Modern Signalling on the French National Railways

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Diagrams—Inset Sheets Nos. 5-11

Those lines of the French National Railways, called hereafter for convenience the S.N.C.F., which are not signalled automatically, are equipped with some form of manual block apparatus. The simplest arrangement, in use where the traffic is very light, is the telephone block. (The use of the ordinary telegraph for this purpose has been given up in France). Although the telephone has the advantage of simplicity it is subject to the risks of mistakes being made with it, such as omission to signal a train forward or to give " train entering section " for it, or the giving of an incorrect " train out of section " signal through some misunderstanding. It is for this reason that, many years ago, attempts were made to construct block apparatus involving a certain amount of interlocking and dependence between the different operations, in order to eliminate the risks of accident due to forgetfulness or wrong movements on the part of the signalmen. There are several types of these interlocking block, or " lock-and-block," systems. It is proposed to give a brief description of the principal ones at present in service and explain what has been done lately, and is being done now, to construct a modern type of manual block apparatus and extend its application.

Double Line Block Apparatus

The most widely used manual block apparatus is what is known as the Lartigue electro-semaphore block. This is in use on the Eastern, Northern, Western and South-Western Regions, and the various installations differ, more or less appreciably, from one another. In every case, however, the signal used with them is a semaphore having a large arm at the top of a post able to take up two positions, horizontal with red light at night, to indicate stop, and lowered practically to the post, with green light, to indicate that the block section in advance is clear (fig. 1). The post also carries a small arm, painted yellow, the purpose of which is to indicate to the signalman whether a train is approaching him or not. Each signal post carries, for each of the two tracks to

which it applies, two mechanism boxes, known as box No. 1, which applies to the section in advance, and box No. 2, which applies to the section in the rear. The handle of box No. 1 serves to move the large arm to the horizontal, or danger position and at the same time to cause the small arm on the signal post in advance to assume the horizontal position. The handle of box No. 2 serves to conceal the small arm in line with the post and simultaneously to release the large arm at the signal post in the rear, which thereupon falls to " line clear," its normal position. The Northern Region has remained faithful to this apparatus and on those lines the approach to each semaphore is announced by a special form of distant signal, having a centrally pivoted arm, known as the " *palette Sem.*" There is also rotation locking between successive sections, compelling the various movements to be made in a pre-determined manner.

On the South-Western Region electric treadles have been added to this system, giving control over the various movements by the passage of the train, while on certain lines in the Eastern Region the Lartigue apparatus has been supplemented by track circuiting, making it impossible for a signalman to clear back and release the semaphore in the rear while the section is occupied.

On the South-Eastern Region, or former P.L.M. lines, there is found what is called the No. 3 type block. It uses semaphore signals operated from levers in frames contained in signal boxes and interlocked with the block instruments, the actual locking portion of which is an electro-mechanical device. A train is signalled forward to the box in advance by means of the so-called Jousselin describer, a step-by-step indicating pointer operating in conjunction with a bell. " Line clear " is returned to the box in rear by sending an electric current, similarly to the act of plunging with Sykes apparatus. This cannot be done unless the box concerned has duly protected the train by returning its own semaphore to danger. On the main line from Paris to Marseilles this block had been supplemented and made complete by the application of continuous track circuiting, but between Paris and Lyons concurrently with electrification, it has now been superseded by automatic signalling.

The Regnault block apparatus is in use on the Western Region and on some routes in the South-Western Region. The general arrangement met with in this case is to control the entrance to a section by the square type absolute stop signal. The lever of

this signal is controlled by an electric lock, the condition of which depends on the receipt of " line clear." To allow a train to enter an occupied section permissively the signalman can display a special warning signboard inscribed ATTENTION, although his electric lock is not free, but he must not do this until he has brought the train to a stand, and the train must thereafter proceed prepared to stop short of any obstruction.

On certain of the Western lines other types of interlocked block are in operation, notably the Rodary block, and the former State Railways 1928 type block, the principles of these being not unlike those of the Regnault system, although the actual design of the apparatus differs. It is not proposed to dwell further on these old forms of block but to describe now the new standard apparatus designed and perfected by the S.N.C.F., in service between Argentan and Surdon and St. Cyr and Plaisir-Grignon, and which is in course of application to other lines.

The operating principles of this equipment are as follows :— The signals used are a semaphore to control the entrance to a block-section, preceded by a distant, or caution, signal to give approach warning of the condition of the semaphore. The operation of the semaphore does not form part of the working of the block apparatus itself, as it does in the Lartigue system, which allows of the locking of the signal being effected after putting the signal to danger and not automatically at that moment. The signalman is free to operate his lever and put the semaphore to danger at any time, without affecting the block apparatus in any way.

As a rule the semaphores are not replaced to danger automatically. The signalman has to do this after a train has passed and can then give " train on line " for it and clear back to the signal box in the rear. The semaphore does not become locked until " train on line " is signalled forward. (If, however, it is placed to danger automatically by the train it then becomes locked, independently of the sending of that signal). Clearing back is made dependent on the operation of a treadle by the train and in addition, proves that the semaphore has been put to danger and locked and that " train on line " has been sent. If a train has to be shunted into a siding a special device, such as a key lock, the use of which can be proved, or a button operating a counting mechanism, is used to enable the sequence imposed by the rotation locking arrangements to be interrupted. This device

can be actuated for one movement only, for each cancellation.

The equipment of the block posts is so arranged as to allow of certain among them being switched out during hours when the traffic is not so heavy as usual and can be dealt with by longer block sections. This standard block operates on the " normally clear " principle, that is to say that in the intervals between trains the signals stand normally at " proceed."

The rules provide for the admission of a train to an occupied section but this is very seldom done, a signalman only resorting to this facility if it is of advantage to the traffic working to do so and, after waiting the usual amount of time taken for a train to clear the section, communicating telephonically with the block post in advance regarding the whereabouts of such train. When entering an occupied section a driver is given a special written authority allowing him to pass the semaphore at the entrance to it. This further instructs him to proceed prepared to stop short of any obstruction.

Should there be some defect in the apparatus which prevents " line clear " from being received, and consequently the semaphore from being released, telephone block is substituted for the normal working. The drivers, stopped at the entrance to the section, are given, if the line is clear, a written authority permitting them to resume normal running, provided, of course, that nothing else interferes with their doing so.

