Electro-Pneumatic Interlocking at the Boston Southern Station.*

By J. P. Coleman.

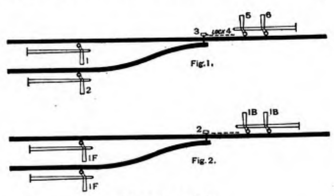
The Interlocking Machine.

The evolutions through which the design of a piece of mechanism passes from its first conception to the period of its greatest utility often render it difficult of interpretation to those not familiar with its development.

The interlocking apparatus used in the electro-pneumatic system has been no exception to this general rule. Those well versed in the art of interlocking, outside of this particular branch of it, have been more or less mystified by the radical departure from former methods of construction that was made in the first pneumatic machine built. Failing to fully realize the benefits resulting from the construction of that apparatus, it was but natural that each succeeding modification in it intensified rather than diminished the original feeling.

The growing necessity for power interlockings has at the present time created a desire on the part of many to fully understand the most modern methods and devices used therein.

The switch and signal operating mechanisms and the general equipment of such a plant have been dealt with in a description of the interlocking at the new Boston Southern Station. An attempt to render equally comprehensive a description of the interlocking machine there would be difficult and scarcely successful without some preliminary remarks and assumptions relating to an apparatus and to a system already well understood by many, hence this seeming departure from the text.



Figs. 1 and 2.

Fig. 1 represents a junction of two single track roads signaled and interlocked by a "mechanical" apparatus in accordance with present practice; distant signals being omitted for simplicity's sake. Each signal is operated by a separate lever, the switch by one lever and its lock and detector bars by another, making a total of six levers necessary.

The locking of this machine would be as follows:

1 locks 3 normal.	4 locks 3 normal and reversed.
1 locks 4 reversed.	5 locks 3 normal.
1 locks 5 normal.	5 locks 4 reversed.
2 locks 3 reversed.	6 locks 3 reversed.
2 locks 4 reversed.	6 locks 4 reversed.
2 locks 6 normal.	

It is possible to operate the above with but two levers, however, under favorable conditions and by means of mechanical appliances in common use, but not with the same degree of safety, nor with the same muscular effort on the part of the leverman or freedom from strains in the operating connections.

A switch and lock movement may be used to perform by means of one lever the work here assigned to levers No. 3 and No. 4. Signals 1 and 2 may be operated from one lever through a "selector" controlled by the switch lever. Signals 5 and 6 may likewise be operated through a selector from the lever operating signals 1 and 2, if the lever is made to stand normally in a central position and to move forward in operating signals 1 and 2 and backward in operating signals 5 and 6.

The load on the signal lever will be doubled by this arrangement, as will also that of the switch lever, but the number of levers is reduced one-third, (See Fig. 2) while the locking reads simply:

1 forward locks 2 normal or reversed.
1 backward locks 2 normal or reversed.

Were it not for the fact that extreme distances, and other conditions affecting mechanically operated switches and signals, would render this practice prohibitory, frequently; and, were it not true that well-founded objections exist to the use of selectors and switch and lock movements in mechanical interlockings, this assumed method might be employed to great advantage in large plants where tower space is valuable and where extreme complications in locking and lever movements are serious considerations.

If, therefore, some means be secured by which the load on levers so connected is easily handled by the operator; if the objectionable feature of switch and lock movements is overcome, and if the selector be discarded, or so modified as to avoid the present danger of false operation of signals through it, the means would find justification in the ends attained.

The objection to switch and lock movements in mechanical interlocking, as stated in a previous article, is directed against the small part of the lever's stroke that is available for locking the switch; and hence the risk incurred in forcing home (through lost motion in connections) the lever without accomplishing this important duty.

If the switch lever of such a machine were so controlled by the switch during operation that unless the latter became fully locked the catch rod of the lever could not be lowered (and hence its locking of other levers not released), the use of a switch and lock movement would not be objected to in the mechanical interlocking, where otherwise practicable.

