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1919

ELECTRO-PNEUMATIC SIGNALLING

at SOUTHPORT L&YR.

McKenzie, Holland and Westinghouse Ltd booklet,

Reprinted from an article in May 1919 Railway Gazette,

About installation of power signalling in Southport area.

(29 Pages)

ELECTRO-PNEUMATIC SIGNALLING AT SOUTHPORT LANCASHIRE & YORKSHIRE RLY.

THE Mc KENZIE, HOLLAND & WESTINGHOUSE POWER SIGNAL Co LTD

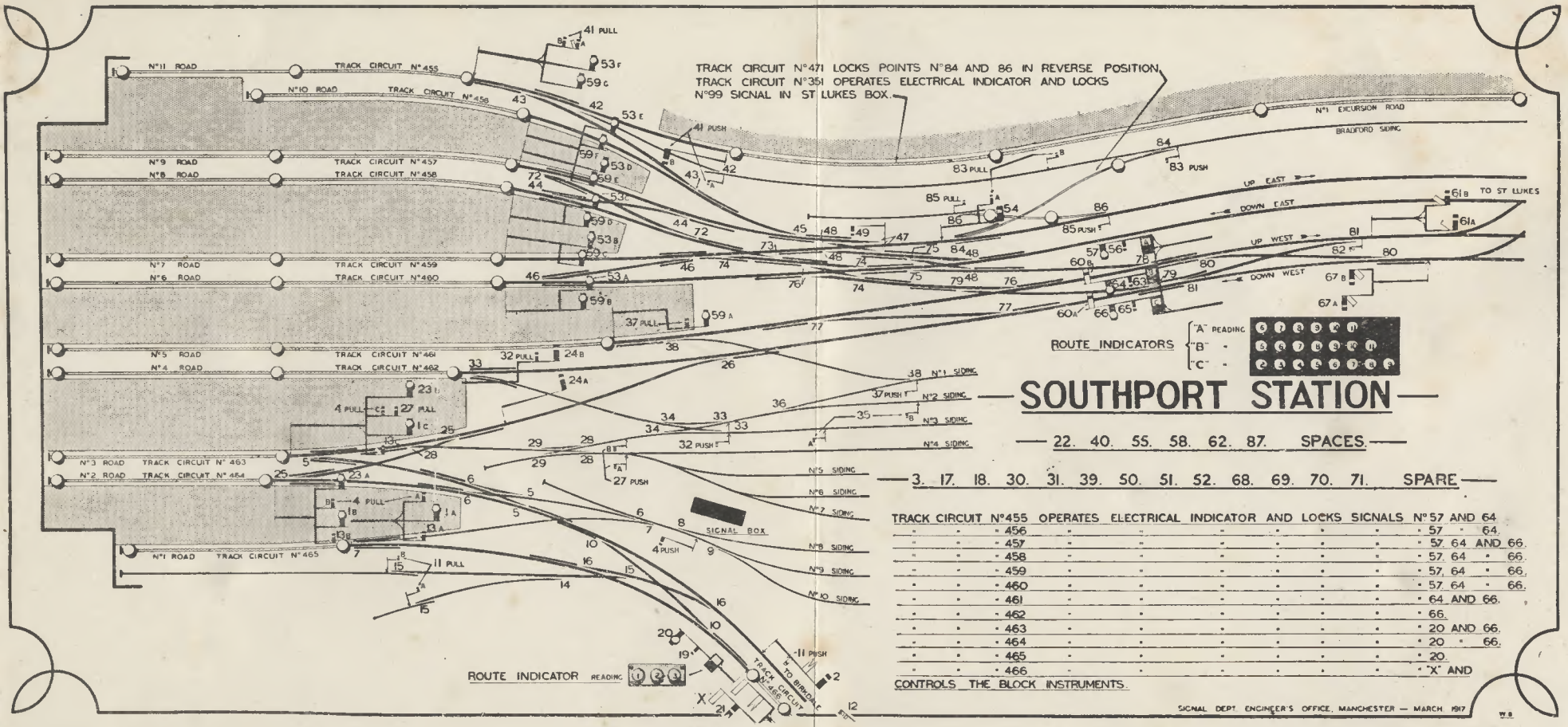
The . . .

Re-Signalling of Southport Station.

Lancashire & Yorkshire Railway.