The construction of this block apparatus has involved a certain number of interesting designs. It is made up entirely of modern items of equipment, such as electric lever locks, relays, repeaters, etc., used to effect the various operations. Fig. 2 illustrates the operating board or panel for an intermediate block post, with the buttons for giving " train on line " and clearing back, the buttons for silencing the warning bell, and the closing switches (where a block post can be switched out). For safety reasons the currents used for giving " train on line " and clearing back are polarised and coded, giving a complete guarantee against irregular interference. Even should the line wires come wrongly into contact, a false clearing of a section is quite impossible.

Single Line Block Apparatus

It is not proposed to refer here to the single line manual block system of older types, never much used, but to describe the

new standard pattern, already in service on a number of sections of line and being progressively extended. Fig. 3 shows the layout of a single line station with its second, or passing, track and two semaphores, station limit signboards, distant and red disc outer signals and four electric treadles. This block is worked on the so-called " free possession " principle, that is to say that when dispatching a train in the normal course the official responsible at the station in advance is not called upon to do anything. The official at the station in the rear A, wishing to send a train to B, first presses a button called the test, or proving button. This serves to prove whether the signals applying to the opposite direction of traffic, B to A, are duly at danger and the line clear of any train coming towards A. If these conditions are proved to obtain, this test action causes a reply indicator to appear at A and this remains showing for a short interval, long enough to allow the semaphore for the movement from A to B to be cleared, on condition of course that the line is not occupied by a previous movement in that direction, so fulfilling ordinary block working requirements.

As soon as the train leaves A and the semaphore is put to danger behind it, A gives " train on line " to B, which locks A's semaphore, but such locking does not take effect unless that signal was passed in the clear position. When the train reaches B the official there clears back to A, but for him to be able to do so the train must have passed completely over the treadle, which is not in circuit unless " train on line " has been duly received for the train.

The act of giving " train on line " or clearing back causes an indicator to appear and a bell to begin ringing at the station concerned. (In the case of " train on line " the bell is silenced by pressing a button. The receipt of " line clear " behind a train causes the bell to ring for a short interval only). Permissive working being allowed with this system it is necessary to make sure, in the case of a train being permitted to enter a section occupied by the preceding one, that the clearing of the semaphore for the opposite direction of traffic at the station in advance shall not again be possible until the last train which has entered the section has passed out of it. For this purpose a special switch is provided at each station called the occupation switch, proved in its normal condition when a test current is sent but which has to be actuated whenever a train is allowed to enter an occupied section. Stations

which can be switched out at intervals have a closing switch which is not locked in any way.

Fig. 4 shows the arrangement of the operating board or panel, with its various buttons, indicators and switches. As in the case of the double line block, this standard single line apparatus uses only standard items of equipment used generally in modern signalling, such as relays, electric locks, treadles, etc. The transmission of the various signals is effected by means of coded currents of varying polarity in the manner shown in fig. 5.

The connection between two stations is effected over two line wires A and B and a common return C, which can be an earth return if desired. Each set of equipment comprises, for each direction of traffic, a transmitting and a receiving unit. The transmitter set in action by pressing one of the block buttons, sends out to the line circuits, according to the particular code applying to any button, three impulses, the polarity of which and the line wire over which they shall pass, being pre-determined. The receiver identifies and stores the impulses received, while forming, as they one by one arrive, the actuating circuit corresponding to the code concerned. The relays are mounted in groups or sets, and have plug-in or jack-in connections, allowing of very rapid replacement in case of any fault developing.

The installations of this system put into service during the last few years have worked in a most satisfactory manner and thus have given proof of the suitability of the operating programme which they were designed to meet.

Development of Mechanical Signal Boxes

General Considerations

The essential aim which the early signal engineers set before themselves when constructing interlocked signal boxes was to increase the safety of working by centralising in the hands of one man the responsibility for controlling the traffic ; this had the secondary advantage of allowing of a reduction in staff and consequently in operating costs. This continually growing concentration, however, led little by little to the use of locking frames needing several signalmen to work them, on account of the large number of levers involved and corresponding increase in the length of the frames. In addition, the application of the various locking combinations added to the problem of operating the signals and led to a still further increase in the number of levers required.

In simple installations it is indeed possible to use one lever for working a signal reading to several directions by making use of conditional locking between the signal and the points concerned, but this has the disadvantage that the signalman can only tell which particular route is set up by examining the positions of the various point levers. This arrangement soon becomes out of the question by reason of the large number of different conditional locking combinations which it necessitates. (It must be borne in mind that in France only *one* stop signal is provided at the diverging point of two or more routes, no matter how many there may be, and applies to them all. The direction the train is to take is indicated to the driver, where considered necessary, by separate junction indicators operated in conjunction with the signal. In mechanical signalling these indicators have fishtailed semaphore arms).

Except therefore in the simplest cases recourse is made to the practice of operating a signal by several levers, one for each direction to which the signal applies which allows the use of ordinary plain unconditional locking combinations, much simpler than those above referred to. This, however, imposes the use of some means of connecting several signal wire transmissions together, seeing that of several levers each by itself must be able to clear the one signal. These arrangements are costly to install, whether effected by rodding (slotted link connections) or, as in the case where the levers are at a distance from each other, a multiple type interconnecting device between the various wire transmissions must be installed outside the signal box.

In order to get rid of the complication involved in these methods the use of the so-called direction levers has been resorted to in certain cases. These are simply interlocking levers, applying to each direction or route to which the signal applies but not actuating any wire transmissions. Conditional interlocking compels the signalman to reverse one of these direction levers before he can reverse the signal lever concerned. The result of this is to eliminate the interconnecting mechanism, above referred to, coupling several transmissions together, but one additional lever, for working the signal, must be added to the group of direction levers.

