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# Institution of Railway Signal Engineers

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FOR THE

## Advancement of the Science of Railway Signalling

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# General Meeting of the Institution

HELD AT

# The Institution of Electrical Engineers,

# 12th January, 1927.

The President (Mr. F. DOWNES) in the Chair.

After the minutes of the last meeting had been read and confirmed, and Messrs. A. W. Woodbridge, W. H. Hallam, and E. G. Westray, Members present for the first time, had been introduced.

The **President** said that that evening they were to have a lecture by Mr. Lascelles. At its conclusion, Members would be at liberty to ask questions to which the Lecturer had consented to reply.

## Railway Signalling in Germany.*

By T. S. LASCELLES (Member of Council).

(*Inset Sheets Nos.* 15-17).

The subject of Railway Signalling in Germany is one which has many rewards to offer to those who will take the trouble to study it, either in Germany itself or in the excellent and numerous works written on it by its capable authors, far exceeding the signalling literature of any other tongue. Until comparatively recently but little attention had been given in England to the signalling systems and appliances used by the Germans, but this situation is changing and it is to be hoped that the British Signal Engineer will devote more thought to the matter than has so far been the case. What is the real significance of German signalling for the English signalling world ? It is that it represents another school of thought, another line of development, which differs in

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* This lecture was illustrated by about eighty lantern slides, which formed an important part of it. The text has been modified and shortened for publication, as these illustrations cannot be reproduced here, except those given on the inset sheets.

some important respects from that followed in Great Britain and America. American signalling apparatus does not differ, on the whole, very much from that usually found in England. It is more a question of magnitude, of money and opportunity. But there is a great difference, as will appear, between German and English ideas (and hence in the appliances based upon them) and which makes it correct to speak of two schools of thought in this respect.

When we say " German Signalling," or " German school of thought ", we must remember that it is far from being confined to Germany. It has spread far beyond over the Scandinavian countries to Russia, is found in Austria and the succession States, Switzerland, in the Near and part of the Far East, Holland and Belgium.† In some places it differs but little from what may be termed the true German form while in others it has been modified to some extent and been combined with ideas emanating from England, as, for instance, in Belgium. So that from the European point of view, it is important that the English signalling engineer should have some understanding of German systems even though he may not wish to adopt them.

The signal engineer has long enjoyed great respect in Germany, either as a railway officer or as a manufacturer. The signalling organization of the Reichsbahn, the National Railway System, is an independent one and those who are in it are very proud of it, as they have every reason to be. The manufacturers, who carry out practically all the work, enjoy the confidence of the Railway Ministry and are helped, encouraged, and rewarded for achievements. Pride in the national railway system is widespread in Germany and the public are enabled to appreciate it through the many excellent railway museums which exist, notably at Berlin, Nuremberg and Munich. In the Berlin Museum, for example, to mention only one section of it now, may be found a complete series of models, illustrating the development of signal apparatus, full sized examples of every kind of frame, signal, block instrument, etc. ; and in a yard outside, two cabins, one power, the other mechanical, connected up to out-door apparatus, in which the visitor, guided by retired signalmen, can learn the working of everything in detail. It is much to be regretted that there are no similar institutions in England.

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† German signalling is now found in France, of course, on the Alsace-Lorraine Railways, where it will no doubt be retained.

There is no need to emphasize the importance of the German National Railways as a system of communication. The geographical situation and industrial development of Germany render this inevitable and it must be admitted that the lines have been made worthy to be the great international highways which their position in Europe makes them. The undertaking is an enormous one, notwithstanding the losses of track—about 4,800 miles—which have followed the treaty of Versailles, and covers about 33,000 miles of track at the present time. Neglecting temporary war conditions the safety of working is excellent and certainly before the war was as good as that obtaining in England. The subject of safe working has all along received the most careful consideration and the appliances in use exhibit an interesting evolution.

The first signalling installations of any importance were laid down in 1868-1869, one or two frames being purchased from Saxby and Farmer and some being built locally. The first signalling firm* was established at Bruchsal, Baden, in 1869. Many others subsequently came into being—Zimmermann & Buchloh, Jüdel, Scheidt & Bachmann, Stahmer, Fiebrandt, and others. Firms with larger interests also developed signal departments, such as Siemens and Halske, and, later, the A.E.G. There were fifteen signalling firms before the war, but now, owing to amalgamations, there are far fewer. The years after the Franco-German war witnessed much activity, the various railway systems being developed and nationalised, great progress being made in the manufacture of apparatus. Outside Germany, too, much work was done in the countries above mentioned.

Turning now to the signals actually in use in Germany to-day it will be convenient to consider those of a subsidiary character first (Fig. 1). These are practically self-explanatory. The "A" and "E" discs correspond with the English "C" and "T" signs,† while the "H" (halt) lantern is employed to indicate the point where the train must be brought to a stand at a platform, etc.; where this is necessary in order (say) to avoid fouling a path across the lines used for luggage, or some similar reason. The one really important signal to remember is the No. 14 signal,

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* Founded by Adolf Schnabel and Theodor Henning. The works still exist and are associated with the firm now called "Jüdel, Stahmer, Bruchsal, A. G.", whose chief works are at Brunswick.

† "A"=Anfang (commencement); "E"=Ende (termination).

called in these remarks the " Banner Signal ", as it almost resembles Sykes' banner signal, so well-known in Great Britain. When at " stop " it over-rules everything. Its signification is absolute, and no train or engine may pass it, save under written permit in case of a defective signal. It is therefore cleared for running movements as well as shunting movements and it plays an important part in the whole German conception of signalling and interlocking, as will presently be seen. Made in fixed form of course, it is used as a buffer stop lantern.

As far as running signals are concerned, German signalling is exceedingly simple, there being but three signals to understand, viz. :—the ordinary semaphore, the junction semaphore, and the distant disc signal (Fig. 2). The first calls for no comment. It has two positions in the upper right-hand* quadrant, with a red or a green light, the upward moving arm having been adopted from the beginning. The junction signal is, however, interesting. In some of the first installations in Germany, the old-fashioned English signals, having several arms, one above the other, were used, but about 1878—by whom it was originated is not clear—a theory arose, which received official sanction and has enjoyed a great vogue, that a driver should never be required to pass a red light or a horizontal signal-arm. This led to the adoption of the signal shown in the figure in which the second arm (assuming a two-arm signal) is normally closed up against the post and its light obscured. One arm—the top arm—is pulled " off " for the direct route, and for the deviating route, the lower arm is brought out at the same time, exhibiting two arms at 45° and showing two green lights. Sometimes—in Prussia and Saxony—a third arm is used and all three appear at 45° for a second deviating route. The result of this arrangement is that :—

(*a*) All signals appear exactly the same when at " danger ", exhibiting one horizontal arm and one red light.

(*b*) A driver taking the direct route at all stations receives the same " clear " signal everywhere, one arm inclined at 45° and one green light.

(*c*) An unusual signal—more than one arm—is only received if a deviation from the main direction of running is made.

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* The trains run on the right in Germany.

Some other countries also adopted this signal, but in Norway the significations are reversed to avoid danger should a lamp go out.*

Distant signals are discs, not semaphores, in order to have as great a distinction as possible between " caution " and " stop " signals. Two yellow lights appear at " caution " and two green at " clear," when the disc, which rotates on a horizontal spindle, is flat on its back. A marker board, as shown in the figure, is placed just before the signal to serve as a location mark when the edge of the disc is presented. These signals are usually on low posts, bringing the disc level with the driver's eye, but if they have to be carried on brackets or bridges, they are hung down as near to the gauge as possible. They are invariably placed on the right hand side of the line, no exception to this rule being allowed. At the present time warning approach boards, on the same principle as is adopted in Belgium, are being installed in front of all distant signals. The signal posts are always metallic, no wooden ones being seen, and are either tubular or made of rolled section steel or lattice work. They are very strongly constructed and no guy wires are employed. Tall posts are hinged at the base to allow the foundation casting to be put in separately without difficulty. The signal-arms are now made of enamelled steel, white with a red border (see Fig. 2), or red with a white border when the background is dark. Originally perforated metal work arms were used, the painting differing to some extent in the various railway divisions, a very general way being half white and half red horizontally. The spectacles and lamps, in Prussia at all events, slide down separately and are kept lowered clear during the daytime. They can be hauled into position at any time, regardless of the indication which the signal is exhibiting. There are no ladders and lamp landings at all. Each signal post carries a large enamelled plate bearing the " number " of the signal, which is generally a letter and not a numeral. The posts are painted in alternate bands of white and red on the front which much improves the visibility, as does the disc end formation of the semaphore arm. The distant discs are also now made of enamelled steel ; they are coloured yellow with a black ring and white edge. Originally the distant signals had green discs and exhibited a green or a white light for " caution " or " clear ". This use of

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* This danger has sometimes been felt in Germany but is not regarded as serious apparently.

green for " caution " was very unsatisfactory—more unsatisfactory than the English use of red—and in 1910 it was decided to change over to the yellow disc with double lights, originally suggested by Director Ulbricht, of the former Saxon State system.

The signalling arrangements are fairly uniform throughout Germany, but in Bavaria there are some important exceptions. White lights were retained for " clear "—abolished, except in the distant disc, in Prussia in December, 1892— and the old green and white distant signal until comparatively recently. The lights have now been altered to correspond with the other parts of the country. The disc of the distant signal is mounted at the side of the post and so constructed that when the lever is pulled it folds back in two halves so as to form a small semaphore at 45°, giving a positive " clear " signal.

