one another than 6 in. in any direction. The stones were soaked in water and then thrown down on, and rammed into, a soft mass of newly laid concrete.

In some few cases it was necessary to continue the concrete work of minor bridges after the frost had set in, in order to avoid delay to the track or the employment of diversions. This was done by carrying out the work on fine days under the hot winter sun, boiling the water of mixture and dissolving 8 per cent. of salt in it and covering the work over each night with a thick layer of straw. Such work has stood well, and only in one case, where the salt or firewood was probably stolen and the work scamped, was it necessary to take down some few feet of a small pier which was found to be touched by frost. The Alsen cement used was packed in sheet-iron drums with ½-in. wooden ends, which were necessary, to stand the tests of transport under Chinese conditions and the exigencies of weather and storage. In no case, except that just referred to, had any concrete to be condemned, or were any cracks due to unsoundness of cement discovered.

General Note on Concrete. The author would here call attention to two apparent anomalies in the general conception of concrete as a material in competition with other masonry:

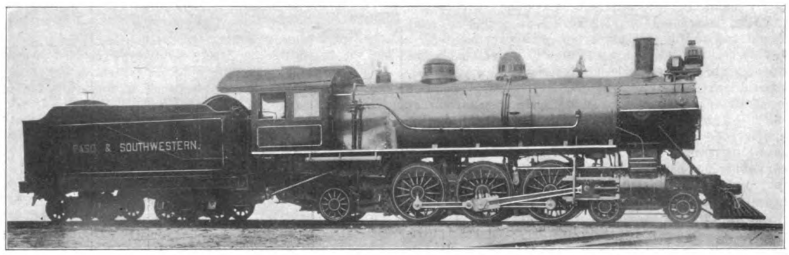
1. Concrete appears almost always to be judged and compared with other masonry by its compressive strength, whereas its ultimate test is rarely that of direct compression. Cracks and failures in masonry, whatever the first cause may be, whether from unequal foundations, unequal loading, or direct transverse stress as in a masonry or concrete beam, are almost invariably caused by cross breaking stress or shearing stress, and therefore, in effect, by tensional weakness or weakness in shear.

2. Although compressive stress is the test adopted, and although concrete generally gives a higher value thus tested than brickwork in cement, still brickwork, at two or three times the cost of concrete, continues to be regarded as a more reliable material.

The author is of opinion that the transverse breaking-strength of beams having a depth equal to one-quarter to one-half their bearing-length is the best test of materials for masonry work, and if this is true, it seems certain that even poor cement-concrete should be preferred to brick much more often than is the case.

Heavy Pacific-Type Locomotives for the El Paso & Southwestern.

The El Paso & Southwestern has received from the Baldwin Works two of an order of four heavy Pacific type locomotives; the remaining two are to be delivered in February. The photograph shows them to be quite similar in their lines and general appearance to the heavy Pacific type passenger engines of the Chicago & Alton; and, in fact, they were built practically to the same specifications, allowing for difference of service and operating conditions; for the El Paso & Southwestern locomotives are for fast freight service. The chief points in which they differ from the Alton engines are in the smaller drivers, shorter stroke and lower boiler pressure. Their total weight is also nearly 10,000 lbs. less. The purpose of the road in selecting this design for fast freight service was to enable it to run 1,000-ton gross load freight trains over its line having 1 per cent. ruling grades, on a 15 m.p.h. schedule.