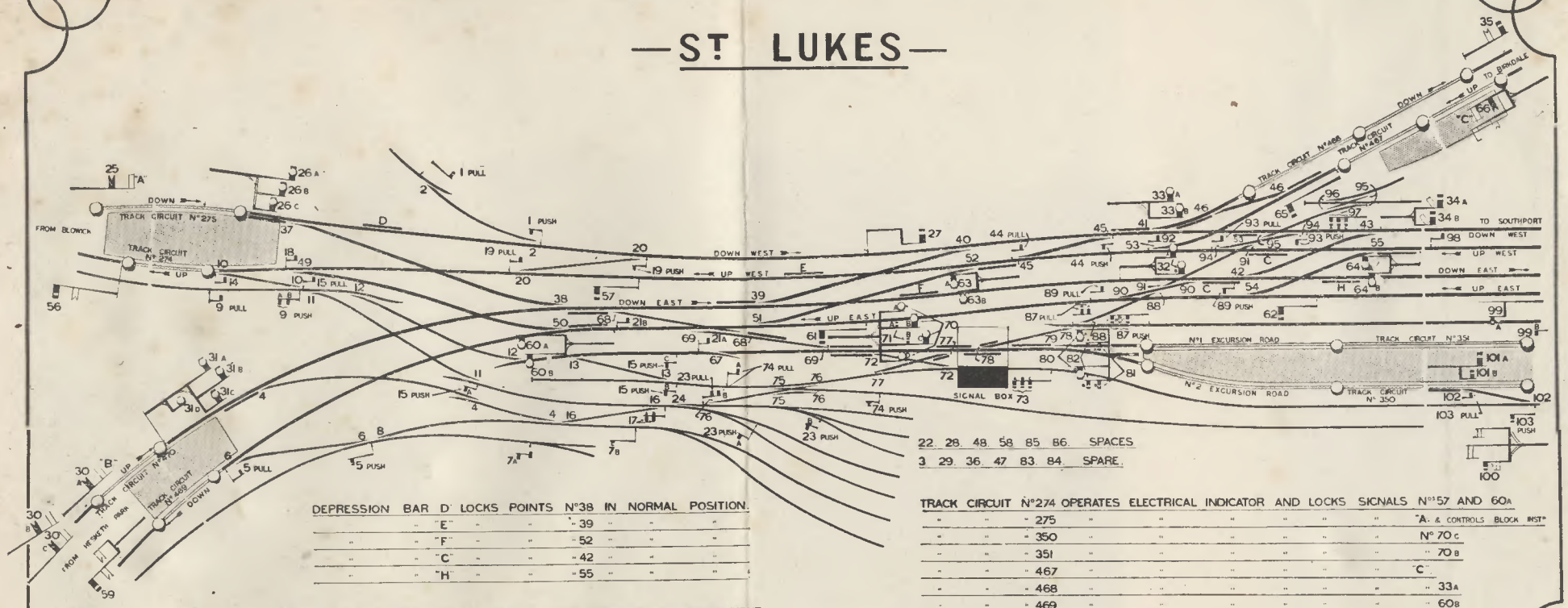
Reprinted from "RAILWAY GAZETTE," May 23, 1919.

The McKenzie, Holland & Westinghouse
Power Signal Co., Ltd., 58, Victoria Street,
London, S.W. 1. :: :: :: ::



Layout at Southport Station.

—ST LUKES—



22. 28. 48. 58. 85. 86. SPARES
3. 29. 36. 47. 83. 84. SPARE.

DEPRESSION BAR 'D' LOCKS POINTS N°38 IN NORMAL POSITION.

"	"	"E"	"	"	39
"	"	"F"	"	"	52
"	"	"C"	"	"	42
"	"	"H"	"	"	55

SIGNAL N°32A CONTROLLED BY STATION DOWN WEST BLOCK INSTRUMENT.

"	32B	"	"	"	EAST
"	33	"	"	"	WEST

TRACK CIRCUIT N°274 OPERATES ELECTRICAL INDICATOR AND LOCKS SIGNALS N°57 AND 60A

"	"	275	"	"	"A. & CONTROLS BLOCK INST°
"	"	350	"	"	N° 70C
"	"	351	"	"	" 70B
"	"	467	"	"	"C"
"	"	468	"	"	" 33A
"	"	469	"	"	" 60B
"	"	470	"	"	"B & CONTROLS

BLOCK INSTRUMENTS.

SIGNAL DEPT. ENGINEER'S OFFICE MANCHESTER – FEBRUARY 1918

Layout at St. Luke's.

THE following article from the *Railway Gazette* of May 23, 1919, sums up in a few words what has been accomplished by the recent re-signalling of Southport Station, Lancashire & Yorkshire Railway, and its approaches. To say that "two power-operated signal-boxes with 160 levers do the work of four mechanically-operated boxes with 340 levers" puts the story of what has been achieved into a nutshell. Signal engineers and operating officers acquainted with the electro-pneumatic power signal system will find that at Southport there have been many improvements made on the installations of the same system of working as found at Glasgow Central, Newcastle, Hull, Bolton, Slough and all over the District Railway and its allied tubes. A new type of route indicator has been introduced, also a method whereby the signalman is so controlled that, when actuating one of a series of selected signals, the particular arm he wishes to lower is the one that will respond to the lever, provided always that the road for that signal be properly made. It is due to the Lancashire & Yorkshire Company and the electro-pneumatic system to say that the installation at Bolton—which was ordered in 1901—was the first fixed in this country on a passenger-carrying railway, and it is significant that although the railway company had, because of its Liverpool-Southport train services, an ample supply of electricity, it adopted the same system—the electro-pneumatic—as at Bolton.