The starting signal has a third position called " rest " or " closed ", with the arm hanging vertically downwards in the post, a blue light being shown at night. In this position it indicates that no train is being signalled into or is ready to leave the track concerned and that shunting movements on that track are therefore permissible. The theory underlying the signal is that the " danger " indication at a starting signal is superfluous as long as no train can come up to such signal from the rear and therefore during that time the starter can serve another purpose. It must be put to " danger " before a train can be signalled to run up to it and when so altered serves as an indication to the staff in the yard, etc., as to what track an incoming train will run on. No running movement may take place past the " closed " sign but shunting movements may do so.

On the Prussian and Saxon lines where both two- and three-arm signals exist, each indication refers to a certain route, occasionally to a group of routes, as in entering a fan-way of sidings. In other words, route signalling is used. The drivers must learn by heart the application of the indications at each place, but this is not so difficult as might be thought, owing to the similarity that exists between the station layouts in Germany. The plan usually followed is to allocate the indication with three arms to the route least often signalled, if possible, but as more than three arms are never used, some other arrangement must be adopted where several important routes exist which must be independently signalled. In that case another signal is put further on at the further dividing point or else a bridge of one-arm signals a short way ahead, one over each route concerned. This leading signal must be pulled off first before the home signal proper and the driver, when reading the latter, looks for the route signal ahead as an indication of where he is being sent. Outside Prussia and Saxony three-arm signals are not used.* Speed signalling is then employed one arm signifying " full speed " and two arms " reduced speed : deviation," an arrangement in existence for forty years past. Speed signalling is not altogether, therefore, an American invention, as some enthusiasts imagine.

The distant signal works almost invariably with the same lever as the home—only in Saxony are separate levers regularly employed—and it is pulled " off " whether a direct or deviating route is announced by the latter signal. This does not matter very much as the home signal is generally some distance back from the points, the road being held always by an electric route lock, while the running of every train at every station is laid down and published beforehand. If this plan has to be departed from for any reason and a driver is given an unusual signal he is informed of the fact by telegram at the last stopping station. If this cannot be done, the train is brought nearly to a stand before the signal is pulled " off ". A driver receiving an unusual signal without previous warning must not accept it but come to a stand and then draw cautiously forward, where this is possible.

The distant signal is not interlocked with the starter—there are practically no advanced starters in Germany—and, in consequence, for a non-stopping train, the home is not pulled " off " until the starter is " off ", or until the train has come nearly to a stand. It is pulled " off ", however, and of course the distant too, as one lever operates both, for a train which is to stop in the station and thus the suburban driver gets the benefit of the distant signal which greatly improves the working in every way.† An exception to this rule is allowed, when there is a distant for the starter and this is a sufficient distance out, as it often is in the

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* They were used on the Alsace-Lorraine lines and are seen in Sweden, Austria, and one or two other places where German methods are used.

† Especially in foggy weather. Quite half the delay in this country on the suburban lines is due to the useless distant signal being continually at " danger " because the *block section ahead is occupied*, necessitating a crawl all the way to the home, though the *station* is clear. What, pray, has the next section to do with a *stopping* train until the time comes to start ?

German layouts. This distant for the starter or "through" signal is being largely used to-day on the main lines.

The numerous ground shunt signals seen in Great Britain are not used by the Germans. Instead of these each pair of points has a lantern which shows their position at any moment (Fig. 3). The lanterns are fitted with milk-glass signs and appear the same, day or night. It will be noticed that a rectangle sign indicates the straight path, while an arrow indicates the direction of deviation, this, on the reverse side of the lamp, being replaced by a circular disc sign. When double slip points are so connected up, as with hand points in sidings, that either both straight or both curved paths are open simultaneously, i.e., there are only two possible combinations, then the rectangle sign is used for the straight, and the double arrow sign for the curved paths, only one lantern being required. Trap points and derailers are signalled with the No. 14 banner signal. The signs used on the Bavarian lanterns are different from the Prussian signs but this detail is of no importance.

When double slip points are operated from a cabin they are coupled up necessarily on the parallel principle, so that four distinct paths are possible. The original practice was to equip each pair of points with an ordinary lantern, using four therefore in all, but this meant using a great many lanterns on ladder tracks and made the reading of the indications difficult. Many proposals were made for signalling all four combinations by one lamp. The standard lantern now definitely adopted is that invented by Professor W. Cauer, the author of a very fine work on signalling,* illustrated in Fig. 4. It represents the four possible paths pictorially, and is very easy to understand. The signal is made by the A.E.G. Company, and a number of them are already in use, not only in Germany but abroad. The Prussian lines also tried a signal, invented by Herr Hoogen, now Director of the Berlin Railway Museum, and formerly head of the signalling on those lines. On the Bavarian lines may be seen the signal employed also in Switzerland and shown at the bottom of Fig. 4. The two straight paths have separate signs, the cross sign being used for the subsidiary direction, oblique to the general axis of the station. It is sometimes, however, difficult to settle which is the "principal" and which the "subsidiary" path. As long as this

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* See the Bibliography at the end of these remarks.

distinction is admitted it is possible to signal parallel double slips with two lanterns only, as is the usual practice in Holland at the present time, but this method has not found favour in Germany.

Now, a necessary consequence of this system of signalling is the employment of what are called " shunting prohibition " signals, and which serve to stop conflicting shunts or, more important still and more usually, to prevent shunting movements from fouling running movements, when it is not possible to set any points as traps to them. Originally the official code included no such signal and to fill the gap the platelayers' portable stop signal, No. 6*b* (see Fig. 1) was requisitioned and turned into a movable signal, turning over flat, and exhibiting a white light for " clear ". This is still to be seen used in this way and sometimes as a home signal at small stations on light railways. Now, however, the banner signal has become the standard shunting prohibiter. It is an absolute unconditional stop to all movements when at " danger " and therefore, as already explained, is pulled " off " when running movements have to pass it. The use of this signal has resulted in coloured lights being kept exclusively to running signals, as far as fixed signals are concerned. This is a very good feature of the German signalling code.

The cabin arrangements are very much the same everywhere. The locking frame is entirely above the floor and beneath the floor are the wire compensators. In Holland and Austria where these are but little used there is then nothing below the floor but the wires running out. Rods are hardly ever seen except in Baden. Elsewhere, double-wire transmissions are used for both signals and points. It is not necessary to go into any great detail here as the Institution has already been favoured with very complete papers on the matter from Mr. R. S. Griffiths* and Mr. W. J. Sadler** and which the reader is recommended to study. No man who will investigate the subject impartially can fail to come to the conclusion that the double-wire system is the only true mechanical signalling. Externally the German signal cabins are often most pleasing to the eye, contrasting with the hideous erections which are often to be seen in this country, having tiled roofs and other artistic features. They are frequently heated by hot water and are invariably most comfortable. The wire lead-

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* Proceedings of the Institution. Session, 1925-26, p. 35.

** Proceedings of the Institution. Session, 1925-26, p. 197.

outs and runs are much neater than those usually seen in England and much more scientifically arranged. The use of wire ropes instead of chains makes for neat and light wheels while ball bearings are frequently employed to reduce the effort required of the signalman*. All this makes the fittings last much longer. At stations of any size the wires are put in conduits below ground wherever there is a possibility of persons falling over them. It has been the fashion in England lately, in some quarters, to keep asserting that power signalling enables one to have " no wires to fall over ", as if wires in mechanical signalling must necessarily be put so as to be an obstacle to people. Such speakers should visit some of the admirable German mechanical installations where there are no wires to be seen. In Prussia always, and to a large extent elsewhere, the expansion and contraction of the wires is kept compensated automatically by compensators fixed under the cabin, or sometimes outside. The signalman has nothing to do with regulating the wires and is forbidden to interfere with them. By these arrangements the doubtful signal indications, constantly seen here, are practically eliminated.

The signals are usually operated through the medium of cam plates and not directly from the transmission. These cam plates have a certain amount of idle move at the beginning and end of the stroke to take up any slight inequalities due (say) to pulling over quickly or slowly, and which cannot be altogether avoided. In this way an absolutely exact travel is always imparted to the signal arm or disc. The arm does not bang itself, the stops and the fittings all to pieces, it moves smoothly and exactly, no matter how the lever in the cabin is worked. The two-arm junction signal is worked by one transmission, driven in either direction by a special arrangement of the two levers concerned, the cam plate for the bottom arm having an idle slot in one direction to allow it to remain stationary while the top arm moves. This principle can be extended to cover conflicting starting signals and enables the number of wires required to be reduced (see Fig. 5).

When three arms are provided on a signal they are usually operated in the following manner. The third arm is normally

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* The Germans are very strict about this. The absurd arrangements seen in England where, with a heavy backtail weight and one foot against the adjacent lever, the signalman bangs a lever over and then produces a half-way indication are laughed at in Germany, and English Signal Engineers ought long since to have been ashamed of them. The backtail weights are most dangerous.

locked by a bolt on the post. A cam plate, worked by a lever known as the " coupling up " lever, when rotated, takes away this bolt and at the same time pulls a connecting rod joined to the second arm, so that it engages with the third arm. The signalman now pulls over the two-arm indication lever, but, necessarily, all three arms now move to 45°, as the third arm is in gear with the second. Thus the working is to pull the coupling-up lever first, then the two-arm lever, if the three-arm sign has to be given.