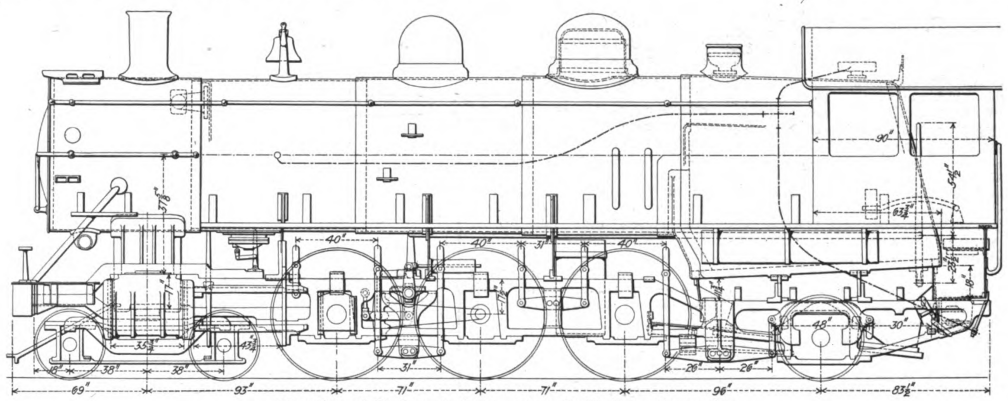


Pacific Type (4-6-2) Locomotive for the El Paso & Southwestern.

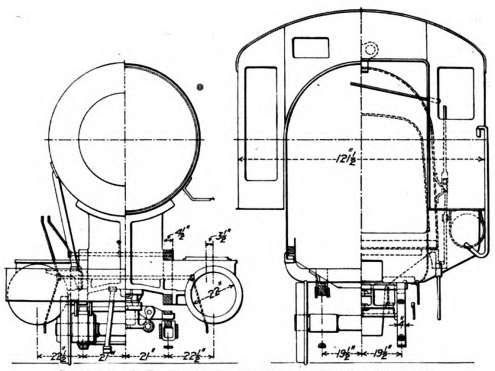
Grate area	52¼ sq. ft.
Drivers, diameter	63 in.
Truck wheels, front, diameter	33 in.
Truck wheels, rear, diameter	40 in.
Journals, driving axle, size	10 in. x 12 in.
Cylinders, diameter	22 in.
Piston, stroke	26 in.
Valves, kind of	Balanced

Boiler.

Type	Straight
Working steam pressure	200 lbs.
Material in barrel	Steel
Thickness of material in barrel	¾ in.
Staying	Radial
Fire-box, length	9 ft. 6 in.
Fire-box, width	5 ft. 6 in.
Fire-box, depth front	75 in.
Fire-box, depth back	65¾ in.
Fire-box, material	Steel
Fire-box, thickness of sheets	⅜ in. and ½ in.
Fire-box, water space, width:	Front, 4 in.; sides, 3½ in.; back, 3½ in.
Tubes, number	318
Tubes, material	Iron
Tubes, outside diameter	2¼ in.
Tubes, length over sheets	19 ft. 6 in.
Tank capacity for water	7,000 gals.



Elevation of El Paso & Southwestern Pacific-Type Locomotive.



Sections of E. P. & S. W. Pacific-Type Locomotive.

Assuming a speed of 10 m.p.h. on the 1 per cent. grades, a train resistance of 4.5 lbs. per ton $\left(\frac{V}{4}+2\right)$, a grade resistance of 20 lbs. per ton for the train, and an additional 20 lbs. per ton for the locomotive with a half load of coal and water (150 tons), the total resistance comes to 27,500 lbs. The maximum available tractive power of the locomotive is 33,950 lbs. On grades, allowing for various contingencies, it is fair to assume that 80 per cent. of the maximum tractive force is available, which gives 27,200 lbs., showing that these locomotives should be able to maintain a 10-m.p.h. speed on the long 1 per cent. grades they encounter. The two already in service have proven their ability to do this.

The main line of the El Paso & Southwestern is laid with 75-lb. rails, with the exception of one short stretch which has lighter rails. The water for locomotive supply is obtained entirely from wells and is unusually good, though some of it has small amounts of alkalies, causing foaming, though not to any serious extent.