It may be noted in passing that at the "A" signal box at Paris (Quai d'Orsay), No. 1 box at Morcenx and No. 2 box at Tarbes, which are of the hydraulic type, what is practically the

same thing has been achieved by adding what is called a selector lever to the several levers applying to the one signal. This selector lever does not itself actuate any locking, but it decides what shall be actuated, and it is only the reversal of one of the several levers referring to the signal which finally operates the locking and clears the signal as well. This arrangement does not reduce the size of the apparatus, but a very important improvement, derived from the method of working a signal in conjunction with direction levers, has been arrived at in cases where there are, in the area controlled by a signal box, two groups or fanways of lines having a common point somewhere in the layout. This has given rise to the idea of using the so-called " director " and " trajector " levers, more particularly explained below.

Director Levers

Director levers are interlocking levers forming the connection between certain signal and point levers. They do not themselves operate any function out on the line. They are used only in groups and effect the interlocking for a number of movements which diverge from a common track. Each one corresponds to a movement in one pre-determined direction hence the name of director lever. A particular point located somewhere on the common portion of the route, called the point of application of the director levers, is marked on the track plans and signalling diagrams, with the numbers of the levers and the direction of running of the movements concerned. This arrangement, with the aid of conditional locking compelling one of the director levers to be reversed before the relative signal lever can be pulled, allows of a reduction in the number of signal levers and in the apparatus required for connecting wire transmissions together. The following example serves to show the saving effected by this system. Instead of using (4×3) levers for working signals, A, B, C, D, controlling movements towards X, Y, Z, it suffices to have $(4+3)$ when director levers are used. In the example given the saving is $12-7=5$ levers and in general it is the difference between $M \times N$ and $M+N$ levers. Considerable use is made of these director levers in France (fig. 6).

Trajector Levers

Trajector levers are levers serving a double purpose, each functioning alternately either as a signal lever or as a director lever. As in the case of the latter class of lever they are used only

in groups in connection with movements which have some point in common. The movements taking place in one particular direction are controlled by the signals which these levers themselves can actuate. Those in the opposite direction are controlled by the same levers functioning as director levers but in that case not actuating the signals just referred to. Each of these levers thus corresponds to a train movement along the same pathway, either in one direction or in the other, hence the name of trajector lever. The change in the function to be performed at any moment by these levers, which form a single group, is brought about by means of a disengager lever which acts on the signal wire transmissions. When this is in the " clear " position these transmissions are joined up, or in gear as it were, and allow of the reversal of a trajector lever clearing the corresponding signal. When, on the other hand, the disengager lever is in the " blocked " position these transmissions are disconnected and the trajector levers function as simple director levers. The signalling plans and diagrams show the point of application of the trajector levers, with their numbers and the movements they refer to, and also the normal position of the disengager lever used to bring about the change of function of the trajector levers.

The use of these levers for movements in opposite directions, combined with conditional locking, as used with director levers, and a disengager lever connected with this interlocking and indicating the direction of traffic applying at a given moment, permits of a similar saving in levers being obtained. Taking the case illustrated previously in connection with director levers, it will be seen that in place of having to use (4×3) levers for actuating signals A, B, C, D, plus (3×4) for actuating X, Y, Z, or 24 in all, it suffices to have $(4+3+1)$ or 8 only, when this double functioning is made use of. The saving so realised is therefore $2\ MN - (M+N+1)$ levers, which is very appreciable, especially when it is considered that a reduction in the length of the locking frame brings with it a corresponding reduction in the size of the signal box when it is a question of carrying out new work. These trajector levers are very widely used, especially on the lines of the former Northern Railway. Trajector and director levers serve therefore to reduce very noticeably the number of levers required for working a particular signal box (fig 7).

Selector Levers

The introduction of selector levers combined with what are called route cylinders in certain electro-mechanical signal boxes of the Saxby type has made it possible to operate a signal by two levers only: (*a*) a selector lever, capable of taking up to ten different positions, each of which corresponds to a particular direction or route for which the signal applies, and (*b*) a lever actuating the signal itself.

Each signal lever of this kind, applying to a number of directions (fig. 9) has to the right of it a small selector lever S provided with ten notches arranged at equal distances round a drum shaped guide. This lever has a toothed sector piece and actuates, through racks and pinions, two cylinders, placed vertically and balanced with respect to each other, one on each side of the mechanical locking box. When the selector lever passes from one notch to the next, each of these cylinders makes 1/10th of a revolution. In addition to this rotary movement the cylinders can move vertically up and down along their axes under the action of the catch-handle of the signal lever. They carry disc shaped pieces to which are attached teeth which project horizontally. Each disc can take ten of these arranged at equal angular distances of 36 deg. It is thus possible to arrange on one cylinder ten rows of teeth on ten separate paths situated at 1/10th of a revolution apart.

When the selector lever passes from notch 1 to notches 2, 3, ... 10, these ten paths come in turn to be situated at a minimum distance from the locking box and its mechanism, along the diametral planes of the cylinders at right angles to the box. When a set of teeth has been brought into this position by operating the selector lever the particular teeth concerned stand above and below special locking pieces or dogs attached to the locking bars in the frame. These teeth and the locking pieces cannot come into engagement during the rotary movement of the cylinders, because the discs and locking bars are normally at different levels, but the locking action is effected during their vertical movement, when they are raised or lowered by the act of operating the signal lever. In this manner it is possible to establish between a signal lever and the other levers in the frame 10 different locking combinations corresponding to 10 distinct routes, to each of which corresponds a certain position of the selector lever, marked on an indicating plate carried by the drum

above mentioned. The teeth are given different shapes according to the locking it is desired to effect. (See details on the sketch).

In order that the effort exerted by a locking bar on a tooth which is holding it shall not tend to twist a cylinder, the latter carries in the middle a disc K1 or K2, pierced with as many holes as there are routes. This disc becomes held fast by a pin, V1 or V2, which enters one of these holes whenever the cylinder is moved vertically. This device also prevents the operation of the signal lever, should the selector lever not be exactly in one of the positions marked by the notches. Saxby type locking boxes fitted with these route cylinders are in use at Nos. 1, 2 and 3 signal boxes at St. Lazare terminus, Paris, box B at Bourges, box C at Vierzon and box No. 2 at Saintes.