Reference should now be made to the bottom part of Fig. 5. It has been already explained that a distant signal and its home signal are usually operated simultaneously by one lever—except in Saxony—unless there is a very special reason to the contrary, such as a transmission too heavily loaded owing to a sharp curve in the line, etc. The one transmission goes on past the home to the distant. The former is then equipped with a special mechanism—a differential—composed of two operating sheaves, one for each wire, coupled to each other and the arm driving portion through a planet or bevel pinion motion. The parts are so arranged that expansion and contraction, being equal and opposite in the two wires, do not shift the signal but pulling the lever does, as in that case the whole mechanism is moved as a unit in one direction. The new standard movement is on these lines but there are other mechanisms in use for the same purpose still. The most noteworthy is what is known as the Jüdel Tongs-Motion. Preference is naturally given to an arrangement in which a wire breakage between home and distant leaves the former still workable. The Jüdel movement did not do this. In recent years many installations of electro-gas distant signals have been put in at mechanical cabins, by Siemens and by the Bruchsal works. Low voltage signal machines are also being used.

The operation of points by wires dates back to the year 1878 and it would appear that Siemens and Halske originated it. They certainly laid down some small installations about this time or soon after in both Germany and Holland. Their " soup-pot " point mechanism is very old and has been followed by a great number of devices of varying degrees of merit.* A widely used arrangement is the crank movement of Jüdel, which consists simply of a large crank moved to and fro by the wires, one arm

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* Some were illustrated on the screen at the time of the lecture and were also dealt with by Mr. Sadler, when reading his paper.

being coupled to the throw rod of the points. The wires are coupled to the crank through triggers loaded by powerful springs. The triggers are held in such a position when the transmission is in order that there is no hindrance to the free movement of the crank, but should a wire break the trigger concerned is forced over so as to engage with a stop, and prevent unauthorised movement of the points or, more accurately, to prevent their being unlocked in the position they occupied when the breakage occurs.* It must be remembered that all points worked from a cabin in Germany have facing point locks, whether facing or trailing. The locks are generally—certainly in the North—what are called hook-locks, invented by H. Büssing in 1892, as an improvement on an appliance constructed in 1887 by the railway workshops at Witten (Fig. 6). To understand the hook-lock it must be borne in mind that in Germany all points are trailable —this is a standard requirement—that is, must be capable of being run through from the wrong direction without damage. When this occurs, the fact must be indicated in the signal cabin. A plunger type of facing point lock is therefore out of the question. It will be seen from Fig. 6 that the closed tongue is clamped to the stock rail by a hook, the tongues not being rigidly connected but being joined through the hooks to each other and to the operating rod. The action of reversing the points is as follows :— The first part of the movement simply withdraws the hook on the closed tongue, moving the open tongue a short way. Both tongues then move together until the stock rail is reached in the new position, when the remainder of the stroke moves the open tongue a bit further and clamps the closed tongue. Should a vehicle come from the wrong direction it acts first on the open tongue and so removes the hook from the closed tongue in time and enables it, in turn, to move. The wire transmission acts on the cabin lever as explained later. This kind of lock registers the closed tongue with respect to the stock rail whereas the plunger type lock registers it with respect to the centre of the track. In South Germany, Switzerland, Alsace-Lorraine, etc., may be seen another device, the Bruchsal linkage lock, which keeps the closed tongue supported against a stout casting in the centre of the track and also operates in three stages.

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* With the excellent maintenance characteristic of the Germans, wire breakages are exceedingly rare.

In the double wire system, of course, the transmission itself automatically affords a certain measure of detection on the movements outside, but this is not sufficient to enable detection, as we know it in England, to be dispensed with. Some parts of the point tongues, hooks, rods, etc., may be defective or missing. Therefore facing points, and certain others at times, are equipped with detectors. These are not now made on the slide principle, as in Great Britain, though they were at one time, in the South, where they may still be seen in this form, but on the rotary principle. They consist essentially of a drum with a raised ridge which can engage with slides coupled to the point tongues and so detect and lock them. These detectors are, in simple cases, inserted in the signal transmission, but only in simple cases, for, as already stated, the Germans take great pains not to make the working of the levers heavy. The detectors are therefore frequently operated by independent levers which are, of course, suitably interlocked with the signal levers. This eminently sensible plan does away with the complicated runs of wires to and fro, seen in many English yards, which are always out of adjustment from one day to the next and have not infrequently led to signals remaining "off" irregularly, and thus to accidents. If two or more detectors are run in series from one lever, then the intermediate ones have a bevel or planet wheel gear, introduced in 1889 by Stahmer, which, as with the "through" signal movement, allows expansion and contraction to take place freely without influencing the detecting portion. The same arrangement is used when a detector is inserted in the transmission of a signal.

Detectors are, however, allowed to be dispensed with on purely goods lines and on passenger lines at stations where trains only start over the points and not traverse them at speed, if detection in the point mechanism itself is provided. This consists in bringing the detector rods from the tongues to blades in the point operating mechanism and so arranging them that unless both tongues move over in correct order during reversal the signalman is prevented from moving the lever more than about two-thirds of the stroke. He cannot force it the remaining third and thus the points detect themselves each time they are moved. Electrical detectors at mechanical plants are not seen in Germany but they are in some countries which have adopted German methods.*

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* Every pair of points on the Belgian National lines which can be run over facing by a passenger train has electric detection.

Turning now to the locking frames used in Germany, the essential point to notice about them is that they impart a long stroke to the transmission to begin with. Originally the frames were copied from English models but these designs gradually disappeared after wire working came in. Even for rod working, indeed, used in Baden, Alsace-Lorraine and Switzerland, the lever passing through the floor of the cabin has long since been abandoned. The fundamental defect of the English or American locking frame is that it imparts far too small a stroke to the transmission and distributes the effort required over too small a time. It has in fact, to be jerked, not worked. Stroke can always be lost between the frame and the appliance but it cannot be gained save by sacrificing the leverage—the mechanical advantage—afforded by the lever to begin with. In consequence, in England, we were in the absurd position of giving the signalman less leverage for the signals most difficult to pull, viz. distant signals, for which gain-stroke wheels were nearly always fixed under the cabins.* This initial error in the English signal frame has resulted in no progress being made at all, save in a few insignificant details, from the first mechanical frames of Saxby & Farmer to the present day, unless it be in the Midland Railway frame which approximates in action to the German type to some extent.

As in other countries many patterns of frame came into existence and also many types of point movement and signal drive. This led the Prussian State Railways, the largest independent state system prior to the war, to endeavour to create a standard mechanical apparatus or " Einheitstellwerk ". The work was begun in 1900 with the co-operation of the various firms, who whole-heartedly assisted, the provision of the new designs being guaranteed to them all in fair proportion, but it was not finished till 1914, when six standard installations were laid down as a beginning. There have been some minor modifications made in the designs lately, as a result of the experience thus gained. It is interesting to know that the Emperor awarded silver and bronze medals to the men who carried out this standardization work.

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* Sometimes the most extraordinary gain-stroke contrivances are seen along the line, which are expected to work in defiance of every principle of mechanics.

The ability to trail through the points has already been referred to. When this occurs, the transmission must be able to rotate the operating drum of the lever although the latter is held in the frame by its catch handle. To allow of this, a spring loaded clutch is provided which is overcome when a run through occurs, the turning of the drum raising the catch handle in mid-stroke and so fouling the mechanical locking, that no running signal may be pulled " off " reading over the points in question. The signalman can restore the drum into re-engagement with its lever by a special spanner. An " out of order " sign—in the standard apparatus a red disc, which emerges from behind the number plate—is given when this occurs, accompanied in Saxony by an alarm gong. Signal levers, of course, do not have this clutch feature.

As in the standard apparatus, and in most of the other types too, the catch handle is governed by the mechanical locking, it is obvious that it cannot rise if a running signal be "off," since the catch must be mechanically held at such a time. Hence something must break if a run through occurs under such conditions, but the liability of this happening is rather remote. Nevertheless, in the Siemens and Halske frame, widely used in Belgium and the Netherlands, the locking mechanism is so made that a locked lever can be trailed without any damage resulting. This principle has not been generally followed, however, because in the first case, the danger of a locked lever being trailed is, as stated, remote, with a thoughtful signal and track layout, while, secondly, the result is that a signalman could, were he so grossly or wilfully negligent, rotate the drum of the locked lever with the re-setting spanner or by some other means, which would be tantamount to defeating the locking. The Siemens frame is nevertheless a great favourite with some engineers. The late Monsieur Weissenbruch, an Hon. Member of this Institution, considered it the best double wire frame in existence.

In addition to the question of trailability there is also that of wire breakage to be considered. In some countries no importance is attached to this, as in Holland. It is considered that, with sufficient care, wire breakages can be altogether avoided. The wire breakage lock at the points has already been mentioned. The action at the lever must now be considered. There are two general methods of making a wire breakage re-act on the lever in the cabin—in the case of point and detector levers, that is—

one, is to rely on the pull of the compensator weight on the intact wire rotating the lever drum against the trailable clutch, so influencing the catch handle and hence the mechanical locking, as if a run through had taken place ; the other way, which finds favour with those administrations which do not use compensators in every transmission, consists in securing the two wires to the lever drum through a spring controlled mechanism,* the power of which is overcome when the transmission is in order but which, should either wire or both wires break, is able of itself to shift the catch handle to the mid-stroke position, or prevent its being dropped, if the irregularity occurs during the stroke of the lever. It is impossible to deal with this subject fully without the assistance of a good many illustrations and hence this general outline is all that can be given here. The subject is very interesting and the Germans have devoted much thought to the problems involved and produced many ingenious solutions of them. Mention should perhaps be made, however, of the peculiar locking frame of Stahmer which employs a differential lever, consisting of two drums coupled to each other and to the lever by a bevel pinion. The compensator weight in this case floats under the cabin in a loop comprised in the transmission, in such a manner that it is raised by the act of trailing and so restores the points to their original position. It is unaffected during the act of reversing the lever and in some respects must be looked on as an exceedingly good compensator. The frame is an expensive one, however. The former Oldenburg State lines used it exclusively but it will now disappear gradually.