SIGNALLING AT SOUTHPORT, LANCASHIRE & YORKSHIRE RAILWAY.

Two Power-Operated Signal-Boxes with 160 Levers do the Work of Four Mechanically-Operated Boxes with 340 Levers.

SOUTHPORT is, to the Lancashire & Yorkshire Railway Company, one of the most important towns on its system. It has a very large residential traffic, which caters for the business men of Liverpool, Manchester, Bolton, Blackburn, Preston, &c.; it is popular all over the Kingdom as a health resort, and rivals Blackpool, in the eyes of many, for an enjoyable holiday. In normal times the ordinary summer service consists of about 146 arriving trains and 148 departing, and, on a popular holiday, there will be about 200 trains into Southport.

Southport is approached from Liverpool in a direction almost due north, from Manchester almost due west, and from Preston, via the West Lancashire line, in a south-westerly direction. On the

Fig. 1.—Exterior of St. Luke's Signal-Box.

Liverpool line there is also a station at Birkdale, on the south side of the borough, and on the Manchester and West Lancashire lines there is a station, common to both but with separate platforms, at St. Luke's. The Manchester and West Lancashire lines converge here and run into the main station—locally known as Chapel Street--where they are joined by the lines from Liverpool. There is also a double-tracked connection from the Liverpool line to St. Luke's, thus forming a triangle. It is over the Liverpool line that the Liverpool-Southport electric services run.

Prior to the outbreak of hostilities the company had put in hand the widening of the line between St. Luke's and Southport, by providing up and down East main lines—the existing lines becoming up and down West mains--and a double cross-over junction between the Manchester lines and the East mains. Additional platforms, and the necessary lines, on the north side of the station at Southport, were also brought into use and give now 11 platform lines. Before these alterations were made there were three signal-boxes, containing 233 working levers between St. Luke's and Southport and, with ordinary mechanical signalling, a fourth would have been required which, it was estimated, would have necessitated an aggregate of 340 working levers. The probability that power-signalling would provide a better solution being recognised, the matter was gone into, and it was found that two power-operated boxes would suffice. With the enterprise that has characterised the railway during Sir John Aspinall's management, power-operation was decided upon. The electro-pneumatic system, further, was adopted and a scheme evolved whereby, instead of there being four boxes with a total of 340 levers, there are two boxes with an aggregate of 160 working levers. A factor that contributed towards the decision to provide power-operation was that the live rails for