Finally, during the last few years the S.N.C.F. has caused to be constructed by the Saxby works at Creil an " electro-mechanical " signal box, which has two rows of levers ; one row of large levers at 127 mm. (5-in.) centres and operating ordinary mechanical transmissions for signals and points, and an upper row of miniature levers arranged at half this spacing, actuating circuit controllers, reserved entirely for effecting certain electrical operations. These miniature levers can also, however, perform another function, that of serving as director levers. Such a signal box takes up a very small amount of room since the length of the frame is determined by the number of large levers required for mechanical functions. Two are under construction for Dax and Bayonne stations. With such arrangements it is possible, while using mechanical operation for functions situated close to the signal box, to have the frame as compact as possible and very readily operated by the signalman.

Development of Power Signal Boxes

The use of power signal boxes in France goes back to the last years of the 19th and first year of the present century. At first the installations differed little from those of the mechanical type, having individual levers which set motor mechanisms in action instead of actuating wire or rod transmissions. Fig. 10 shows the principles of a box of this kind. Although the hydraulic and pneumatic type power boxes achieved a certain degree of success at the outset, the electrical type came more and more to predominate. Almost from the first days of power boxes French

engineers interested themselves in perfecting the route lever type installations. By using motors to actuate signals and points it becomes feasible to arrange matters so that when setting up a route the signalman needs to operate only a single lever or handle, the motor mechanisms performing all the necessary operations as a result of that. Almost from the beginning two methods of doing this were used concurrently, known as the "electrical combiner" and "mechanical combiner" respectively. These "combiners" took the place of the frames known under the earlier arrangements. In the first system the interlocking combinations required between the route levers are effected entirely by means of electric locks, themselves under the control of all the conditions affecting the matter, such as interlocking between conflicting levers, proving of signals at danger, approach and route locking, etc. With the mechanical combiner on the contrary, conflicting interlocking is effected by mechanical mechanism, such as locking bars and dogs, or locking slides, etc., in the machine. Only the other locking then needs to be carried out by electric locks. This difference of working presented considerable interest and gradually the mechanical type combiner, of which there are very many in France, obtained the advantage over the other type. Fig. 11 shows how a route lever apparatus of this kind is constructed.

In this particular arrangement the route lever drives a locking tappet which carries locking dogs and also has an electric lock acting on it. There is a bar in the combiner for each pair of points to which also are attached locking dogs. Such bars also have electric locks acting on them. A route lever cannot be reversed unless both the mechanical and electrical locking allow of it. The mechanical locking combinations are those resulting from the action of the point bars or lever tappets, with their locking dogs, while the electric locks, acting on these tappets or bars, provide the electrical locking effects. (These signal boxes provide in particular for sectional route locking, which allows a signalman to operate points as soon as they become freed by the train passing clear of them.) The mechanical locking between conflicting levers is not cancellable, but the electric locking is. Any such cancellation is valid for one movement only and a tell-tale appears showing for which function or functions this has been resorted to. These signal boxes, of which the S.N.C.F. has had a very considerable experience, give excellent results.

Of late years, however, the management has been led to design and build other types of installation, which have been perfected, step by step, and have brought with them new operating advantages. An arrangement standing half-way between the earlier ones above mentioned and those of today is represented by the No. 3 signal box at Montauban, put into service in 1941. It comprises a mechanical combiner of the same type as those already referred to, containing lever tappets and point locking bars carrying locking dogs; there are, however, no electric locks in the apparatus. The locking which they would be used to effect is accomplished directly by purely electrical means in the circuits of the various items of apparatus concerned, and in this way the clearing of a signal or reversal of a pair of points is prevented when necessary. The working of this signal box, the principle of which is illustrated in fig. 12, is satisfactory, but the methods involved have not been retained for the following reasons. The preventing of conflicting movements involves a double action, since any confliction between route levers actually prevents their simultaneous reversal, while the approach locking, etc., acts directly on the operation of the signals and points, without positively locking any lever at all. Further, from the moment the electric locks are eliminated the opportunity presents itself of reducing the size of the equipment by using levers which are free at all times.

This conception has been followed in the case of the Darnetal signal box, brought into use in 1947. Fig. 13 shows the construction of the group of levers and fig. 14 is a general arrangement of the work. The levers are of very small size and have no locking on them whatever. In the machine there are for each set of points two slide bars, one applying to the right-hand, the other to the left-hand position of those points. The reversal of a lever moves the point bars concerned into the desired position, but the actual movement of the points themselves and the clearing of the relative signal does not take place unless all necessary safety conditions are fulfilled. It is important to note that at Darnetal what is called the " momentary control " is employed, the principle of which is as follows : When the control over the reversal of a pair of points is set in action, those points respond only if all necessary conditions which should apply at that moment do in fact apply. If this is not the case, then this particular control becomes definitely lost, hence the term used in France to describe such working of " a commande perdue." The signalman has then to

go through the operation concerned again later on. This is of considerable interest since it renders the working practically immune to any loss of shunt on a track circuit, which sometimes occurs, especially when light-weight vehicles are passing.

Another type of signal box, retaining some resemblance to the earlier ones is what is known as the remotely controlled combiner installed at Villeneuve-St. Georges by the Thomson-Houston Co. This installation comprises a mechanical type combiner, without any electric locking, similar to that used at Montauban, but with remote control over the actuation of the route levers. For this purpose there are arranged on the illuminated diagram small handles, by means of which the slide bars in the combiner are moved to and fro from a distance. This installation was put into service in 1949.

The Darnetal and Villeneuve-St. Georges signal boxes differing in several respects from those having interlocked levers, it appeared of some interest to go a step further in the same direction of making use of electrical circuiting arrangements by constructing " all-relay " type boxes, providing a more satisfactory operating programme for the traffic department. These all-relay boxes, with automatic cancellation and pre-setting of routes, have now been applied in a large number of the most up-to-date installations of the S.N.C.F., notably at Les Laumes, Dijon (Perrigny), Montereau, and Gagny, and also in connection with the centralised traffic control between Blaisy and Dijon. As an example of this kind of working a description of the Montereau installation may be given. At that station there were formerly five mechanical signal boxes containing, 120, 100, 36, 39 and 30 levers respectively. The first two were operated by two signalmen per shift, the remainder by one. They have been replaced by a single box controlling 350 routes operated by two men at peak periods and one at other times. The cost has worked out at 8 per cent less than would have been necessary had the interlocked combiner type of box been adopted. Had one signal box of this kind been put in, assuming it could have been constructed, it would have occupied 15 m. (49-ft.), but thanks to the new methods adopted the console or desk in front of the panel is only 3.65 m. (12-ft.) long. This result has been arrived at by adopting the following arrangements.