These considerations lead us to an examination of the mechanical interlocking mechanism used in the German frames and the principles involved in it, perhaps the most interesting thing in the whole subject. An all important fact must be remembered at the outset, viz. :—that the interlocking is not moved by the signal and point levers being moved but is only governed by their movements, strange as that sounds at first. Except in one or two unimportant cases, unnecessary to mention, there is no locking between one lever and another, as usually understood in England. None at all. The interlocking is shifted separately by hand.

How this is done may be seen by examining Fig. 7. Coupled

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* By using suitable triggers or *two* drums, very close together, which rotate in opposite directions under spring power against a stop and are pulled the other way up to a stop by the transmission.

to the catch of each lever, by links, is a plain rectangular section steel bar, the cross bar, which passes transversely across the locking box;* when the lever is normal (or +, as the Germans say), this crossbar is in its highest position. During stroke, the catch being raised, it is in a midway position and when the lever is reversed (or in its – position) it is in its lowest position. It does not drive or shift anything. The catch is therefore never hard to clasp as it has no bevel motion action to effect at all.

The locking bars are slide bars running lengthwise in the box and have fixed to them what are called "plus" or "minus" elements, the former plain square pieces which can come under a crossbar when it is up, the latter, hook shaped pieces which can come over a crossbar when it is down. With the crossbar midway, neither type of element can pass. Thus the movements of the locking bars are governed by and, in turn, govern the cross bars, but there is absolutely no bevel action about it. Each locking bar is driven by means of a small handle called a " route handle ", or " Fahrstrassenhebel," which can occupy three positions, viz. :— neutral, set for one route, or set for another route, the neutral position being, as seen in Fig. 7, horizontal. These route handles are, as a rule, grouped together at one end, sometimes at both ends, of the frame.† A simple example of this method of locking is shown in Fig. 7, where two conflicting signals, reading through a pair of points in different positions, are treated.

Normally the route handle a/b, allocated to the two moves A and B, controlled by the signals similarly designated, is neutral. As will be seen easily by examining Fig. 7, under these circumstances both the signals are locked, but the points are free. This principle is carried out, whatever the size of the frame, all points being free with the route handles normal. There is no direct interlocking between point levers themselves and there cannot be, because if there were, it would obviously defeat the trailability feature of the levers. There is a small exception to this in the case of a derailer leading the corresponding points on the main line ahead but this is allowable as it does not interfere with the

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* The locking box is now always arranged horizontally behind the levers and equipped with a glass cover. The parts are invariably beautifully finished.

† The route handle must not be confused with a lever or handle used in certain power systems to set up a whole route in one pull. Such systems are not in use in Germany except in one form of Gravity Yard Frame.

feature mentioned. In order to liberate one or other of the signals concerned the route handle must be moved to the appropriate position, which can only be done if the points are in the right position. Turning the route handle secures the points and frees the signal. It is therefore correct to say that the interlocking is moved by hand. This idea was once in vogue in England. Rapier's frame, patented in 1870, had small hand grips attached to the locking bars to allow of their being moved to and fro by the signalman.

The real distinction between the English and German theory of interlocking is really this :—In England the various *appliances* are looked on as conflicting with one another, this pair of points with that pair of points and so on. In Germany the *train movements* alone are looked on as conflicting or otherwise and it is on this basis, as expressed in the functions given to the route handles in each frame, that the locking is built up. This has an important consequence, as will shortly appear.

It will now be convenient to study the German form of locking table, which was originated by a Dr. Scheffler in 1871, and has been retained almost unaltered to this day.

Fig. 8 illustrates a plain double junction, with the points lying for the main or straight routes, as shewn by the little plus signs which are marked on the straight side of the points. This way of shewing the normal position of points is not very clear. In Saxony the English way is used. The signals can be easily understood, from what has been said, it being unnecessary to bother about the distant discs which have no separate levers in this case.

The locking table is divided into vertical and horizontal columns. Each horizontal column is devoted to a definite train movement. The vertical columns refer to the functions in the frame—the levers and handles.

It is important to understand that the object of this form of table is not to show the mere mechanical combinations, as is done by the English locking table, and which are set out in it without any reference to train movements at all, the connection between them having to be traced out laboriously with the aid of a signalling plan. The object is to show the locking as a result of the train movements, stage by stage, which is what it ought to be, since the whole justification for installing locking at all is that the train running calls for it. It is correct, therefore, to take the operating viewpoint as predominant in the arrangement of the table. In this the Germans are on very safe ground. This too, fits in with their conception of locking and the use of route handles.

Turning now to Fig. 8, the movement from N to M, straight along the top track, may be considered. This requires signal $A^1$, i.e., signal A pulled " off " with one arm only showing. (The two-arm sign is called $A^2$). Under the heading of point levers, it will be observed that Nos. 1 and 2 are both shown to be + (normal), which is obviously correct. A ring, however, is drawn round the + sign in the case of No. 1 points. This signifies that the points require to be detected in this position for the movement, which is clearly so, since they are facing points. There is, it will be noted, a column allocated to the detector,* which is in the wire of signal $A^1$, and there it is shown that points No. 1 are to be detected +. It will be noted, too, that an " a " is entered against the + sign for No. 2 points. This means " abweisend " (" leading aside ") and signifies that those points must be +, not because the train runs over them so but as a trap to the movement on the adjacent line. This corresponds to the English practice at a junction.

The route handle columns should now be examined. There are only two handles, each allocated to two conflicting moves, the handle $a^1/a^2$ and the handle b/c. For signal $A^1$, with which we are concerned, we must reverse the handle $a^1/a^2$ to the $a^1$ position, indicated by the — sign in the corresponding square. As we cannot turn it both ways at once we are, in effect, locked normal, or neutral, as regards the $a^2$ move, and this is indicated by the + sign in the $a^2$ square. The other handle, b/c is locked against moving in the c direction (+ sign, therefore) but is free to move in the b direction, no sign being put in this square in consequence.

Under the signal lever headings, we see that a " clear " sign is entered in the $A^1$ column, this being the signal for the N–M movement. In the $A^2$ and C squares " danger " signs appear because those signals cannot be cleared, but in the B square nothing is shewn, the condition of this signal being immaterial. Thus on the one horizontal line the exact condition of the whole frame, locking and all, is given for the N–M train move. The other columns are exactly similar in principle, as can be seen by tracing out the signs.

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* Another way of showing this has recently been decided on but it is not so clear to those unacquainted with these tables.

This type of diagram is therefore :—

1. A diagram of signals ;
2. A table of movements ;
3. A diagram of the frame ;
4. A manipulation chart ;
5. A table of locking ;
6. A table of detection ; and
7. A diagram of locking—all rolled into one !

No diagram of locking is really wanted, because any fitter can put the + and – elements on the locking bars (there are only two in this frame) according to the signs in the squares in a few minutes.

When studying the locking with a table of this character all that is necessary to do is to make a separate print of the heading only and move it downwards over the table line by line, so that it is always directly over the one being considered at the moment. In large tables the columns on the left, indicating the train movements, are repeated on the right.

By extension this form of table can be made to show also the lock and block or any track circuit locking whatever ; the power cabins on the Berlin Elevated lines have tables, of this kind, showing the approach locking, route locking, signal controls; etc., in a very simple way.* It is possible to make this table shew English interlocking too but the conditional locking, practically unknown in Germany, is not evident at a glance and has to be looked for by comparing the various columns with each other.

In Fig. 9, a larger layout is illustrated. This does not differ in principle from Fig. 8 at all but there are one or two points in it of special interest. There is a detector lever in this frame for the detection of points Nos. $1^b$ and $2^b$, to avoid complicating and overloading the wires of signal D, reading from the branch line from P. Therefore two columns are allocated to this as it is a double lever, driving one transmission in two directions. The rings round the signs and the " a " qualification will be noted in the point lever squares.

It sometimes happens, of course, that two movements conflict that do not involve any difference in the position of the points.

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* Something of this kind is ever so much more logical than attempting to show all the characteristics of signals, etc. ; by a maze of characters on the signal arm itself, as seen in American practice.

It is then necessary to establish a direct lock between the route handles concerned. This is shown on the locking table by hatching the squares involved, as in vertical columns b, c and $d^1$. This informs the fitter that he must make a lock between the route handles direct. Except for this there is nothing in the table in Fig. 9, to pay special attention to.

Let us now consider Fig. 10, which contains a special feature of some importance. It is only an example to illustrate a principle, therefore the track layout need not be criticized as such. It will be observed that in the column for point lever No. 1, on the right, in the horizontal line B, the points are shewn as having to be in the — position, with the " a " sign added, and that this square is crossed off by diagonals. This means that No. 1 points ought strictly to be reversed, as a trap, but that the fitter must not put a lock on to compel this, as it would stop a parallel movement. This is obvious, because indication $A^1$ wants No. 1 points +, as a trap. In order to get the use of the trap, as far as possible, however, the signalman is instructed to set it when no obstacle exists to his doing so and he is reminded of this by the number plate of lever No. 1 being marked " Pull over for B, if $A^1$ not wanted simultaneously."