Following are the general dimensions:

Weight on drivers	132,500 lbs.
Weight on front truck	36,800 lbs.
Weight on rear truck	40,200 lbs.
Weight, total, engine	209,500 lbs.
Weight, engine and tender	340,000 lbs.
Wheel-base, total, of engine	30 ft. 9 in.
Wheel-base, driving	11 ft. 10 in.
Wheel-base, total (engine and tender)	60 ft. 7½ in.
Heating surface, fire-box	184.5 sq. ft.
Heating surface, tubes	3,634.0 sq. ft.
Heating surface, total	3,818.5 sq. ft.

Progress of Power Signaling in England.

BY CHARLES H. GRINLING (*London*).

The first English experiment in operating railroad signals otherwise than by manual and mechanical power was made on the Liverpool Overhead Electric Railway, which since its opening in 1893 has been worked by electric automatic signals except at the termini, where interlocking frames of the ordinary mechanical type are provided to control the shunting of the trains. There are 12 intermediate sets of block signals which are automatically operated by means of "long-pole" electro-magnets, the invention of Mr. Illius A. Timmis, an English engineer. Mr. Timmis was also concerned with Mr. F. W. Webb, chief mechanical engineer of the London & North Western, and Mr. A. M. Thompson, electrical engineer of that road, in working out the "Crewe system" of all-electric power signaling, the first experimental installation of which was completed in the freight sidings at Crewe in January, 1898. The whole of these extensive sidings are now electrically signaled from cabins containing in all nearly 1,000 levers. The semaphores and ground disk signals and also the trailing points are operated by the Timmins long-pole magnet, and, in the case of the signals, counterbalancing weights are provided so that, as soon as the current is cut off, they fly back to danger. The facing points are worked by electric motors of a type specially designed and constructed at Crewe, which operate through a worm-gear with right and left-handed clutch for moving the switch and locking rods. One of these motors is provided to each set of facing points. The electric current is supplied from the station lighting generator at 110 volts. The amount of power required is small, 50 amperes being computed to be the maximum demand for the largest cabins. The Crewe system is represented commercially in the United Kingdom by the Railway Signal Company of Fazakerly, Liverpool. This company has recently completed a contract for the North Eastern for an installation in one of the largest cabins, controlling freight sidings, near York. This cabin is known as Severus Junction. The "Crewe" system of power signaling has not so far been applied to passenger lines, but Mr. Webb publicly stated not very long ago that it was the intention of the London & North Western to do so. Mr. Webb has since retired from the position of chief mechanical engineer of the road, but his co-inventor, Mr. A. M. Thompson, is still superintendent of the signaling department. No other system of power signaling has so far had a trial on the North Western.

The well-known Westinghouse electro-pneumatic system was first introduced into England on the Great Eastern by the instrumentality of a director of that road, Sir H. W. Tyler, who was formerly one of the inspecting officers of the Board of Trade and afterwards president of the Grand Trunk of Canada. The plant for the Great Eastern box was made in America and then shipped piece-

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meal to England, where it was put together and installed by Messrs. McKenzie & Holland, the well-known English signaling firm. This installation, like those at Crewe, is in a freight yard, viz.: at Bishopsgate, London, which is the London terminus for the freight traffic of the line. The cabin contains a 47-lever frame, and it commenced work on Jan. 15, 1899. The Great Eastern has not adopted this or any system of power signaling at any other part of its line; but two other English roads—the North Eastern and the Lancashire & Yorkshire—have contracted for electro-pneumatic installations, and both these companies are now using this system on passenger lines, although the North Eastern's installations are primarily for working mineral and goods traffic. At Tyne Dock, the well-known coal-shipping station on the North Eastern, there are three electro-pneumatic signal cabins, which were opened respectively in July, 1902; September, 1902, and April, 1903. They contain 29, 66 and 30 levers respectively. The most recent, and the most important installation of the Westinghouse system in England is that of the Lancashire & Yorkshire at Bolton passenger station, which has just been brought into use. It contains 83 levers and is the first English example of the use of the electro-pneumatic system on a large scale for the control of passenger trains. The Lancashire & Yorkshire authorities purchased the patented parts from the Westinghouse Air-Brake Company in London and put together the installation themselves.