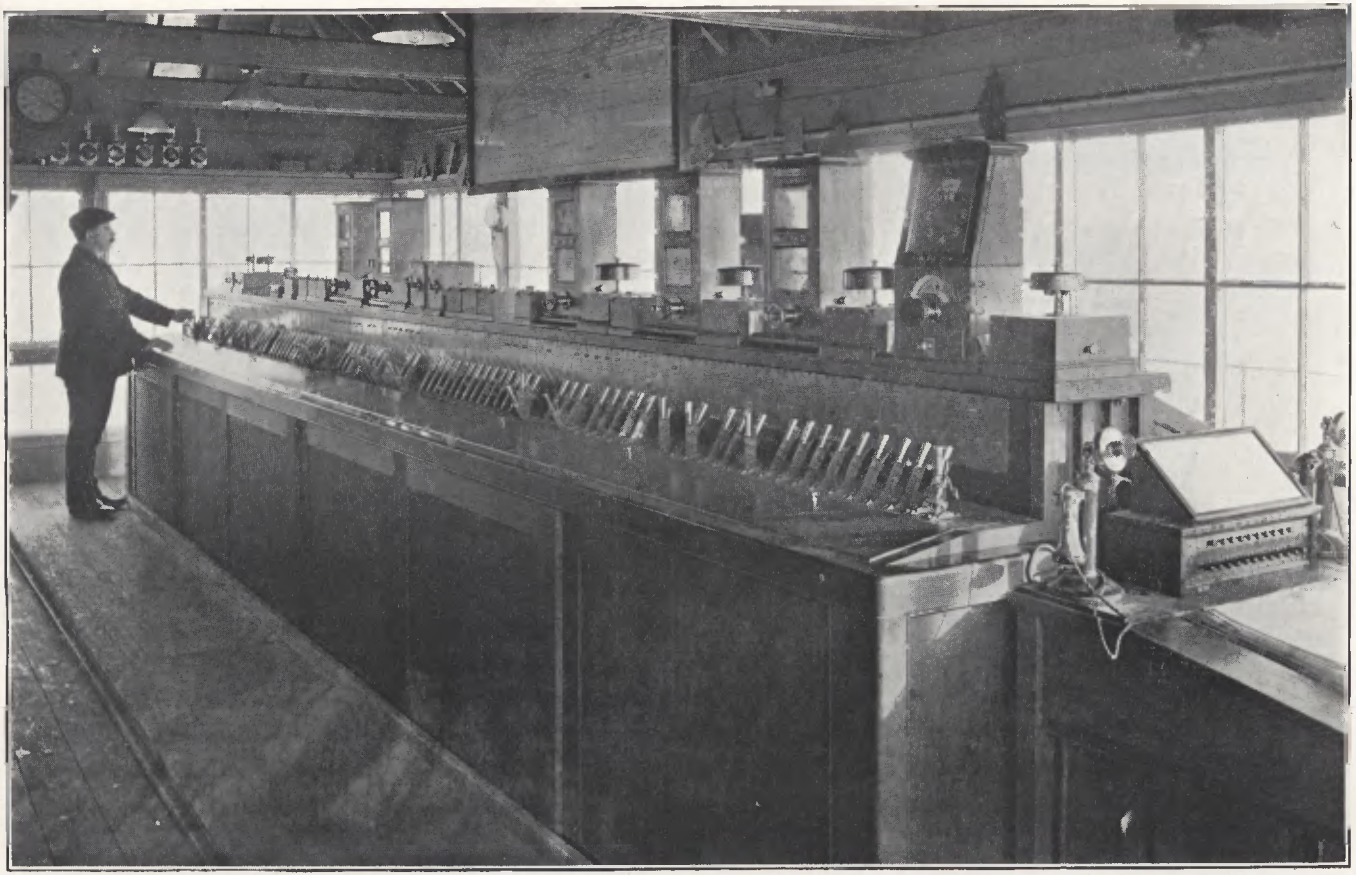


Fig. 2. General View of the Interior of St. Luke's Signal-Box.

the electric train service took up a good deal of the space that would be required for the point rodding and signal wires. A contract was then placed with the McKenzie, Holland & Westinghouse Power Signal Company for the supply of the necessary material, which was installed by the company's own staff under the direction of Mr. R. G. Berry, the Signal Superintendent. A feature worthy of mention in connection with the supply of material is that, with the single exception of the relays, it was all made in this country, which allowed for a much quicker completion of the work than would have been possible had the material been shipped from America. The relays could, of course, have been also made here, but the signal company's works at the time were very busy.

The accompanying diagrams show the lay-out at each of the two boxes. We will take St. Luke's, Fig. 13, first. On the upper left are the Manchester lines and on the lower left the West Lancashire. On the upper right are the two lines connecting the Liverpool lines; next are the four running lines into Southport station, then there is a siding, known locally as Bradford siding—which is actually a carriage loop to and from the station—and below are the two excursion lines.

The diagram for Southport Station, Fig. 14, has the east on the right and not on the left as with the St. Luke's diagram. The four running lines, Bradford siding and one of the excursion roads in the St. Luke's direction, are seen on the right—the two connections near signals Nos. 61A and 61B are those worked from St. Luke's by Nos. 43 and 55 levers—the Liverpool lines are in the lower centre and the 11 platform lines on the left. In the angle between the St. Luke's and Liverpool lines are 10 carriage sidings. The Liverpool lines have connections with Nos. 1, 2 and 3 platform lines only, but from the St. Luke's direction trains can approach on either the down East or down West main

Fig. 3.—View from St. Luke's Signal Box, looking North.

and enter any platform line except No. 1, and trains can leave any platform except No. 1 for St. Luke's over the up East or up West.

Fig. 13 is an exterior view of St. Luke's box and Fig. 5 one of the Southport Station box. The former has no special features as regards construction except that it is erected on steel columns. It is 32 ft. 11 in. long, 13 ft. 9 in. in width and the floor is 20 ft. above rail level. It has 91 working and 6 spare levers and 6 spaces. The Station box has three floors, 31 ft. 3 in. long and 12 ft. 9 in. wide. The ground floor has the compressor house for the compressors and motors; on the next floor are the track relays and transformers, and the top floor, 23 ft. above rail level, is the operating floor. The ceiling of the compressor room is packed with silicate of cotton to deaden the sound of the compressors. On the ground floor and in the foreground of Fig. 5 is the accumulator room, 6 ft. 5 in. by 14 ft. 4 in. The Station box has 69 working and 12 spare levers and 6 spaces.

Fig. 2 shows the interior of St. Luke's box. The locking-frame, it will be seen, is of the usual electro-pneumatic pattern. The interlocking is arranged vertically, and direct access is obtained thereto by means of the sliding doors that form the front of the frame.

Fig. 3 shows the view from St. Luke's box looking towards St. Luke's station—seen beyond the footbridge over the railway. The single arm post in the foreground is No. 61. Fig. 4 gives an idea of the view from the same box towards Birkdale on the left and Southport station on the right. The signal-box at the latter place will be seen beyond the footbridge. The arm in the "off" position on the left is No. 32A. The "four-doll" bracket signal is for leaving the excursion

Fig. 4.—View from St. Luke's Signal Box, looking South.

platforms behind it, No. 1 excursion road being to the left of the signal as seen in the illustration, and Bradford siding being to the left again.