It will no doubt have been gathered, from the construction of the locking, that this system of signalling with route handles and free points eliminates conditional interlocking. There is, however, one case of conditional locking which is sometimes seen, but this can be done without. If, in Fig. 10, shunting movements could issue from the middle track, and which, of course, signal C would not hold back, they could foul a running movement if signals $A^1$ and B were " off " together, since then there is no absolute trap. A shunting prohibition signal would be necessary to prevent this—the banner signal, shown dotted in the figure. These banners are worked normally " clear ", whenever it is possible to arrange it. To avoid putting this one to " danger " more than is really necessary the following plan would be adopted. The locking shown crossed off would be put on, stopping the parallel movements, but would be cancelled—lifted clear—for signal B by pulling the shunting prohibiter to " danger." This is the only true case of a conditional lock known to the Germans.

When a signal reads for several directions, its lever is preceded by one or other of a group of route handles but this is not a conditional lock, only a group lock.* A conditional lock must be cancellable under some particular set of circumstances. In other words the word " if " must come into it.

Absolute block working is universal in Germany, no permissive working, such as exists in France and some other countries, being allowed. This dates from 1870 as an actual Government requirement. In the following year, in response to an appeal from the railway authorities, Frischen, an assistant with the firm of Siemens and Halske, produced the alternating current lock and block apparatus that afterwards spread all over the German field of influence in railway working. Invented not long before the Sykes system, the Siemens is in some respects very like it, in others, very different.† There is a certain amount of telegraph block by Morse instruments on unimportant lines but no such thing as an ordinary block instrument, such as the needle, Tyer or Spagnoletti disc, as used in England. All lines of any consequence are worked by lock and block and they must be if more than four trains an hour can run. The great merit of the Siemens block, when it was introduced, was that the use of alternating current from a magneto rendered interference with the block by contact with ordinary telegraph wires impossible. In recent years the extended use of alternating current electric traction has given rise to considerable difficulties from inductive influence, necessitating metallic circuits and other precautions. For this reason a direct current form of motor block has been put forward and has been adopted in Norway, it is understood. Generally, however, the Siemens apparatus has given excellent service and it lends itself very readily to all kinds of special locking associated with, but not necessarily a part of, block working. Its detailed operation would require a great many diagrams to explain and must be passed over here. In essentials it has remained practically as Frischen left it, but naturally experience has led to development in the details and circuits.

It is in use in Germany on both double and single lines.‡ On the former it is operated on the normally " clear " or free principle,

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* The locking " 3 is released by 8, 10 or 17 ", for example, is often called in England a conditional lock, but it is nothing of the kind.

† See the paper on " Lock and Block," in the Proceedings of the Institution. Session, 1925, p. 102.

‡ There is only one case of token working in Germany, a short section near Saarbrücken, worked by the Jüdel electric staff.

save in certain selected places where it is modified to give a normally blocked effect. It thus resembles the Sykes apparatus, in the form seen on the former London & South Western Railway. The clearing of a section is made dependent on a treadle release and the signal arm is proved at " danger " behind the train before the rear section is again liberated. To escape from the rigidity of the system arrangements are made for the station master to be able to separate the working of certain parts and avoid failures repeating themselves beyond a particular point. In some countries such as Belgium, the apparatus is worked on the " line closed " principle everywhere.

On single lines the new standard system has one rather peculiar feature, in that trains can be accepted simultaneously in opposite directions, which seems rather paradoxical. It is, however, a very good idea. If (say) a train be on its way from A to B and there is one at B waiting for it, B can offer the train to A and get it accepted in readiness. The acceptance cannot actually be made use of till the A-B train arrives in the regular course, when, without further ado, B can despatch the waiting train, no block instrument formalities being necessary. This saves time at the crossing places and is a most useful feature. Unfortunately several line wires (five, it is understood) are necessary with this apparatus.

In busy cabins the magneto generator is only used as a reserve. A small motor generator or a transformer is provided to supply the block current and the mere operation of a block plunger handle brings it into operation. Sometimes, where connecting up to power worked cabins, the Siemens block is not used, its place being taken by some direct current control system, resembling electric locking, as we know it here.

Signal arm replacers are widely used, being always installed to compel the working of the block where otherwise it might be possible to get two trains away into one section. There are several patterns in use.

The Siemens mechanism is also used for such purposes as outlying siding locking and for establishing mutual control between cabins at stations; mechanical slotting between boxes, as understood in England, being unknown in Germany. It is also employed as a route lock apparatus. This is a very important feature of German signalling, in which Germany has been far ahead of England—not ahead of English engineers but ahead of the extraordinary attitudes taken up by some traffic men, the men who would not look at the lock and block till forced out of their impossible position by the painful logic of accidents.

In Germany, before a running signal can be pulled " off " an electric lock on the route handle must be set which makes it impossible for the signalman to change the road by mistake in front of the train, even though he may put his signal back the moment the engine is past it. No impediment to the full replacement of a signal lever is allowed. This route control is taken off by the train working a " last vehicle " treadle. This arrangement is not only exceedingly safe but it has other consequences. One is that far fewer signals are used in Germany, as there is no need to put them in to hold the road. Secondly, facing point lock bars can be eliminated in numbers of cases. This improvement, imagined to be a product of the American power signalling school, has been known to the Germans for years. Why it has been so long in taking shape in England is a mystery. In the Sykes lock and block it existed in effect in the backlock, but did not the great main lines to the North laugh at the Sykes lock and block ? To leave a signalman free to restore a signal accepted by a driver and change the road in front of him is to make interlocking a farce.

The Germans distinguish between block working from station to station and block working in a station. The two are practically treated separately, due to the method of station control and supervision which they favour. The working in a station is always under the supreme control of an official called the " Fahrdienstleiter " (traffic leader), really a very superior kind of signalman. He is often stationed in a cabin—in fact in the North this is preferred wherever possible—but sometimes he has a place to himself right in the station, where he can personally see the condition of the lines, etc. ; if he is in a cabin such is then called a " leading signal cabin " (" Befehlstellwerk "). When he has his own office he controls every running movement through the agency of a special apparatus called the " Station Block Instrument," really a set of Siemens electric units with suitable handles. These appliances frequently assume quite considerable proportions. At the smaller stations this official performs other station duties also. The training of these leading signalmen is exceedingly thorough and they are all men of wide experience and ability. Even in power signalling installations the same system of working is followed. The " Fahrdienstleiter " is the supreme authority and makes all decisions as to what is or is not to be done in the station.

Bell coding from cabin to cabin, such as with the Clearing House Code, is not used by the Germans, save in a most restricted way. The ordinary block working is done by simply manipulating the Siemens instruments. Train descriptions, where necessary, are Morse telegraphed from point to point. On the main lines, however, and on single lines, large signal gongs, with clockwork strikers, standing some seven or eight feet high and giving a very loud ring, are rung from one station to another (not box to box) whenever a train leaves the station block area and enters the section block, with an " Up " or a " Down " code, as the case may be. The bells are placed at all level crossings, block posts and other useful points on the line, such as platelayers' huts. An emergency " stop everything " code, consisting of thirty blows on the gongs, can be given from any place and anyone hearing this and able to do so must hasten to exhibit hand signals and lay down detonators in all directions. These gongs have often enabled accidents to be averted. They were invented in 1852 and thousands have been installed, in many lands.

Automatic signalling is comparatively little used in Germany, for several reasons, but it is in use on the National lines between Berlin (Potsdamer Station) and Lichterfelde, which is but a short distance. It will be installed on the Stadtbahn between Charlottenburg and the Silesian Station in the very near future. Before the war, the English Westinghouse Co., laid down the first automatic signalling controlled by track circuit* on the Berlin Elevated Railway line. Extensions were made during the war by the company themselves and since then Siemens and Halske have installed some. The newer North-South railway is also fitted with their apparatus. On the Elevated line the train-stop apparatus is fixed on the car roof. Semaphore signals were originally used but now light signals are being put in. The automatic signal question is affected by many factors, notably the large extent to which steel sleepers are in use and which prevent the use of track circuits. In addition there are a great many level crossings which cannot be left unattended and which

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* Not the first automatic signalling of any kind. Automatic signals were put in, on the Natalis system, on the Barmen-Elberfeld Suspended Railway in 1901 with day colour light signals, approach lighted ! This installation which has worked faultlessly, affords a 1·8 minute train headway.

may therefore just as well be utilised as block posts. Even track circuit itself is not very much used. The sleeper difficulty is there while the German station block is already very safe. It is, however, used at some stations, notably at the great Leipzig terminus on the Saxon side. It must be remembered too that the goods trains have the Kunze-Knorr air brake now and therefore the terror of the English Signal Engineer, the detached unbraked goods truck left in the section, is unknown.

Power signalling has been very widely used, far more so than in Great Britain. The Germans were early working at this. Siemens began at Prerau, Austria, but in 1895 put down the first plant in Germany at Westend, on the Berlin Ringbahn, an all-electric one. This has only recently been taken out and put in the Railway Museum. The development that has been gone through since then is exceedingly interesting, and a thoughtful study of it has been written by Becker. The scheme of connections has been modified through eleven stages to reach the present practice, and it may here be mentioned that constant, permanent detection control has been used from the beginning and that no other arrangement has ever been entertained by the authorities. The first frames widely used were similar to those which the members inspected at Brussels Nord in 1925, at the Summer Meeting. Made in 1905 and 1906 and containing 309 levers it was a very remarkable frame in its day and is still working with every satisfaction. Changes have gradually been made and the latest frame used on the Elevated line and on the Athens-Piraeus electric line in Greece, is a very creditable production.