Selectors are objected to almost solely on account of possible entanglement of the operating wires leading from them to the signals, resulting in danger of the pull wire of one signal clearing with the latter a signal conflicting with it—the "back wires" of all signals operated through a selector being necessarily joined in common to a single wire extending from them to the selector and hence being "slack" to all signals of the selector but the one engaged by it for legitimate operation.

This and minor considerations—such as difficulties in the matter of adjustment, fitting, and in the general arrangement of selectors in a manner consistent with the advantages intended to be secured by them—discourages their use, and it is pretty generally conceded that where used they are as expensive as, and are more troublesome than, the levers they would supplant.

The prime objection to them is, however, the danger incurred from the possibility cited, which may be said to result broadly from the fact that the motion of one wire may be accidentally transmitted to another during operation.

In the Railroad Gazette of November 10 and December 1, 1899, appeared a description of the switch and signal movement used in the electro-pneumatic system at the Boston Southern Station, with sectional drawings illustrating these devices.

Assuming that the construction and operation of these individual parts were made clear in that description, an effort will be made to render clear the advantages they possess in overcoming the objections cited as peculiar to the arrangement shown in Fig. 2, if they were so applied to that arrangement as to control from the two-lever machine the one switch and the four signals shown. The only connections that would be required between these two levers and the electro-pneumatic devices mentioned, were the latter substituted for the mechanical appliances ordinarily used in connection with these levers, would consist of electric wires suitably insulated and protected from injury.

The usual pipe and wire lines, cranks, compensators, wire and pipe carriers, rocker shafts, and the numerous foundations required for their support, together with much labor in installation and attention in maintenance would be entirely avoided in the lead-out of such a plant if it were thus equipped.

Problems as to the loads that are practicable of operation from one lever under the varying conditions met with in practice would cease to longer be a subject for controversy, and the ability to operate through any distance desired by this means the lightest or the heaviest switches, or the combinations of switches, with equal ease, is at once apparent, since their operation would involve, on the operator's part, only such muscular effort as would be necessary to shift the electric contacts by which their motion is indirectly affected, and incidentally such mechanical locking between levers as would by local conditions be required attached to them.

The use of selectors of the usual mechanical design would be avoided under such a system, as would also the objections common to them.

The use of switch and lock movements would, however, be retained and their use would be extended on all switches operated, owing to the fact that switch locks and detector bars constitute attachments essential to the proper protection of every switch, and that this device affords the simplest means of operating the switch and these appliances by a simple acting cylinder.

Some positive means must be provided, however, of detecting failures of switch and lock movements to respond fully to the motion of the levers operating them, when these movements are not shifted mechanically by the levers, since the nature of the power and the appliances used for shifting them otherwise is necessarily of an elastic nature, and, were precautions not provided for preventing it, a full movement of the lever might be made without the switch necessarily responding. Such a movement of the lever would (through the mechanical locking of the machine) release the levers which control signals leading over the switch operated by it, and if the latter failed to respond, disaster might result. To prevent this condition, the switch lever may be arranged to shift the switch completely by a partial lever movement; its complete movement, then, at that stage, being prevented by electric locks, engaging it and so controlled by the switch that until the latter has fully shifted the locks will not release the lever.

Switch and lock movements operated by air pressure, from levers so controlled, may be used with greater safety than they are when shifted mechanically by levers which have no other means of detecting failures of the movement to properly shift, than that furnished by the operating rods connecting them.

The precautions cited as essential to the safe operation of switches by compressed air also apply to a like operation of signals, and the many advantages of the electrical method by which both may be controlled when so operated will become apparent with a clearer understanding of the means through which it is accomplished in the electro-pneumatic system.

[TO BE CONTINUED.]

* Continuation of a series of articles published in 1899, as follows: May 12, July 21, Nov. 10, Dec. 1.

Signaling as it is and as it Might Be.

BRIEF HISTORY OF SIGNALING.

