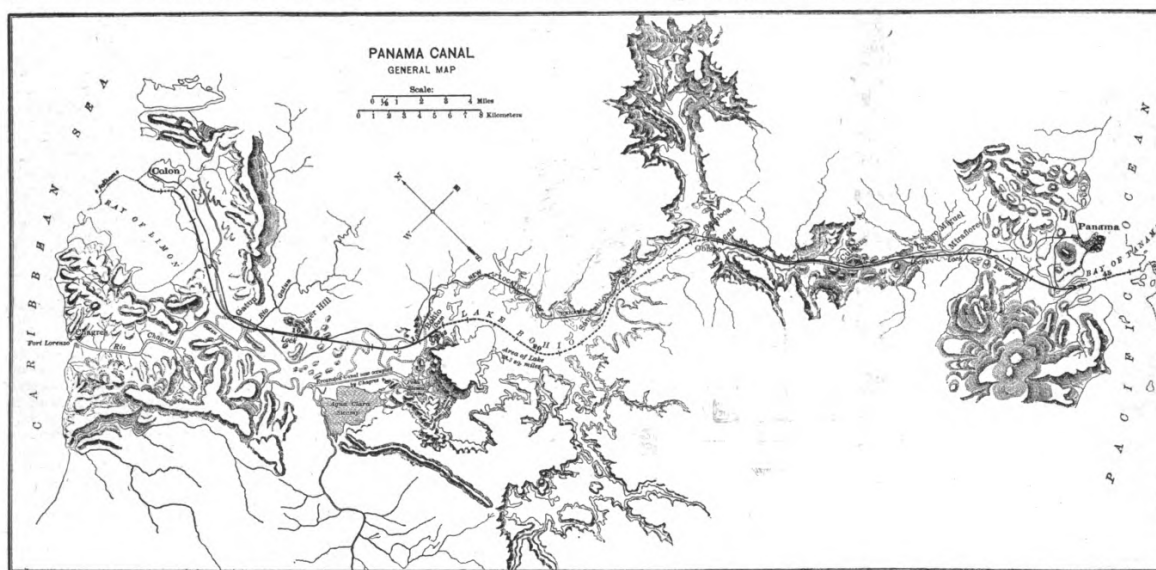
I have attempted in this article to sketch briefly the improvements on the main line from Pittsburg to New York only. Prodigious as may seem the scope and magnitude of the work in hand upon this part of the system, it is but a part of the total betterments that are engaging the energies and capital of the company upon the whole system under its control. Improvements upon the other lines and branch lines of the system are being projected and carried out upon the same broad and liberal scale, in order to meet the growing demands of their business.

The keynote to the whole policy of the management seems to be that in serving the public best it will best serve its own interests. President Cassatt voices this policy in his annual report when he says: "The duty which your company owes to the public, as well as to the shareholders, clearly requires that your lines should be put in a condition to supply the legitimate demands of your shippers."

(TO BE CONTINUED.)

The Panama Canal Treaty.

The Panama Canal Treaty between the United States and Colombia was ratified by the United States Senate March 17, with only five negative votes. It was signed at Washington on Jan. 22, 1903. It was negotiated by Secretary Hay on the part of the United States and Thomas Herran, Charge d'Affaires, on the part of Colombia. Neither in committee nor by the Senate was the



The Panama Canal.

(From Mr. George S. Morrison's paper in the January, 1903, Proceedings of the American Society of Civil Engineers.)

cities and suburban towns along its lines in the vicinity of New York.

The disadvantage and expense attending the transfer of all this business from Jersey City to New York by ferry boats is very great, particularly when it is remembered that a considerable part of it originates in or goes to Brooklyn, now a city having a population of over 1,000,000, and separated from New York proper by another channel of the sea. The company evidently realizes that the problem of handling this great passenger business satisfactorily requires heroic treatment. It has, therefore, projected and is about to begin the construction of a great tunnel which will pass under the North River, under Manhattan Island and under the East River to Long Island. The route of this tunnel and its connections will be substantially as follows: The double-track elevated road leading to the tunnel will leave the present main line about one mile east of Newark, and run thence north of east to the foot of Bergen Hill in West Hoboken. Here the double-track tunnel will begin, passing under Bergen Hill, Weehawken and the North River in the general line of 32d street, New York, produced; it will follow the line of 32d street under New York continuing under the East River and under Long Island City until it emerges and connects with the Long Island Railroad near Thompson avenue in that city. The whole length of the tunnel will be in the neighborhood of 5½ miles.