Fig. 6 shows the view towards the station from the Southport Station box. On the extreme left, but not very distinct, is No. 1 platform road, the two lines seen together a little less to the left are, respectively, Nos. 2 and 3 platform roads.

The connections on the St. Luke's lines near the entrance to the station and north and north-east of the end of Nos. 5-6 platform deserve attention. There are no less than three sets of double slips—Fig. 8—and the signalling is so arranged that alternative routes for arriving and departing are provided so as to allow for simultaneous movements that would ordinarily conflict. The short lines shown on the diagrams near points, and outside and parallel with the rails, indicate facing point locks and locking bars. These work with the points, and it will be seen that No. 48 lever thus works four pairs of switches and four facing-point locks and bars—all the full length of 45 ft.—whilst other levers, *e.g.*, No. 74, work three pairs of switches and three facing point locks and bars. Many points have two bars—one on each switch. Nos. 25 and 5 points—Fig. 7—are such.

It is one of the advantages of power-signalling that points, lock and bar thus work together; moreover, the working—to the signalman—is no heavier for such a load as No. 48 referred to above than for moving a single pair of switches. It is this combination of points with lock and bar that, in part, secures the reduced number of levers; also provides the ready means for adding the facing point lock and bar equipment to any point needing it without having to bring into use another lever and run additional connections.

Fig. 5.—Exterior of Southport Station Box.

Another feature securing a reduced number of levers is the selection of signals, *i.e.*, the working, by one lever, of a series of signals from one common line into several directions or from several directions to one common line. Only one of the selected signals can be lowered at one time, and this is decided by the position of the points. There are, for instance, to take a simple case, the three signals for leaving Nos. 1, 2 and 3 roads respectively for Liverpool at the Station box and worked by No. 1 lever. With No. 16 points reversed the arm from No. 1 road falls; with No. 16 and No. 5 points normal, that for No. 2 road will fall, but if No. 16 be normal and No. 5 reversed that for No. 3 road comes. Similarly the signals for leaving all the roads from No. 5 to No. 11 inclusive for the up West main are connected to No. 59 lever. Here, perhaps, we ought to say that on the diagram letters are shown against many of the numbers, *e.g.*, 1A, 1B and 1C. These are, however, purely for the purpose of giving each signal a title, so as, for example, to distinguish which of the three signals worked by No. 1 lever is being referred to. Many opposing movements may be controlled by one lever, having, normally, a mid-stroke position and, for a movement in one direction, being pulled and being pushed for the opposing movement. Selection can be applied to either or both push and pull operations.

The foregoing not only leads to a less number of working levers but power-operation, being effected by miniature levers spaced at $2\frac{1}{2}$-in. centres, allows for the size of the locking frame being further reduced. Thus the frame at Southport Station, with its 87 lever spaces, occupies 18 ft. 10 in. only in length and 4 ft. 8 in. in width.

A feature at Southport that has lead to an economy in signal arms is the route indicator designed and patented by Mr. Berry and Mr. H. W. Moore, his electrical assistant. The purpose of route

Fig. 6.—View from Southport Station Box, looking towards Station.

indicators is fairly well-known now so they need not here be described. Those at Southport are, however, of a new type in that they are, as in this case, operated by power or they may be operated mechanically, as at Victoria Station, Manchester; the one lever works the signal arm and indicator. At Southport Station box the home signal from Liverpool has three indicators, the home signal from the down West main has eight indicators, that from the up West main seven, and that from the down East six indicators. Four arms thus do the work of 24.

Fig. 9 shows the home signals from St. Luke's at the Southport Station box and Fig. 10 shows a back view of No. 20 signal—the home signal from Liverpool.

Yet another feature at Southport is the check provided on selected signals. Where, as with the seven signals mentioned above as being connected to No. 59 lever, two or more signals are controlled by the same lever, only one arm can be lowered at the same time; moreover, this arm must correspond to the way in which the roads are "made." It is, however, possible for a signalman to fail to see exactly how his roads lie, and should he want, for instance, a train to leave say No. 7 road he might fail to notice that No. 47 points were reversed, and so when he pulled over No. 59 lever for arm No. 59C, the arm No. 59E would be connected. No accident would result but an unintended movement might be made, and the train in No. 7 might also be delayed; some electrical means have, therefore, been devised to obviate this possibility.