In the summer of 1900 Mr. John N. Beckley came over from America to Europe with the object of introducing the low-pressure pneumatic or "all-air" system of signaling into England and the Continent. Mr. Beckley quickly fixed up an arrangement for this system to be represented in Europe by Mr. John P. O'Donnell, of the firm of Evans, O'Donnell & Co., signal engineers of London and Chippenham. This firm has since amalgamated with Saxby & Farmer under the title of "Saxby & Farmer Ltd." For the purpose of exploiting the "all-air" system a separate undertaking was formed under the title of the "British Pneumatic Railway Signal Co.," with Mr. O'Donnell as chairman. Considering the comparatively short time it has been in the field and the conservatism of English railroad methods, this undertaking has made very considerable progress. Two of the leading officials of the London & South Western, Mr. Sam Fay, superintendent of the line (who has since become general manager of the Great Central), and Mr. Jacomb-Hood, chief engineer, after a visit to America in 1900, during which they studied all the power systems then in vogue, recommended their directors to adopt "all-air" in a new cabin which was about to be built on the London & South Western main line at Grateley, in connection with the opening of a short branch from that place. This was a 72-lever cabin and it was opened in July, 1901, in the presence of representatives of all the leading British lines, who besides inspecting the signaling installation enjoyed the pleasure of hearing an oration from Mr. Chauncey M. Depew. Following the Grateley installation the London & South Western soon decided to place two similar installations at Salisbury, a much larger station which was about to be remodeled, and these were completed about a year ago. A detailed description of the Salisbury plant appeared in the *Railroad Gazette*. Within a year, too, of the opening of the Grateley cabin, the London & South Western gave to the British Pneumatic Company by far the largest power-signaling contract yet let in the United Kingdom, namely, for the installation of the low-pressure system on its main line between Woking and Basingstoke, a distance of 24 miles, including eight pneumatic interlocking plants averaging 70 levers each. It should be stated that, in connection with the Grateley plant, a small experimental installation of automatic signaling was laid down in 1901 between Grateley and Andover, the low-pressure air valves being operated by a track circuit. Mr. Jacomb-Hood, the engineer of the road, stated last June at the Engineering Conference in London that they had not had a single failure of these automatic signals in 18 months' experience. Thirty-one sets of these automatic signals are now being erected in connection with the widening of the South Western main line between Woking and Basingstoke, the semaphores being placed on bridges spanning the four tracks. The British Pneumatic Company has also in hand a contract—the first in England for which tenders were openly invited—for the installation of its system of power and automatic signals at Staines Junction on the London & South Western. Here two "all-air" cabins are being erected to do work which would require four or five equipments of the manual type. It should be stated that in connection with the introduction of power signaling the British Board of Trade has considerably increased the distances at which it will allow switches and signals to be worked, the limit for facing points, for example, having been increased from 200 to 300 yards. Six miles of track circuit also is being laid down at Staines for the automatic returning of the levers to normal—that is the "electric slot." The North Eastern intends soon to have an installation of the British Pneumatic system, so as to give a fair trial to each of three competing methods.