BY A. H. RUDD,

Signal Engineer, Hartford Division, New York, New Haven & Hartford.

The first known fixed signals for land work in America were two lights displayed from the belfry of Old South Church, Boston, forming a "distant signal," and indicating to Paul Revere "proceed to the homes." From his time until the close of the Civil War, the subject was little thought of here, although in England as early as 1844 the dangers of time spacing were recognized and on some roads block sections of varying length were established, protected by semaphores, communication between towers being effected by the needle telegraph and in some cases by bell code. The operators were instructed, but not forced by any mechanical or electrical device, to restore the signals to danger after the passage of each train, establishing in effect the telegraph block, as it here exists to-day.*

As early as 1865 a number of "turn towers" were installed on the Philadelphia & Reading. These towers were located always on sharp curves, at the point of intersection of the tangents, being often several hundred feet from the track, but giving the engineer a good line of sight in a clear atmosphere. A large fan arrangement on top of the tower revolved, displaying red until a train had passed out of sight of the operator, at all other times showing white. While most of these devices have been supplanted by automatic signals, two of them still remain in service.

Omitting (as they are not properly block signals) any description of the banners, balloons, Dutch clocks, flip-flops, red balls, windmills and various other fantastic and unique shapes, varieties and systems (?) of signals, some of which are still extant, we find that in 1866 Thomas S. Hall of Connecticut began work upon an automatic block indicator. In 1871 he installed a crude but ingenious apparatus on the New York & Harlem, and the Eastern (now the Boston & Maine), operated on an open circuit. After a number of years of constant labor and many improvements he evolved the "banjo" signal of to-day, in which a closed electric circuit is employed to raise a disk, so that any broken or crossed line wires or defective battery will allow it to drop by gravity and indicate danger; this circuit being opened at a relay by the passage of the train.

In place of track instruments, whose treadles were depressed by the wheels of passing trains, and which if broken or set too low would not operate, we now have track circuits which keep the signal at danger as long as a pair of wheels is in the block; while non-fusing relays, with lightning arresters, guard against sudden heavy currents. This system appears to be capable of but little farther development.

On February 1, 1881, the first patent was issued to George Westinghouse, Jr., for electro-pneumatic signals. This was followed by five others to him and two to other parties during that year; also two reissues and three new patents, prior to 1887, in which year Mr. Westinghouse took out ten additional patents on these devices. The system has since been constantly improved by employees of his company, and to-day the automatic block semaphores, notably on the Pennsylvania Railroad, give evidence of its perfection. The first signals of this class were installed in 1882. In recent years a number of other devices have been evolved, and some are being perfected, but the results achieved by the two above noted and their extensive use warrant us in taking them as examples of American practice.

No successful automatic systems, I believe, have originated abroad. Although automatic signaling has thus far made little or no progress outside of America, there is still the possibility of a wide and profitable field for American inventions.

In manual controlled block signaling, however, English inventors were early in the field, the Sykes system being perhaps the most widely adopted and best known among them. This device was brought to our shores about 1882, but had several defects, chief of which was the lock falling free by gravity, instead of being pulled out by the electric current; there was also the liability to unlock by the action of lightning or by crosses of foreign wires. Here

* In fact the principle of the telegraph block system appears to have been fully recognized by the English as soon as the telegraph was put in use, and experimental block signaling is reported as early as 1839.

again our inventors set to work and the Patenall and Union lock and block instruments are further proofs of their ability and perseverance.

The electric train staff was originated in England and improvements on it or useful additions to its facilities have been devised in this country.