The locking in power frames are made on the same principles as in the mechanical frames, i.e., without conditionals, but, except in the A.E.G. Co.'s frame and the earlier electro-pneumatic plants there are now usually no true route handles, a part-way move of a signal handle taking the place of this. The detection control is always carried out on the frame, never in a separate relay room, for several reasons, but chiefly to allow of the actual reversal of the lever positively forcing off the control relay armature. The principle followed is to prove continuously that the position of the function outside and the position of the lever correspond.

There are many enormous frames in use and some of the installations, such as Nuremberg, Munich, Stuttgart, Hamburg, etc., are second to none in the world.

The Westinghouse frame, so familiar to us in England, was used naturally on the Berlin Elevated and was also installed in many large electro-pneumatic plants of the Westinghouse-Stahmer pattern, on the Prussian lines. The modifications there made were to allow of the use of route handles and trailable points. The low-pressure pneumatic and electro-pneumatic systems were laid down at several places by Scheidt and Bachmann, notably Düsseldorf and Stendal, but it appears that all-electric is the definite choice for future work. The Bruchsal works put in their electro-pneumatic system, with diaphragm movements for both points and signals, on the former Imperial lines in Alsace-Lorraine and some large electro-mechanical plants, notably at Colmar, Upper Alsace.

In pneumatic systems it is difficult to avoid the points springing back after trailing. This is not really good practice, as a train shunting and trailing some points unknowingly and then setting back, gets split in two. In the low pressure pneumatic system, by special arrangements, the points do stay put over after trailing, the lever being set half-stroke by a special cylinder and an air whistle being set blowing in the cabin. In electric systems it is easy to meet these requirements and ring an alarm after trailing.

A special feature that needs mention is that signals are always returned to " danger " by power, as well as having a release clutch fitted. This is to comply with the standard rule of the compulsory return of all signals, as found in the double-wire working.

Primary battery work is not much in evidence but a Russian invention, developed by the Stahmer Works, the Gravity Machine, is being tried, by permission, generally. In this the trains, by a special treadle device, keep a weight wound up and the power stored in this works the points, etc. This is an interesting idea.

The latest actual frame is the Gravity Yard Frame of the A.E.G. Co., in which the whole of the point moves required are plunged and stored up in a magazine apparatus before the hump movements commence, treadles operated by the descending vehicles, releasing the controls, stage by stage, contained in the magazine mechanism. In conjunction with rail brakes, this is in use at Hamm yard and elsewhere.

Automatic stops and train control are attracting careful attention but little has been made public on the devices and the trials which are being made with them. Fog repeaters have been put in at Lindau by Krauss and Co., of Munich, but generally speaking, Germany is little troubled with fog. Siemens and Halske are the actual original inventors of the fog repeater and made the first installation on the Belgian State lines before the war.

Summing up one can say that the Germans may be justly proud of their signalling achievements, which on the whole, bear favourable comparison with those of any other land and certainly contain meritorious features deserving of imitation. Anyone who will take the trouble to study even a few of the numerous works on the subject will find himself well rewarded and his whole outlook on signalling strengthened and improved. As a help to those wishing to dip into this fascinating field the following bibliography has been prepared.

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In addition, a large number of articles has appeared in the German technical press in recent years on the latest developments in signalling, especially light signals, gravity yards and power working generally. Most of the best books and the chief periodicals may be found in the Patent Office Library, Southampton Buildings, Chancery Lane, London.

## DISCUSSION.

After the Lecture, questions were asked or comments made by Messrs. B. Wagenreider, H. M. Proud, W. S. Every, A. Oldham, W. J. Sadler, H. E. Morgan, and W. J. Thorrowgood.

**Mr. Wagenreider** thought that the operation of the magneto-generator for block signalling must give the signalman a lot of work to do, particularly at a busy box. Did not that delay traffic ?

**Mr. Proud** remarked that his experience was that the block working between stations was carried out in a separate office by the leading signalman while the lever movements were made in the signal box by levermen.

Mr. Proud, continuing, said that a point which had always interested him was the very great difference between British shunting movements and those in Germany. He had not sufficient practical experience to know whether in Germany they gained any advantage by their methods, but it did seem to him that the British method of giving definite signals for shunting movements ought to be better than that which simply gave permission to shunt and indicated the direction in which the points lay. That difference probably had some bearing on the question of the use of trailable points and had influenced their design. The German points have to be very strong to stand the switches being trailed through ; that could not be done with the British type without extra stiffening. Further, it would be very interesting to know whether the German method did not require a larger number of staff than the British. Mr. Proud also thought that the lowering of the spectacles during the daytime a good idea and would like to know how that was accomplished. In speaking of route locking, the lecturer said that at least two route levers were required for three routes. Mr. Proud had always felt that the methods of locking through routes was a very important one to understand when dealing with designs where German methods were used. Mr. Proud heartily commended the fact that the railway companies supported the contractors in supplying signal material.

**Mr. Every** mentioned the very fine school on the Underground system of Berlin for the training of engineering men. At one of the depots he visited last year there was a complete miniature installation of power signalling, in full working order ; it was quite an elaborate affair. The London Underground started such a school on similar lines some years ago at West Kensington, but some time back it was removed to South Kensington, where it was reorganised and brought up to date. That was probably where some British railways were backward ; they did not train their men in advanced signalling, and it should be borne in mind that men could not be so trained unless proper provision was made to meet requirements.

**Mr. Sadler** said that as a keen student of foreign railway signalling and of signalling generally, it was very gratifying to him to find the Institution studying the philosophy of other countries. It was a great mistake to stand still and to say that what they did was the best in the world. A good deal, particularly from the point of view of railway signalling, could be learnt by studying what was done in other countries. Throughout Germany the Signal Department was constituted as a department in itself and was not trailing behind another. The Institution could do a great deal to raise the status of their work generally. He agreed with the lecturer that the appearance of their signal boxes was hideous ; German and American cabins put the English to shame. Double-wire working was, mechanically, the only true system. He hoped they would take a proper view of those things and not be content to stand and say how very well they did everything.

**Mr. Morgan** agreed with Mr. Sadler that the lecture had brought out a very important point—the difference between the German views on signalling and our own. The Germans did not believe in " trapping " any movement and they allowed the signalman to move the point levers in any order he pleased. That saved a good deal of running about and a large amount of locking, but he was not sure whether it was right in principle. It was true that the signalman had instructions to pull certain levers for " trapping " movements but the man was not compelled to do so. Mr. Morgan preferred the conditional locking which compelled such action.

The German system necessitated separate signals for each route and their ground signals were not ground signals as we understand them; they were merely point indicators to show the position of the points and therefore did not give permission to proceed to a definite position.

Mr. Morgan had been interested in the signs exhibited, as he had been concerned in the development of a sign to show banking engines how far they should proceed. He was also glad to see the sign for the " limit to shunt " and for buffer stops. On one section of the London, Midland and Scottish, a distinctive light was used for buffer stops and was much appreciated by drivers.

**Mr. Thorrowgood** would rather have the locking absolute than free for the signalman. There was a good deal to be said for conditional locking which prevented a signalman making a mistake; most mishaps were due to the human agent. He was pleased to hear that there were railway schools in Germany. The Southern had two schools—his own at Wimbledon and one under the Operating Department at New Cross—and both were well attended. Mr. Thorrowgood was not sure, having regard to the money paid in taxes, for education, to the local authorities, whether those bodies had not a function to perform in regard not only to signalling but to other work. In signalling schools it was not only useful to show the students the apparatus itself but if they gave them the basis of the principles on which the apparatus worked they would soon pick it up. He was pleased to say that the London County Council had taken 100 of his men and had started on teaching them the principles upon which the signalling apparatus was worked, e.g., the mechanics of cranks, electrical apparatus and electro-magnets, magnetism, the chemical action of batteries. It seemed to him not only did they want a school of signalling, with the apparatus itself, but to give the student some basic principles which he could apply for himself as he went about the line and so, as it were, find out for himself.

The **Lecturer,** in reply to the various questions, said that Mr. Proud was quite right about the block signals being exchanged by the leading signalman in, sometimes, a separate office or cabin. At other times this official was stationed in a regular signal box. Mr. Wagenreider would be interested to know that in busy boxes current was available for the block signals which was switched on automatically and the hand generator had not to be employed. Moreover, where the magneto generator was used it was only for block signals as there were practically no bell signals.

Replying to Mr. Proud he said he had had no actual experience of shunting as described by that gentleman, but the Germans seemed to get through their work very well. If they were asked about shunting signals, such as we use, they replied they were superfluous. The difference may lie in the arrangement of the stations; British yards were rarely alike, but the German were nearly always similar, and, moreover, they contrived to get their shunting largely done away from the main line. All their movements, even the shunting, appeared to be laid down beforehand. Mr Sadler would agree with him that the shunting at Brussels Nord was continually going on without any whistling, as they watched it on one occasion together.

**Mr. Proud,** rising again, asked :—Did not the question of State ownership arise? Layout of stations could, no doubt, be more easily arranged when there was State ownership, while at extensive stations extra staff could be provided and congestion thus avoided. But it needed money. The German arrangement of mechanical interlocking may have some influence on the use of ground signals, as there would be some difficulty in arranging the locking for these with the method described by the lecturer.