The operations to be performed by the signalman are reduced to the fewest possible. To set up a route it is sufficient to press a

button for a brief instant. The route will be cancelled automatically as a train passes or if a succession of trains has to use the same route it will remain set up and those trains will be signalled without any further action being necessary on the signalman's part. Finally, if a train is to be followed by another shortly after, requiring to take a different route, the signalman can go through the action of setting both routes. The first one will actually be set up, the controls for the second being held stored in the apparatus, that route being set up in turn directly the first train clears the original route and so cancels it.

As the signal box controls quite an extensive area, several kilometres long, it has been necessary to adopt some arrangement in order to economise cable costs. It would of course have been very expensive to connect each individual function to be controlled and detected by its own cable with the signal box, but the object has been attained by using a system of remote control and detection specially designed to meet the circumstances of this case. Apparatus locations are arranged along the line where required and are connected to the central apparatus by a few conductors which serve to transmit the controlling and detecting currents.

Put into service in two stages, in September, 1949, and January, 1950, the Montereau signal box has worked with the greatest regularity and given complete satisfaction. It is very easily maintained, from the fact that the various component items are of standard construction and special arrangements allow of the instant replacement of any relay which is out of order, for which purpose all relays, or sets of relays, have plug-in connectors.

The results obtained have been so good, both as regards the quality of the equipment and the small cost of installation that it is intended to use this type of signal box also where a few routes only are involved, in places where there are other and older arrangements in service, less perfect and costlier. In such circumstances there was put in service in November, 1950, at the Gagny spur junctions, connecting the Grande Ceinture and former Eastern main line, a signal box containing 16 routes. It is an all-relay box with automatic cancellation and pre-setting of routes, such as will be installed more and more now in France, wherever it shall prove necessary to put in power signalling.

DISCUSSION

Mr. A. Moss in opening the discussion, said he was very pleased to see the author there that evening, as he had had the pleasure of meeting him on several occasions in Paris and the present meeting gave him a further opportunity to express his appreciation of the many kindnesses he had received. He thought that one of the most outstanding points of interest in the paper was the indication it gave of the very large measure of progress made by the French National Railways in the standardisation of signalling equipment. It seemed to have progressed in well defined stages from the simple block apparatus and mechanical signalling frame to the most modern type of power installation. The development of the power signal boxes as described would be of very great interest to signal engineers both in Britain and other countries. French people had the reputation of being very logical, and it was most interesting to note that with all their vast experience of the directional lever type of electro-mechanical and all-electric installations, they had now standardised on a form of route relay interlocking panel, with switch control. He had seen many of the installations referred to and had been greatly impressed by the progress made in that field. He thought that France had made greater progress in the technique of relay interlocking than had Britain, up to the present.

He enquired as to the reason for adopting the normally clear principle in the standard block arrangement. The controls affected seemed to achieve the same object as those in Britain, but in a reverse method.

In regard to director levers, he asked if an indicator was provided at each signal A, B, C and D at fig. 6, to show which of the routes, X, Y or Z, was signalled. It appeared to him that although only seven levers were required, there would be several wires to each of the signals, therefore whilst saving a few levers, the outside connections would be almost the same as though there were separate levers.

He thought that the mechanical and electrical combiner used with the early type of power frame was peculiar to the French Railways, and he knew of no similar device in Britain. The description of the installation at Montauban was interesting because the mechanical locking effected by the combiner was retained whilst the electric locks were substituted by circuit interlocking. In regard to route relay interlocking panels, Mr.

Moss asked for the author's opinion on the question of using switches arranged on the panel instead of concentrating them on a separate desk or console.

The question of cost was most important, and he had seen on the installations in France that use was made of groups of telephone type relays for circuits which did not involve the safety of working. He thought that they must have a large bearing on the cost of installations of that type, and that in the development of panel working, British engineers would have to consider some such arrangement in order to keep the cost within reasonable limits.

Mr. H. H. Dyer also recalled the pleasure of meeting the author in France when he had been shown many of the signalling installations. Contrary to Mr. Moss, he had been impressed by the many different systems used in that country, and as they all had their features, he asked if the author particularly favoured any particular system for general adoption. He thought it was a matter of opinion as to whether one considered that more progress had been made in France than in Britain. There were a number of features in France that were not seen in Britain, but which could be provided, if considered necessary. He asked if the pre-setting movements had really justified the additional complications. The author said that everywhere now he was installing all-relay interlocking, but Mr. Dyer enquired if there were not a great many cases where he would still use lever operation. In regard to switches being on a panel or on a separate console; he thought that depended largely on the size of the panel. With a small installation, there was something to be said for switches on the diagram where they could be reached easily, but with a very large diagram, he thought a separate console was usually better. At Stratford, on the Eastern Region, there was a large diagram with switches and it was a very ingenious arrangement, but he thought this exceptional, as the track layout lent itself to it.

Although he thought it somewhat outside the scope of the paper, he raised an interesting question concerning concrete sleepers. He recalled that in France there were some tracks laid on concrete sleepers with the rails on rubber pads and with rubber pads between the spring clips and the rails. He had heard that these had been working satisfactorily for upwards of a year

from an electrical point of view, and he asked if the author would give some information concerning these.

Mr. E. G. Brentnall also recalled the happy visits he had paid to the author, whose wide signalling knowledge and command of the English language had made the visits of outstanding value. Regarding the standard block mentioned in the paper, it appeared that there was no indication at the sending signal box for either " train on line " or clearing back, although it had an indication for the far box. There was an elaborate arrangement for polarisation, to ensure that the correct current was there to give a signal, but he enquired if it would always get through on a single line block. The sending box could send a train without the receiving box co-operating and he asked if any trouble was experienced, as the receiving box might not wish to accept the train. The trajector lever was very ingenious, and he believed there was only one signal arm for all routes for any one road, and no detection of points. Referring to the question of relay interlocking, he thought that all types of power interlocking had been tried out extensively in France, and from the experience gained, relay interlocking had been decided as being the best. This was very interesting and provided other countries with the results of all that experience. He thought that on some occasions relay interlockings had been condemned through lack of experience. In the case of failures, emergency arrangements for working traffic presented considerable difficulties and he invited the author's views on this matter.