These consist of push buttons in a small case on the instrument shelf—one case for each group of selected running signals—and a push button for each arm. The buttons are lettered A, B, C, &c.,

Fig. 7.—View from End of No. 2 Platform, Southport Station.

to correspond with the arms. After the lever has been pulled in the usual way—say, No. 59 to lower arm No. 50c—the man will, if the road be properly "made," see the miniature lamp on the corresponding arm on the illuminated diagram switch in, but the arm will not fall until he has depressed button C. On being depressed the button is locked by the releasing of an electro-magnet working in parallel with the return indication lock coil, and it remains depressed until, the signalman having reversed the lever, it is released by the return indication current when the arm has gone to danger. Were the man to fail to observe the lamp and thus not learn that the road was not properly made he would on pressing button C, find that it would not remain down, and thereby be told that he had not set his points as he wished. Should, further, the road be properly made but he had pressed the wrong button, say D instead of C, it would not remain down. Finally should the arm fail to respond to the pulling over of the lever and the depression of the button the latter would not be held. The button thus serves the same purpose for the "off" position of a signal as the return indication does for the "on" position.

The air for operating the point and Signal motors, which is maintained at a pressure of about 70 lb. per sq. in., is compressed by two Alley & McLellan's Sentinel two-stage compressors, Fig. 11, housed on the ground floor, Fig. 12, of the Station signal-box. These compressors, which are used alternately, are capable of compressing 150 cub. ft. of free air per min. to a pressure of 130 lb. per sq. in. They are water-cooled and fitted with an automatic governor responding to a variation of air pressure of 5 lb. or less.

The oiling of the cylinders and gearing is done automatically by forced lubrication whilst the machine is running.

Fig. 8.—Three Sets of Double Slips at Entrance to Southport Station.

The compressors are belt driven by a 600-volt 50 h.p. Mather & Platt D.C. motor, which is automatically started and stopped, at pre-determined pressures, by means of an air pressure switch and automatic starter. This motor takes its current from the live rail of the electric railway.

As a failure of the traction current would mean a shut-down of the entire signalling installation, an alternative for driving the compressor has been provided in the shape of a 50 h.p. single-phase A.C. motor, made by the Brush Engineering Company, working at 220 volts, 50 cycles, which takes its current from the mains of the Southport Corporation.

By means of clutches operating on the shafting the compressors can be driven by either the D.C. or the A.C. motor. In addition to driving the compressors, the motor also drives a 6 kw. D.C. generator, from 0 to 30 volts, for charging the accumulators for point and signal operations, and a 6 kilo-volt ampere generator, 220 volts, 50 cycles, which is an emergency machine for feeding the track circuits and A.C. point relays in the event of the failure of the Corporation A.C. supply. A set of accumulators for the operation of point and signal motors is housed on the ground floor of the box and is insulated from the rest of the machinery. It consists of 12 cells, having a capacity of 930 ampere hours. The cells are charged every two days.

The air, after being compressed, is cooled by being passed through about 300 ft. of $1\frac{1}{2}$ in. piping, and then enters two large reservoirs fixed in a building immediately alongside the Station signal-box; two further reservoirs are provided, one at St. Luke's and one midway between St. Luke's and Southport station. Each of these has a cubical capacity of 80 cub. ft.

Fig. 8.—Signals with Route Indicators, Southport Station.

Condensation is dealt with by means of water traps fixed near the compressors and reservoirs, which automatically eject the condensed water.

An air meter has been fixed, and periodical readings are taken. Weekly readings are taken of the consumption of current and curves plotted, so that leakages may at once be detected. This is very essential in order that the plant may be run as economically as possible.

The compressed air is carried completely round the system in the form of a belt loop through a $1\frac{1}{2}$ in. main pipe. By the provision of the belt loop and three-way cocks, it is possible to cut out sections of the air main at any time without seriously interfering with the plant. Wherever practicable the main pipes are run above ground with a view to keeping the air as far as possible at atmospheric temperature. From the main pipe, $\frac{1}{2}$-in. pipes are run to the point and signal motors. The point motors are, in order to be kept clear of the live rails, usually fixed in the "four foot," and the point valves are fixed separately from the motors in the "six foot." These features are clear from Fig. 7.

The whole of the platform roads at Southport station are equipped with track-circuits, which are repeated on the illuminated diagram where the presence of a train, engine or vehicles on a circuit is represented by the miniature lamp, applicable to that circuit, being extinguished. The track-circuits are of the A.C. single rail type, but two track-circuits near St. Luke's Road are of the double rail type, and are provided with impedance bonds, this being necessary because both the running rails were required as returns for the propulsion current.

The track-circuit relays are placed in the signal-boxes, although, in a good many instances, the track-circuits are some considerable distance away. This has the advantage of concentrating all the relays at two

Fig. 10.—Back View of Signal No. 20 at Southport Station, with Route Indicator.

points and also of avoiding the use of repeater relays. To reduce the size of the conductors between the track rails and relays to a minimum, the relays, which are of the two-position galvanometer type, are wound to operate with approximately 10 to 15 volts on the armature, and small transformers are used to step up the track voltage, between 2 and 3, to this value.