The **Lecturer,** resuming, said that he wrote to Mr. Hård, Signal Engineer of the Swedish State Railways, on that question and asked his opinion. The reply was to the effect that for stations up to a certain size he preferred the German arrangement of locking, but beyond that size the British method had, he thought, the advantage;* at every ordinary station the German route system was the better. The arrangement for lowering the spectacle would be exhibited after the meeting. German switches were mostly of the strong angle pattern to allow for trailability, but this was not essential. Sprung switches could be, and were, used.

It was well known that, in respect of training, the Germans were very thorough. He had brought with him two copies of a signalling periodical showing very good photographs of two training schools. As illustrating the thoroughness with which the work was done he would say that at the desk where the superintendent of the school sat there were switches, and while learners were

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* Because otherwise a very great number of route handles would be necessary.

going through the movements of the frame, he could, by pressing one or other of the switches, produce, at will, any kind of failure. The men must then show that they know what action to take. The training was, certainly, very exact, particularly that of the leading signalmen; they had to thoroughly understand the mechanism of the apparatus and know exactly what they were doing. At the Railway Museum in Berlin the whole of the front of the block instrument cases was made of glass so that all the movements could be seen. That was quite a good idea.

Mr. Oldham, Mr. Thorrowgood, and, to a certain extent, Mr. Morgan, would appear to have missed the point about conditional locking. Perhaps he had not been as clear as he might be. The fact that the signalman shifted the locking bars by hand, through the route handle, did not mean that he could do as he liked. He was, of course, limited by the mechanism. Mr. Oldham had implied that the locking was discretionary. The absence of conditionals did not, as Mr. Thorrowgood supposed, mean that the signalman had the locking at his disposal, as it were. The absence of conditionals arose from the fact that a route handle movement was allocated to each train movement. It was the method of construction which eliminated them.* The locking was not less secure in consequence. The point levers were certainly all free when all signals were locked with the route handles normal and this enabled a route to set up in any order, which was a great convenience. Mr. Hard maintained that this was correct. The Germans did correctly trap movements, contrary to Mr. Morgan's supposition. But they were often in the position we were in of not being able to put certain locking on as it would be too tight and stop parallel movements. That was the meaning of the lock crossed off on the locking table. One signal could, and in the speed signalling in the South, did, often lead in several directions. But it was preceded by a definite route handle move for each and this eliminated the conditional locking. The mere releasing of one signal lever by any one of a group of route handles was not a conditional lock, though often mistakenly considered as one in England. It was a group lock and very simply effected in the German type of locking box.

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* Recently in France, a route handle, having several positions, has been introduced in a mechanical plant to eliminate conditionals. See " Revue générale des chemins de fer." January, 1926.

He cordially endorsed all that Mr. Thorrowgood had said as to training the men. He had visited the school at Strasbourg, Alsace, and found it beautifully fitted up. It had, of course, been installed before the war. He would very much like to see a Railway Museum in this country where anyone could go and learn all about Railways. He thought this would have a beneficial effect in that the public themselves would appreciate our Railways more. He did not think the British public really appreciated their railways. Certainly, as a national affair, they had never accorded that justice to them that Bismarck gave to the German railways. As John Bright said:—" Railways have rendered more services and received less gratitude than any other institution in the country ".

The **President** was glad that the question of training had been made so prominent. It was to be regretted that the desire to train a staff had not been extended more, also that there was a tendency to deprecate some methods of training already established. When he spoke of training he was not referring only to technical training but to operating training also.

In moving a vote of thanks to the Lecturer, the **President** would remind him of his promise to read papers later on, on some of the particular subjects mentioned that night; they would provide interesting matters for discussion.

The **Lecturer,** in his reply, said he would like to acknowledge his indebtedness to many gentlemen who had helped him in his study of German railway signalling, and in particular, to his friend, Geheimrat Kemmann, of Berlin. It was that gentleman who had introduced automatic signalling on to the electric railways in Berlin, and he owed more than he could say to him. He wished particularly to make this public acknowledgment of his debt to one who had himself written one of the ablest works on automatic signalling and whose kindness had been unfailing.

# RAILWAY SIGNALLING IN GERMANY (LASCELLES).

Proceedings 1926.
Part 2.
Inset Sheet No. 15.

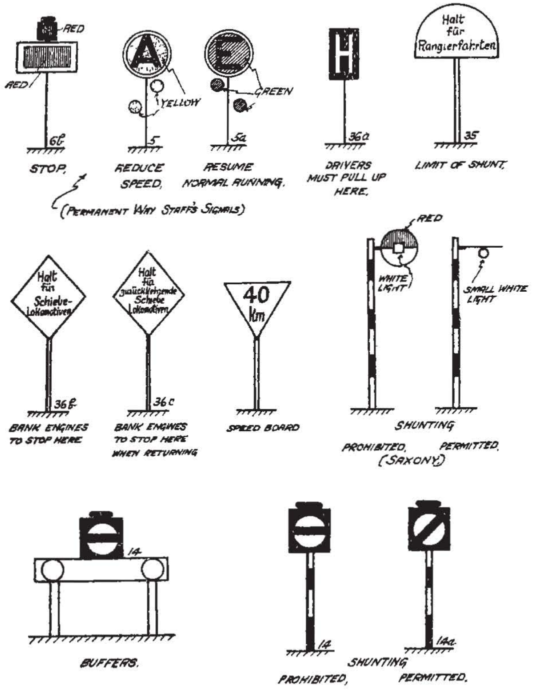

FIG. 1

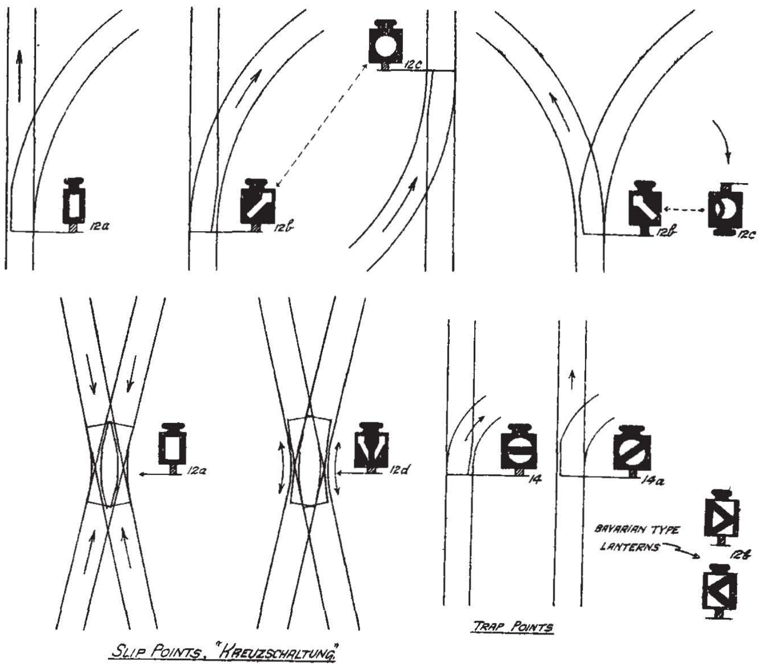

FIG. 3

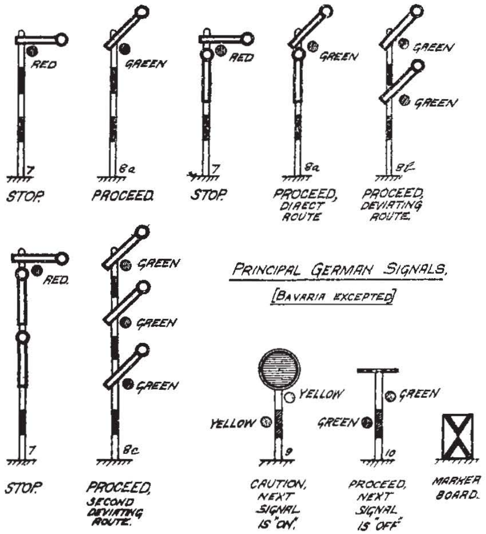

FIG. 2

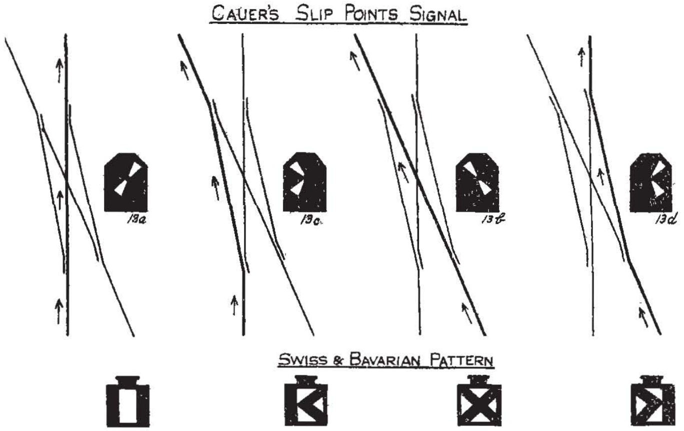

FIG. 4

# RAILWAY SIGNALLING IN GERMANY (LASCELLES).

Proceedings 1926.
Part 2.
Inset Sheet No. 16.