The **Author**, in reply to *Mr. Moss*, said that the standard manual block had been put into service only on the lines where there had been no block at all, and they had not taken out old blocks to put in new ones. They had begun to improve the old block and to put in treadles in order to be sure that when sending a releasing current, the train had actually passed the post. Regarding the principle of a normally clear signal; after nationalisation in 1930, it had been the subject of prolonged discussion with the Operating Department. They had a number of blocks with signals normally in the " stop " position and others which were normally at " clear," and although they found good reasons for having both types, it was decided that, in the future, they would have normally clear signals. Regarding the director lever, he agreed that though the number of levers was less, the outside connections were more complicated, but at times it was

very important to have the least possible number of levers, particularly when they had to install additional signals with an existing mechanical cabin. In cases the arrangement might save the installation of a longer frame and perhaps a new cabin. They had found it useful to use the director lever, especially with the standard electro-mechanical frame where with the miniature levers on the upper row, it was possible to have only one lever per signal. Although they had made great progress in France, the author recalled that he had visited Thirsk and other places in 1937 and had seen very remarkable all-relay interlockings, and he knew that many more had been put into service since. In 1939, when France had many all-relay interlockings, they installed the first type with switches on the illuminated diagram and he did not think they had others of that type, as the operating officials thought it better to have the switches on a separate desk, which enabled them to put the illuminated diagram a little further from the signalman where they considered it was easier to see. Both operating officials and signal engineers had come to the conclusion that it was better.

In reply to *Mr. Dyer*, the author said that both he and Mr. Moss were correct when one said that the French railways had standardised to a considerable degree and the other said that they had not standardised very far. They had in fact standardised the principle, but had left to the contractors a wide measure of ingenuity and invention over the question of design, such as the type of relays used, providing that they fulfilled certain electrical conditions to correspond with their specification. They had a great number of types of relay and a great number of types of block working, but this was of no consequence as they were arranged to work one with the other.

With their lay-out and electrical design, pre-setting movements did not present the complication to which Mr. Dyer referred.

He did not claim that all-relay interlocking would be the solution in every case, and there were places where mechanical frames were more suitable. He agreed that in the case of a large panel it was not the best arrangement to have switches on the illuminated diagram, but with a small one it might be so.

Regarding concrete sleepers, they had rubber pads under the rails, even if there were no track circuits, as the pads were put there for the preservation of the sleepers. If there were track

circuits, other rubber pads were added on the fitting that held the rail on the sleeper. This had been carried out as an experiment, but he did not consider it as a solution as it was too expensive.

In reply to *Mr. Brentnall,* there was an indicator by the signalman's button, which changed colour, and though it was not exactly an indication of what happened in the other box, it practically served as such. If the signal were clear, the signalman in the receiving box had to accept the train that came, there was no question about it whatever. The principle was quite different from that in Britain; in stations in France which were not very important the station master did not know which train was coming.

It was quite true that they had only one semaphore arm for different routes. Previously they had several levers for different routes but they found it preferable to have a trajector lever, which meant only one main lever for the signal.

The **President** said he was quite sure that all present would agree that the reading of the paper and the answering of the questions had been so entirely satisfying, that none could be other than grateful and glad to have been there. Unfortunately there was not time to make detailed comment on the film, but it was really first-class and he did not think he had ever seen such a complete pictorial explanation of marshalling yard operation. He moved a hearty vote of thanks to show appreciation of the author's knowledge and the very delightful way in which he had explained points and answered questions. The vote of thanks was carried with acclamation.

The **President** announced that the next Technical Meeting would be held on Wednesday, November 7th, 1951.