The point levers are equipped with the usual check locks, which ensure that the points have operated before the stroke of the lever can be completed. In addition to this, "constant detection" is fitted. Constant detection, as its name implies, ensures proving not only that the points are in the correct position when the point lever is operated, but also proving that they are in the correct position whenever a train is to pass over them.

Constant detection can be carried out in several ways. At Southport every endeavour has been made to secure the safest and most up-to-date method ; for this reason alternating current is used to operate three-position galvanometer relays, thus making the indication system immune from operation by the D.C. current used for train propulsion and for signal and point control circuits. The circuit between the point detectors and the point indication relays, which is the standard circuit of the McKenzie, Holland & Westinghouse Power Signal Company, is an extremely simple and yet an extremely safe one ; it requires only two wires between the point detector and the relay, and is so arranged that the opening of one pair and the closing of another pair of contacts in the detector—this takes place when the points are operated—will cause the relay to reverse, so opening one set and closing another set of relay contacts. The opening of any detector contact—wilfully or accidentally—the breakage of a wire or short circuit between wires will cause the relay to be de-energised and all its contacts to be open.

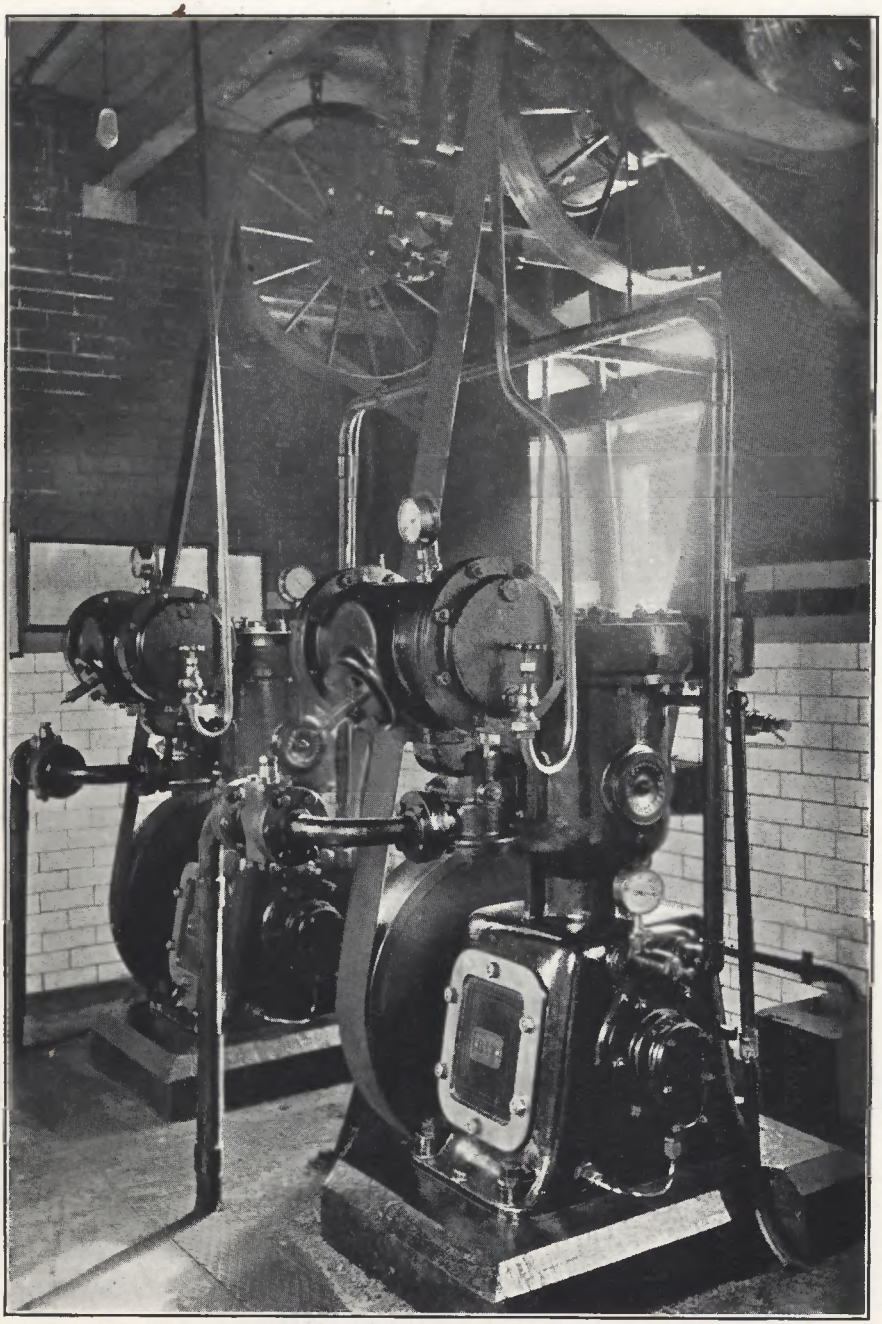


Fig. 11.—Air Compressors.