In regard to automatic signaling the leading officials of the North Eastern, when they visited America in 1901, were favorably impressed with the Hall system, and they entered into a provisional agreement with the Hall company to lay down an experimental installation on 11 miles of their main line north of York. Some detail difficulties, however, arose, and it was not until after a second deputation of North Eastern officers had visited America in 1902, that this contract was finally sealed. As a result of this delay, it was decided to adopt compressed carbonic acid gas for lowering the semaphores instead of electric motors, as originally intended, the gas valves being opened by track circuit. Automatic signaling by track circuit has been recently installed by the Westinghouse Brake Company on the electric section of the Metropolitan District Railway between Ealing and South Harrow, near London. This equipment, which includes the automatic train-stop, is the second example of an electric railway being signaled automatically by means of track circuit, the only other installation being at Boston, Mass. The British Pneumatic is also arranging to install about 12 automatic block sections on this line, which is being used by Mr. Yerkes as a sort of trial-ground for testing various types of apparatus, with a view to deciding which are the best to adopt on his system of "tubes" now under construction and on the electrified district. Messrs. Spagnoletti also have a system of automatic signaling for tube railroads in the market, which is being installed on the Great Northern & City line, a road outside the Yerkes group, shortly to be opened for traffic. Trials of the Spagnoletti system are also taking place on the Central London To prove that track circuits can be relied upon even under the most unfavorable conditions the British Pneumatic recently laid one down through the Woodhead tunnel of the Great Central, which is over three miles long and exceedingly damp. It is expected that this road will be the next to adopt automatic signaling on an extensive scale. The Great Central recently allowed the Miller Cab Signaling syndicate to give a demonstration of its system. A system combining the operation of signals by electric motors with the working of switches by manual power has just been installed at the St. Enoch's Station, Glasgow (Glasgow & South Western), by the W. R. Sykes Interlocking Signal Co., which company has also obtained a contract at the Folkestone Station of the South Eastern & Chatham. The company (of which Major-General Hutchinson, formerly chief inspecting officer of the Board of Trade, is chairman,) was formed some years ago to exploit the Sykes "lock and block" system, which, however, seems to be in danger of being superseded by automatic track circuit signals.

Foreign Railroad Notes.

A Prussian railroad regulation requires that before an employee gives the signal for a train to enter a station he must ascertain that the track is clear in front of it. In one case, a station officer ordered the drillmaster to switch a baggage car from the main track in front of the station, which would have cleared the track for the following train. Assuming that his order had been obeyed, he signaled line clear. But the baggage car had not been moved, and the entering train ran into it. Tried for negligence in signaling line clear, the station man was acquitted by the trial court, which held that he had a right to assume that his order had been obeyed; but on appeal the imperial court reversed the decision, holding that the rule that he should "ascertain" that the line is clear, means that he should see for himself, go where he can see, and if it is not light enough find out by feeling.

The Belgian State Railroad authorities, moved thereto by some recent accidents, have given notice to enginemen, firemen and signalmen, that hereafter violations of the rules will be followed by immediate suspension, and, unless on investigation, grave reasons do not excuse their acts, by final dismissal from the service.

American Railway Association.

This Association held its fall session at Richmond, Va., October 28. There were present 84 delegates, representing 61 members, and President A. W. Sullivan occupied the chair.

The Executive Committee reported that the membership of the Association now comprises 279 members, operating 211,664 miles, an increase of four members and of 1,347 miles. The question of the proper design and construction of tank cars for the safe transportation of volatile oils, and action taken by the Master Car Builders' Association in connection therewith, was also referred to in the report of the committee. The Association voted that to be admitted to membership a road must be a common carrier, dependent upon its revenue from transportation. Railroads are ineligible to membership, whether incorporated or not, which are used primarily to transport the material or product of an industry or industries to and from a point on a railroad which is a common carrier, or those which are merely adjuncts to such industries."

Several amendments to the Articles of Organization and Sections of the By-Laws were submitted, which will come up for action next April.

Section 8 of the By-Laws was amended so as to have the President and Second Vice-President elected in April, and the First Vice-President in October.

The Association adopted the following:

Rules Governing the Movement of Trains with the Current of Traffic on Double Track by Means of Block Signals.

1. On portions of the road so specified on the time-table, trains will run with the current of traffic by block signals whose indications will supersede time-table superiority.
2. The movement of trains will be supervised by the ——* who will issue instructions to signalmen when required.
3. A train having work to do which may detain it more than —— minutes, must obtain permission from the signalman at the last station at which there is a siding before entering the block in which work is to be done. The signalman must obtain authority to give this permission from the ——*
4. Except as affected by these rules, all Block Signal and Train Rules remain in force.