At the present time, however, many of our large roads, as a matter of economy, or for other reasons of policy, cling to the time interval as a method of spacing trains, and the following incident actually occurred on a large double track line not a thousand miles from New York, as late as 1887. On a day of extra heavy travel Father Time was represented by section men stationed at convenient intervals armed with five minute sand glasses to mark the fleeting minutes and with red flags in lieu of scythes, with instructions to display the latter as soon as each train passed, turn the glass, and stop all trains until the sand ran out. The first *down* special passed a timeboard, indicating that the preceding train was over an hour ahead, only to be stopped by the next red flag. An examination of the glass showed that the sand had run about two minutes. "Where is the other train?" thundered the Superintendent, who was aboard. "Just gone up, sor!" That block station was abolished, the flag was replaced by a pick, and the "aisy job" discontinued for the day. This line now has a complete block system, and trains are not stopped by the propinquity of those on the opposite track.

In interlocking, Great Britain was in the lead for many years. Our first machine was devised and installed by Messrs. J. M. Toucey, General Superintendent, and William Buchanan, Superintendent of Motive Power, of the New York Central & Hudson River at Spuyten Duyvil Junction, N. Y., in 1874. It was replaced in 1888 by a Saxby & Farmer machine of American make. In 1875 the Pennsylvania Railroad imported from Saxby & Farmer of England a complete plant for Newark Junction, N. J., and soon after erected a large tower at Broad Street Station, Philadelphia. The elevated railroads of New York City were also early in the field.

With the exception of the Pennsylvania, few roads accomplished much until 1887, when the persistent efforts of the Railroad Gazette and other agencies in calling the attention of Managers to the advantages of these devices began to bear fruit, and improved financial conditions began to permit their adoption.

Until 1888 the Union Switch & Signal Co., successor to the original Jackson Manufacturing Co., dominated the field, furnishing a modified Saxby & Farmer machine, and employing the old gridiron flop locking. In 1888 the present Stevens locking, with patented swing dog special, was invented by Mr. J. T. Hambay. Soon the Johnson Railroad Signal Co. entered the field, putting on the market the Johnson machine, which was patented in 1885, 1888 and 1892, and using vertical locking invented by Mr. Arthur H. Johnson. Later the National Switch & Signal Co. was organized, languished a while, was reorganized, then absorbed the Johnson Company and was in turn amalgamated with the Union Switch & Signal Company, leaving as its record of contribution to the general good the National machine, with its beautiful special locking. This also is of the vertical type, and was patented by Geo. H. Pfeil in 1892.

During the later period of the above changes in organization the Standard Railroad Signal Co. entered the field, and in 1896 the Standard machine was put on the market, with locking designed, I believe, by Messrs. Henry Johnson and John T. Cade. Meanwhile the Hall Signal Co. was pursuing the even tenor of its way, confining itself to the manufacture and sale of the electric signals only.

Under the head of interlocking machines to be used with switches and signals worked by other than manual power, there is first to be noted the electro-pneumatic, manufactured by the Union Switch & Signal Co., brief mention of which has already been made in connection with automatic block signals. The first machine (1876) was purely pneumatic. The electro-pneumatic was tried in 1877. Also, the hydro-pneumatic was developed, and quite a number of plants of that kind were installed up to and including 1890. In 1891 other experiments were made with the hydro-pneumatic.

In 1892 the electro-pneumatic, with many improvements, was brought out, and in 1893 the patented Hambay tongue locking was adapted to this machine, and substituted for the purely electric locking which was in vogue up to that date—a great step in advance. In 1897 the final mechanical locking was used in this machine, and other improvements were made, the result being the electro-pneumatic machine which is the standard to-day. Recently, also, power machines operated wholly by compressed air, or entirely by electricity, have been devised, and a few installed, but they can hardly be said to have as yet passed the experimental stage, although they also will doubtless be rapidly perfected, and much may be expected of them.

Thus, after early struggles against adverse circumstances of every sort, obstacles seemingly almost insurmountable in the way of defects in the systems themselves, new conditions to be met in every installation, lack of financial support, narrow markets and infinitesimal returns, which only those men who bore the brunt of these burdens can ever realize, the American systems of to-day are established; and their universal adoption must be only a matter of time.