The control circuits for the signals are in every case taken over the contacts of the point indication relays corresponding to the points over which the train will run. It will be realised that a very safe and efficient system of point detention results.

All the wires from the points and signals when within the signal-box are labelled and are taken to fuses fixed in a special relay cabinet on the second floor of the Southport Station box. This enables a test to be easily taken and a fault immediately located.

Our illustrations will, we think, speak sufficiently as to the manner in which the work has been done, and it only remains for us to congratulate Mr. Arthur Watson, C.B.E., the General Manager of the Railway Company, Mr. D. C. Rattray, the Chief Civil Engineer, Mr. G. Hughes, the Chief Mechanical Engineer, and Mr. R. G. Berry, the Signal Superintendent—to the first named of whom we are indebted particularly for the photographs—on being in possession of, also the McKenzie, Holland & Westinghouse Power Signal Company on having provided, as fine a signal installation as is possible to be found, and to thank them for this opportunity to describe it.

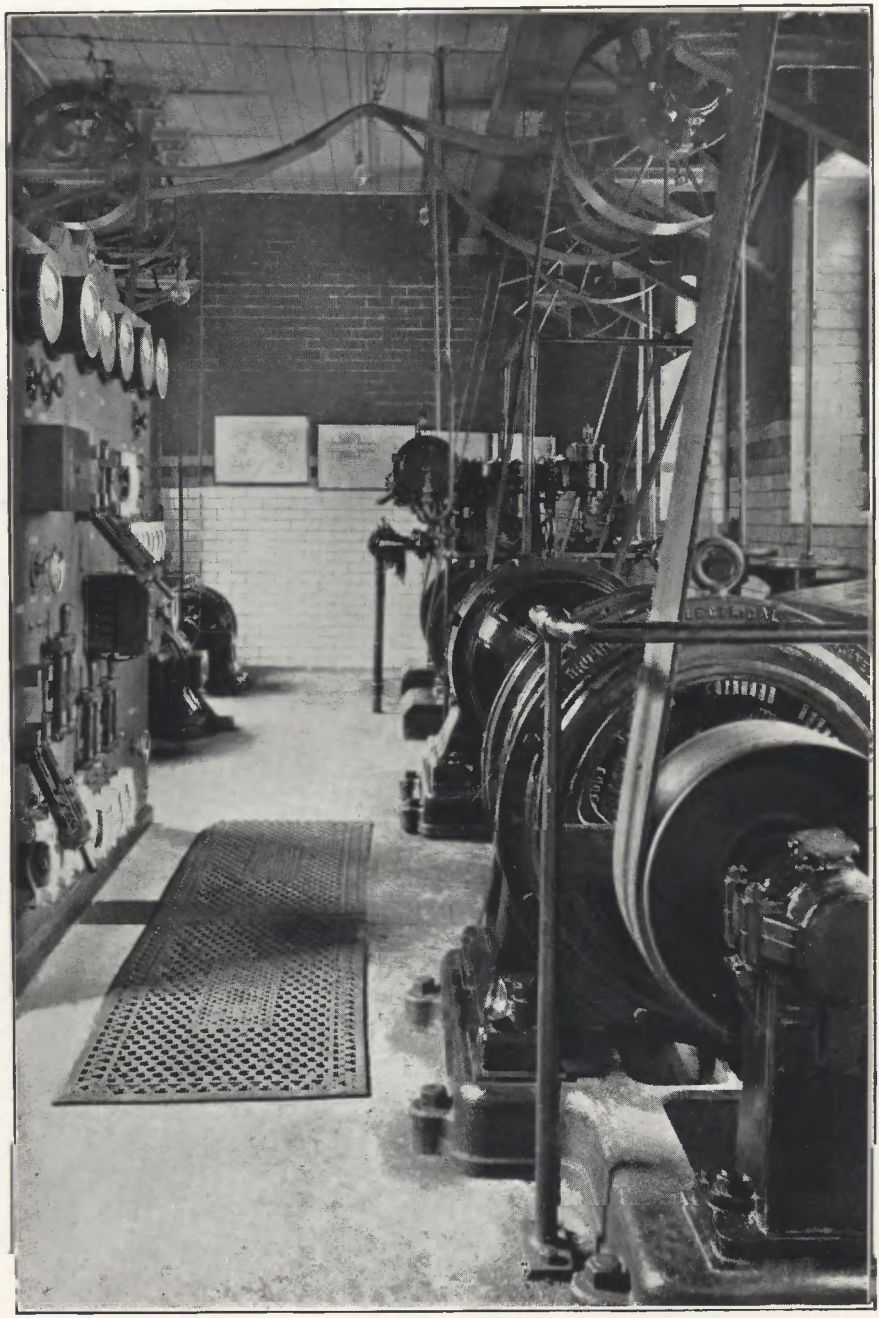


Fig. 12.—General View of Compressor House.