An additional parallel double-track tunnel is provided for over the whole route, and a third one from the New York passenger station to Long Island City is contemplated. Upon the line of the tunnel in New York there will be constructed the largest passenger station in the world, occupying the space between 31st and 32nd streets and Seventh avenue and Ninth avenue. These tunnels are intended to be used primarily, if not exclusively, for passenger business, and they will probably be operated by electricity.

While the general plans of this gigantic enterprise are

the present shore line of 3,600 ft., and extends out to the established pier line, a distance of about 9,500 ft., or 1.8 miles, its width along the pier line being 1,900 ft. The distance between pier line and bulkhead line is here 4,400 ft., admitting of the construction of piers of more than four-fifths of a mile in length. The area of the whole submerged tract acquired by the company is about 550 acres, and the area of that part of it between the bulkhead line and the present shore line is about 340 acres.

The company has been engaged for some time in dredging channels and in filling in that portion inside the bulkhead line. About 8,000,000 cu. yds. of filling will be required in all, of which about three-quarters has been put in place. The material excavated from the great tunnel under New York will be deposited here, and plans for transporting and handling this material are being worked out. The company has also acquired a strip of land 400 ft. wide extending from the above described tract entirely across the peninsula to Newark Bay, a distance of nearly one mile. Right of way is also secured for the extension of the New York Bay R. R. from the main lines across Newark Bay to the above described property.

Upon the property described will be constructed freight yards and piers of very large capacity. The strip between Newark Bay and the present shore line of New York Bay will be utilized for a receiving yard, and upon the reclaimed land west of the bulkhead line will be laid out and built a vast classification yard. From the bulkhead line will be built out five great piers, one of which will be used for warehouses, one for export grain business, with a grain elevator at its outer end, and the three others for coal and other freight. There will also be a special commodious pier for car floats, from which cars will be distributed by transfer boats to various points in New York city, or transferred to the Long Island Railroad, and to New England points via the New York, New Haven & Hartford road. The Bay Ridge terminal of

treaty amended, and it was ratified as first negotiated. The treaty is yet to be ratified by the Colombian Government.

The treaty, as ratified, gives the United States exclusive right for 100 years, renewable at the option of the United States, to complete the Panama Canal, maintain, protect and operate it.

Also gives to the United States "the use and control of a zone of territory three miles wide on each side of the canal. The United States recognizes the sovereignty of Colombia over the Isthmus. Colombia agrees not to cede or lease naval stations or military posts within the Department of Panama to any foreign government.

The treaty relieves the canal from taxes of any kind, permits immigration of workmen, authorizes the United States to preserve order and discipline on the canal and railroad, declares the canal neutral in perpetuity, gives Colombia the right of free transportation of its vessels, wipes out all anterior concessions, and transfers to the United States Colombia's interest in the new Panama Canal Company and in the Panama Railroad.

Colombia agrees to provide armed forces for the protection of the canal, if necessary. In the event of her inability to do so, the United States is authorized to employ such forces as may be necessary.

The United States agrees to begin the main work within two years and to open the canal for passage within 14 years. For the rights and privileges secured by the treaty the United States agrees to pay Colombia \$10,000,000 in gold when ratifications of the treaty are exchanged, and \$250,000 annually after the first nine years.

Under the contract drawn between Attorney General Knox and the Panama Canal Company the latter will receive \$40,000,000 in a lump sum upon the exchange of ratifications.

It is said that President Roosevelt will not appoint the members of the Canal Commission until after ratification by Colombia.