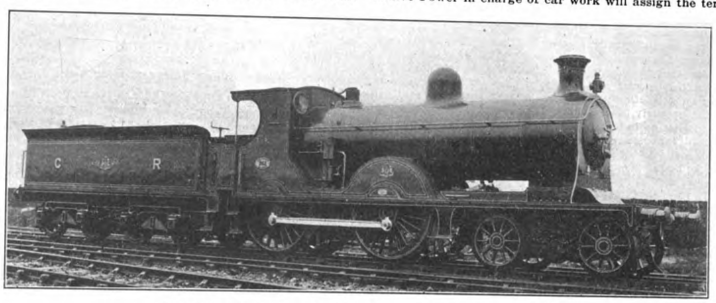
When the history of this work is some day written, the names of a score of modest men, little known at present outside their own small circle, will be honored as the pioneers of a science which has added as much as any single branch of engineering to the safety of passengers and property. It is this science or art that has made possible the tremendous increase of train manipulations at great terminals; the decreased safe time interval between trains, and the consequent increased capacity of the lines; and the greatly enhanced peace of mind of operating officials.

Signaling is a science not at present appreciated at its true value by one manager in a dozen, nor by one of the general public in ten thousand, because they do not understand it in detail or adequately appreciate its difficulties, its demands upon the men who pursue it (compensated in large measure though they are by the fascination of the study), or its great and absolute advantages to the railroads themselves, through safeguarding traffic and rendering possible its advantageous increase. But in the near future interlocking and block signaling will receive due credit, for it will be seen that traffic may be doubled, yes, quadrupled, by the use of signals.

[TO BE CONTINUED.]

Eight-Wheel Express Engines for the Caledonian Railway.

An eight-wheel engine has recently been built at the St. Rollox Works of the Caledonian Railway Company, intended for heavy and fast service. It is built from the designs of Mr. J. F. MacIntosh, Locomotive Superintendent of the Caledonian, whose reputation as a locomotive designer is not confined to his own country, engines built after his plans being in use on the State Railroads of Belgium. On the Caledonian is a combination of heavy and fast trains with heavy grades, and the weight of the West Coast expresses increases year by year, as is common experience in our own country. These new engines have been brought out to meet these conditions. The principal dimensions and weights are given below. These engines are fitted with steam sanders, Westinghouse brakes and apparatus for steam heating of the trains. An engraving is shown, from a photograph.



Eight-Wheel Express Locomotive for the Caledonian Railway.

Cylinders	19 x 26 in.
" c. to c. of	28½ in.
Wheels, diameter, truck	3 ft. 6 in.
" " driving	6 ft. 6 in.
Boiler, center above rails	8 ft.
" diameter of barrel	4 ft. 9½ in.
" thickness of plates	11/16 in
Firebox, length	6 ft. 11 in.
" breadth	4 ft. ½ in.
" depth, front	5 ft. 9 in.
" " back	5 ft. 3 in.
" thickness of plates	⅝ in.
Tubes, number	269
" length	11 ft. 7 in.
Heating surface, tubes	1,462 sq. ft.
" " firebox	138 sq. ft.
" " total	1,600 sq. ft.
Grate area	23 sq. ft.
Steam pressure	200 lbs.
Weight on driving wheels	79,968 lbs.
" of engine	115,808 lbs.
Tender, tank capacity	4,125 gals.
" coal capacity	5 tons
" wheels, diameter	3 ft. 6 in.
" weight	100,800 lbs.
Total weight of engine and tender	216,608 lbs.

Packing and Lubrication.

At the last meeting of the New York Railroad Club the discussion of the evening was on the subject of lubrication. In the course of the talk Mr. Waitt told something of the recent instructions put in force on the New York Central & Hudson River Railroad. We print below, in full, the general instruction circular No. 2, issued Jan. 1 of this year, governing the practice on the New York Central system.

Passenger Equipment Cars.