*Superintendent or Train Despatcher.

The Committee on Safety Appliances reported progress in formulating rules governing the determination of physical and educational qualifications of applicants for employment.

The Committee on Statistical Inquiry reported that a large amount of data has been obtained, and that considerable work has been accomplished.

The Committee on Standard Cipher Code reported progress. The committee finds it will require a longer time to complete the task than had been anticipated.

The Committee on Car Service submitted a number of amendments to the Code of Per Diem Rules and the Code of Car Service Rules. The rules as revised by the committee, with a single unimportant exception, were adopted by the Association, to take effect on Jan. 1, 1904. Interpretations of the per diem rules by the Arbitration Committee were approved.

Mr. A. H. Smith, General Manager of the New York Central, and Major E. T. D. Myers, President of the Richmond, Fredericksburg & Potomac, were elected members of the Committee on Nominations.

The Buffalo & Susquehanna, the Delaware, Lackawanna & Western, and the Wabash were re-elected members of the Committee on Car Service.

The Chicago & North Western, the Cleveland, Cincinnati, Chicago & St. Louis, and the Philadelphia & Reading were re-elected members of the Committee on Safety Appliances. The next meeting of the Association will be held in New York City on April 27, 1904.

Cost of Line Wires for Automatic Signals.*

In November, 1902, your committee . . . concluded that copper wire of certain gages should be recommended. In order to make the above named report more comprehensive, we quote the data in Tables 1 and 2. (All the items refer to wire with Doublebraid weather-proof insulation.)

Table 1.—Cost of Wire Lines on Poles for Signaling.

Reference to Table 2.	Gage.	Weight per mile.	Cost per pound, cents.	Ohms per mile.	Labor per mile.
A	8BWG	483 lbs.	4.5	12	$5.00
B	10BWG	350 lbs.	4.5	18	5.00
C	12BWG	158 lbs.	13	8	4.00
D	10BWG	238 lbs.	13	5½	4.00

Table 2.—Statistics of Certain Installations.

Miles track protected.	Miles and kind of wire.	No. of signals.	To install per mile—— Wire & Labor.*	Battery material.	To maintain battery per mile per yr.†
5½	5½A, 5½B	4	$23.83	15 cells, $30.00	$18.00
30	30A, 60C	13	25.27	11 cells, 22.00	13.20
39½	30½A, 30½B, 39½C	19	24.10	10 cells, 20.00	12.00
108½	108½D, 217C	37	28.00	8 cells, 16.00	9.60
29	29D, 29C	13	29.75	8 cells, 16.00	9.60

*This item indicates cost exclusive of pole line and fixtures. †This represents an average delivery of .120 amperes of current through the circuit, i. e., from battery to common wire through relay and other contacts through signal instrument magnets, through signal circuit back to battery, for distances, in feet, to correspond with our previous reports.

For reasons shown in the tabulated statement, we respectfully recommend that copper wire be adopted as the standard for signaling circuits. While the first cost per mile is a little in excess of iron, the saving in installation of battery and the cost of maintenance, both material and labor, soon more than offset that factor.

In addition to this, the lasting quality of copper as compared with iron, the difference in the weight that the poles and cross arms have to carry, the reduced liability of failures due to broken jars, loose connections or exhausted cells, and the smaller chance of failures due to defective joints in the line wire are all in favor of copper.

H. S. Balliet, W. A. D. Short, C. S. Rhoads, S. K. Bullard, C. Selden, Committee.

*Railway Signaling Club: Committee Report, Detroit meeting, Nov. 10.

Foundation Brake Gear for High-Pressure Control.

The Master Car Builders' Association standard details of foundation brake gear for freight cars were adopted in 1889 and with the exception of a few minor changes still remain as adopted, although entirely inadequate to resist the stresses imposed by increased air pressures acting through 10 in. x 12 in. cylinders which are in use

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