Table d'enclenchement Saxby à cylindres d'itinéraires

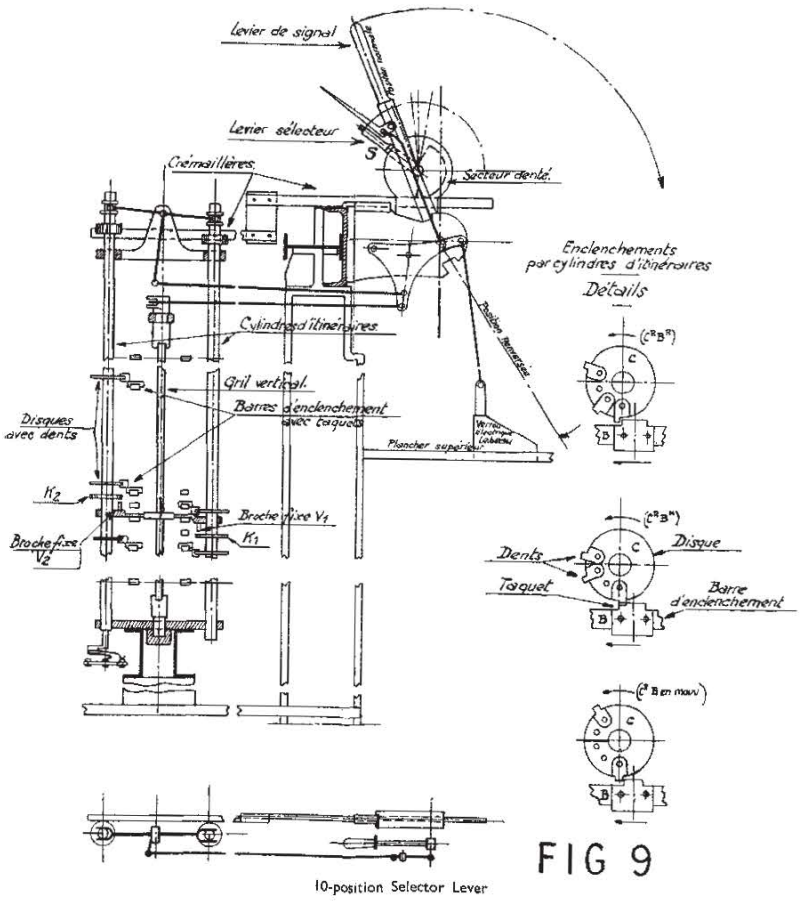


FIG 9

10-position Selector Lever

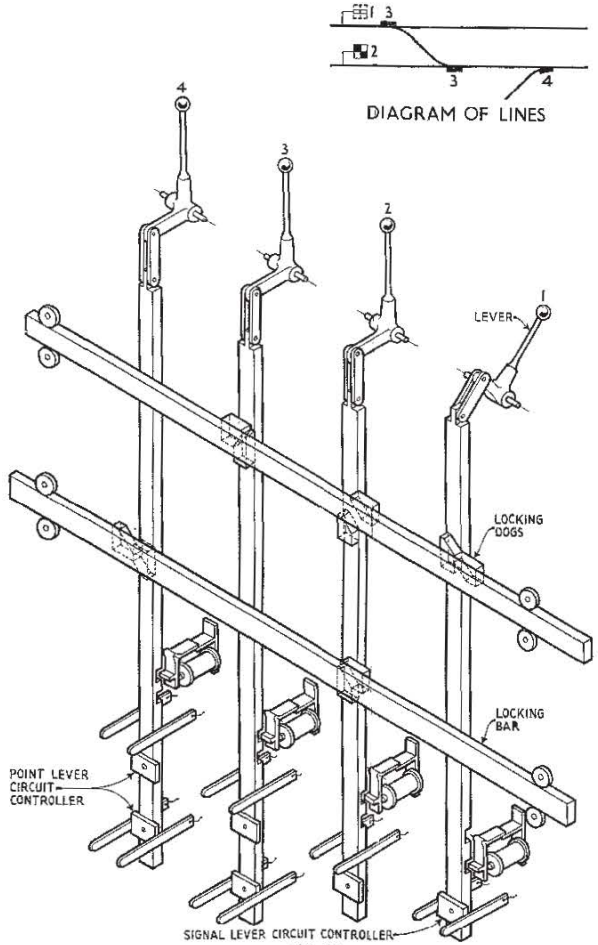


FIG. 10

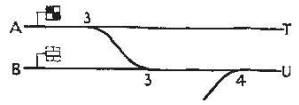


DIAGRAM OF LINES

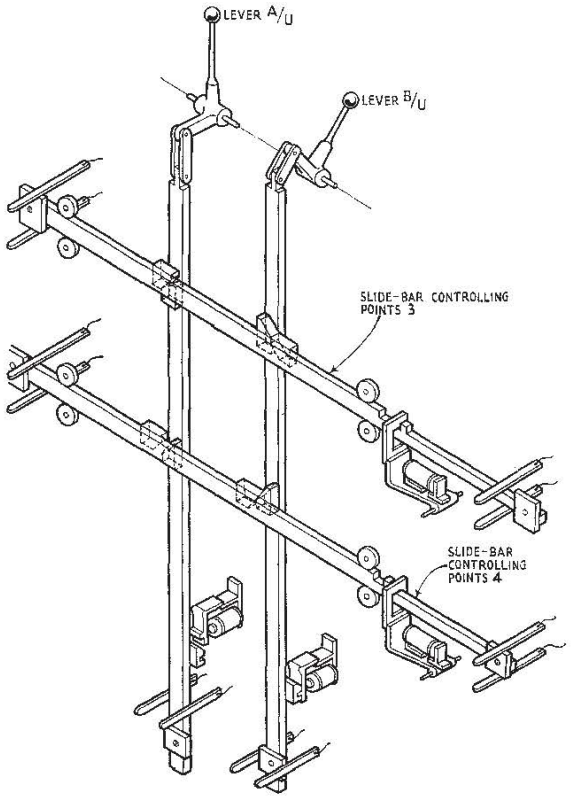


FIG. 11

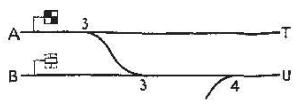


DIAGRAM OF LINES

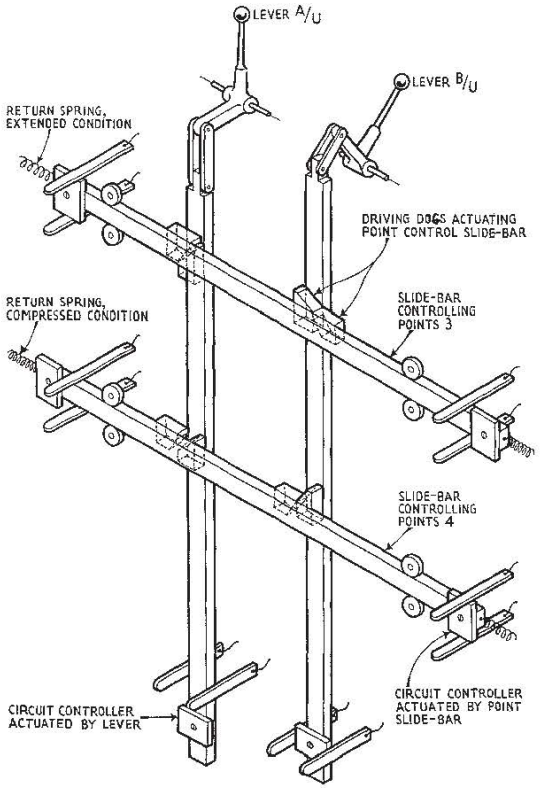
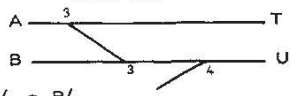