Packing.—The journal boxes in passenger equipment cars belonging to this company are to be repacked with waste saturated with winter oil each year, beginning the work on the 15th day of November and completing it as quickly as possible after that date.

All good, clean waste removed from the boxes at this time will be used again in repacking, after having the summer oil thoroughly squeezed out by pressure, and after it has been resaturated with winter oil.

In addition to the above repacking, all passenger equipment cars will be repacked when passing through shops for general overhauling, all waste in the boxes being removed, and that which is good and clean being resaturated.

In repacking boxes, preferably, new waste should not be used alone, but should, where it is practicable, be mixed with the old, the two being mixed in the proportion of one-half old and one-half new.

When the boxes are repacked, tin tags (1 in. x 3½ in.), having stamped on them in ½-in. letters and figures, the station abbreviation for the place where repacking is done, together with the month and year, are to be attached to two opposite inner corners of each truck frame. The tags applied when the boxes are repacked with winter oil are to have four dots marked after date, thus: M. H. 12-99. : : These tags will indicate to foremen and others at terminal yards where repacking is done, whether the boxes have been repacked within the specified time, and whether they have been repacked with winter oil after November 15, and will prevent any duplication of work. The tin tags should be painted standard truck color.

Oiling.—All through passenger trains on the main line will be oiled at New York and Buffalo, and on the West Shore at Weehawken and Buffalo, and no oiling at intermediate points will be done, except in case of warm or hot box, or other emergency. Journal box lids should not be opened at intermediate points unless box is found to be above running heat, as indicating by feeling it with the hand.

All local and branch passenger trains and cars not in main line or through service between New York and Buffalo are to be oiled once in every 3,000 miles run, the date of oiling all cars in such trains to be marked on the under side of the side sill over each truck, giving the month and day of the month.

In case of cars having no regular run, inspectors are expected to use their judgment in seeing that they are given sufficient oiling when at their station, care being taken to avoid using oil unnecessarily, and when such cars are oiled, the month and day of the month is to be chalked on the under side of the side sill over each truck.

Master Car Builders and Division Superintendents of Motive Power in charge of car work will assign the terminals at which regular oiling of passenger equipment cars in local and branch trains will be done, and they will file with the Assistant Superintendent of Rolling Stock a statement of such assignments.

Freight Equipment Cars.

Packing.—All freight equipment, work train and miscellaneous cars belonging to this company are to have all the waste removed from the boxes, and the boxes repacked, whenever they are placed on shop repair tracks for repairs. All waste removed that is good for further use is to be picked apart and resoaked in the tanks provided for saturating waste. Such waste is to be saturated in oil for not less than forty-eight (48) hours, then drained, after which it can be used again in repacking boxes in freight equipment, work train and miscellaneous cars. Such waste removed from the boxes as is found poor and dirty, is to be placed in proper receptacle and later is to be burned up.

The above practice of repacking boxes of cars placed on repair tracks is to be carried out at inspection points to as great an extent as possible consistent with the surrounding conditions.

All cars received from connections at interchange points, also all cars set out at stations where inspectors are located, and all foreign cars placed on shop repair tracks, are to have the lids of the journal boxes opened and the packing put in proper condition to run over this company's road without question, unless it is already in such condition. Well saturated packing only is to be used and applied in the boxes for this purpose. If in such cars the packing is found very dry, and not in good shape to carry the car over this company's line properly, it is all to be removed and the poor packing thrown away, and such as is good saved and resaturated for future use. The boxes from which packing is removed should be repacked carefully with freshly soaked packing. In addition to putting the packing in good condition, an examination must be made to see that the journals, journal bearings and keys are in proper condition.

Caboose cars are also to be taken care of by the use of saturated packing, in the same manner as other freight equipment cars. The boxes are to be examined after each trip, and when needing oil are to have saturated waste applied. This should not ordinarily be required more than at intervals of once each month.

In treating boxes having a sufficient quantity of packing, but which are lacking in oil, a small amount of