FIG. 12

PRINCIPE DU POSTE À LEVIERS LIBRES DE DARNÉTAL

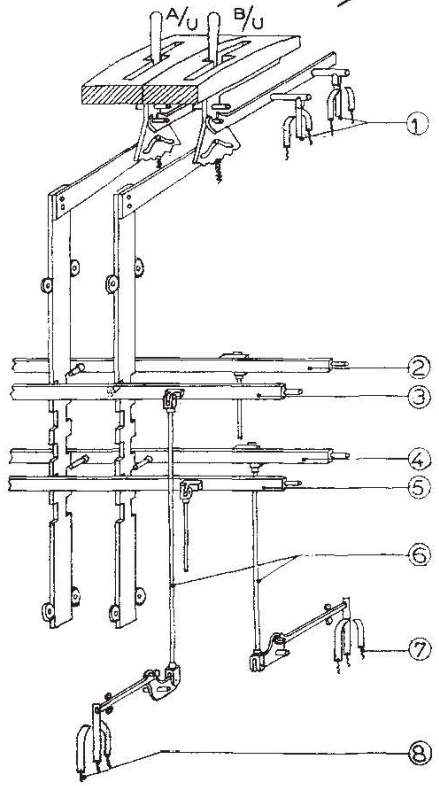
Schéma des voies



Légende

1. Contacts d'itinéraires
2. Barre d'aiguille 3/D
3. Barre d'aiguille 3/G
4. Barre d'aiguille 4/D
5. Barre d'aiguille 4/G
6. Transmissions
7. Contacts d'aiguille 4/D
8. Contacts d'aiguille 3/G

FIG 13



Route Lever Frame with non-interlocked Levers

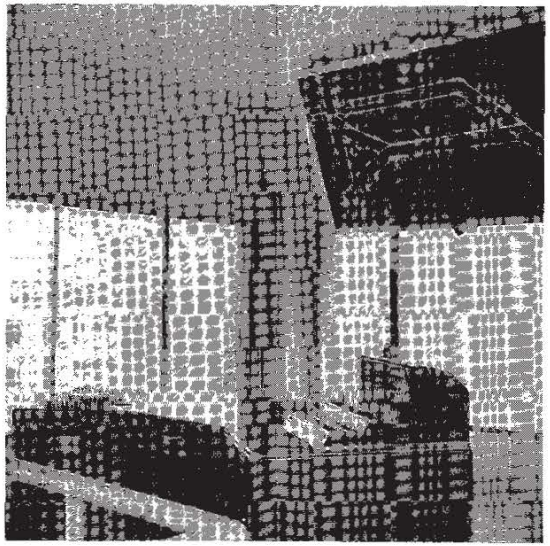


FIG. 14 Interior Darnetal Signal Box

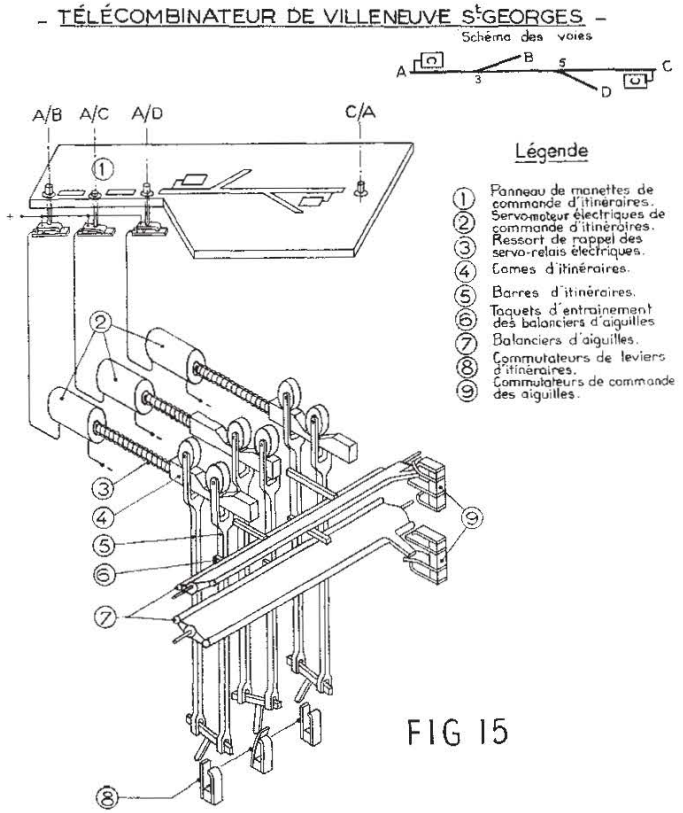


FIG 15

Remotely Actuated Route Lever Frame

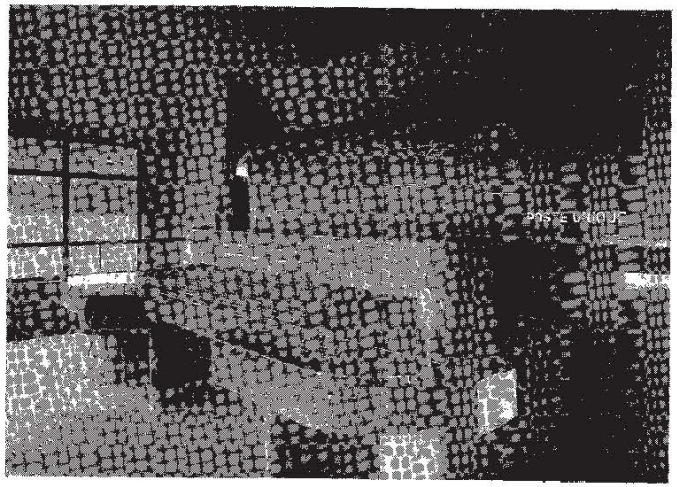


FIG. 16 Interior Montereau Box

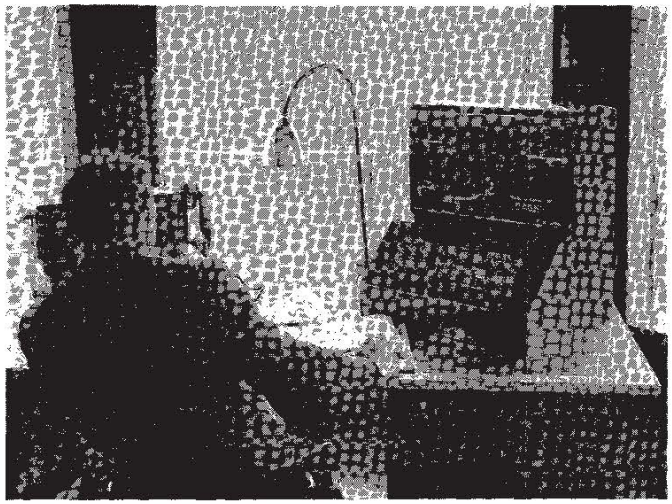


FIG. 17 Interior Gagny all-Relay Signal Box