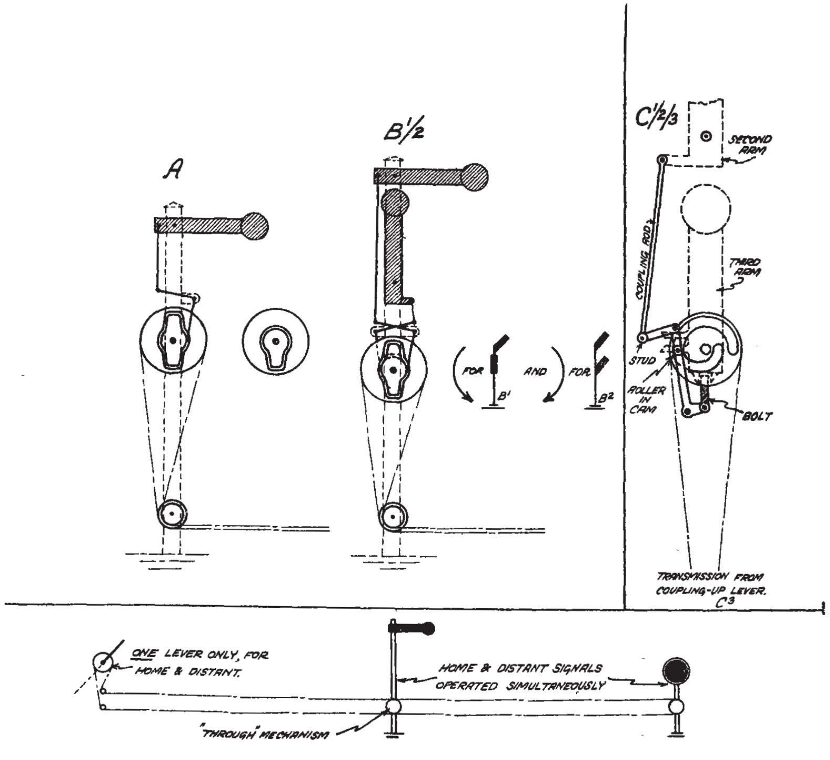

FIG. 5

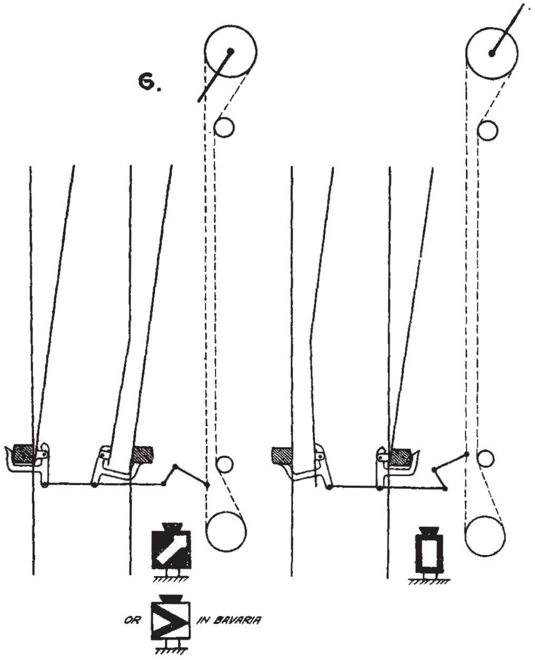

FIG. 6

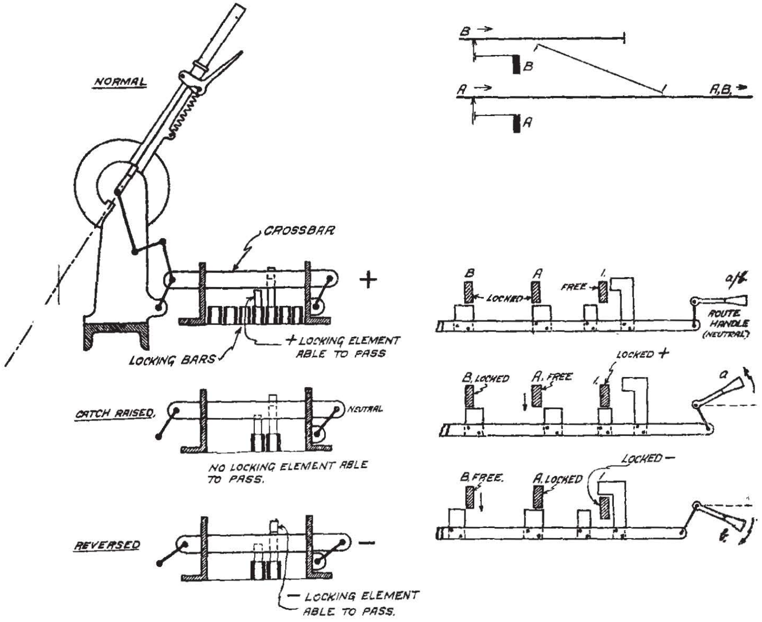

FIG. 7

# RAILWAY SIGNALLING IN GERMANY (LASCELLES).

Proceedings 1926.
Part 2.
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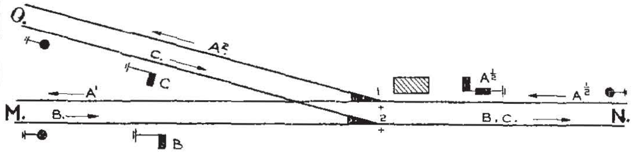
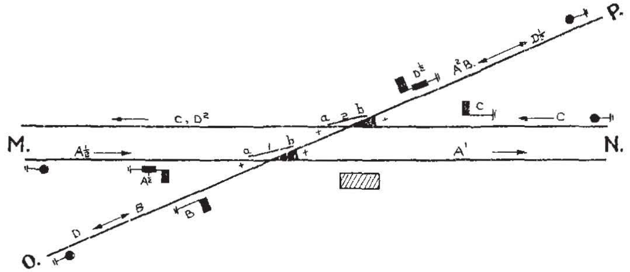


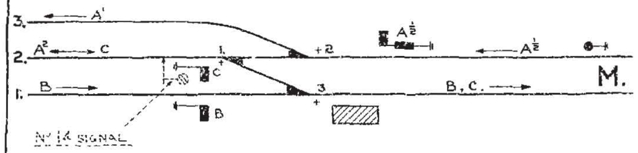
| SIGNAL | TRAIN MOVEMENT. | ROUTE HANDLES | | | | SIGNAL LEVERS | | | | DETECTOR IN WIRES OF SIGNAL A½ DETECTS | POINT LEVERS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | + | | + | | ⚑ | | ⚑ | ⚑ | | | |
| | | a¹ | a². | b | c. | A¹ | A² | B. | C. | 1. | 1. | 2. |
| A¹. | FROM N TO M | − | + | | + | ╱ | ⚑ | | ⚑ | + | ⊕ | $+_a$ |
| A². | FROM N TO O | + | − | | | ⚑ | ╱╱ | | | − | ⊖ | |
| B. | FROM M TO N. | | | − | + | | | ╱ | ⚑ | | | + |
| C. | FROM O TO N. | + | | + | − | ⚑ | | ⚑ | ╱ | | $\bar{a}$ | − |

FIG. 8



| SIGNAL | TRAIN MOVEMENT | ROUTE HANDLES. | | | | | | SIGNAL LEVERS | | | | | | DETECTOR IN WIRE A½ | DETECTOR LEVER D¹ D² | | POINT LEVERS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | + | | + | | + | | ⚑ | | ⚑ | ⚑ | ⚑ | | | | | | | | |
| | | a¹ | a². | b | c | d¹ | d² | A¹ | A² | B | C | D¹ | D² | 1a | 1b | 2b | 1a | 1b | 2a | 2b |
| A¹ | FROM M TO N | − | + | + | | + | | ╱ | ⚑ | ⚑ | | ⚑ | | + | | | ⊕ | | | $\bar{a}$ |
| A². | „ M „ P. | + | − | + | + | + | + | ⚑ | ╱╱ | ⚑ | ⚑ | ⚑ | ⚑ | − | | | ⊖ | − | | + |
| B | „ O „ P | + | + | − | + | ▨ + | + | ⚑ | ⚑ | ╱ | ⚑ | ⚑ | ⚑ | | | | | + | | + |
| C | „ N „ M | | + | + | − | ▨ + | + | | ⚑ | ⚑ | ╱ | ⚑ | ⚑ | | | | $+_a$ | | + | |
| D¹ | P „ O | + | + | ▨ + | ▨ + | − | + | ⚑ | ⚑ | ⚑ | ⚑ | ╱ | ⚑ | | + | + | | ⊕ | | ⊕ |
| D² | „ P „ M | | + | + | + | + | − | | ⚑ | ⚑ | ⚑ | ⚑ | ╱╱ | | | − | $+_a$ | | − | ⊖ |

FIG. 9



| SIGNAL | TRAIN MOVEMENT. | ROUTE HANDLES. | | | | SIGNAL LEVERS | | | | DETECTOR IN WIRE OF SIGNAL | | POINT LEVERS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | + | | + | | ⚑ | | ⚑ | ⚑ | A½ | C | | | |
| | | a¹ | a² | b | c | A¹ | A² | B | C | 2. | 1. | 1 | 2. | 3 |
| A¹. | FROM M TO TRACK 3. | − | + | | | ╱ | ⚑ | | | + | | $+_a$ | ⊕ | |
| A². | „ M „ „ 2 | + | − | | + | ⚑ | ╱╱ | | ⚑ | − | | − | ⊖ | $+_a$ |
| B. | „ TRACK 1 TO M. | | | − | + | | | ╱ | ⚑ | | | $\xcancel{+_a}$ | | + |
| C. | „ „ 2 TO M. | | + | + | − | | ⚑ | ⚑ | ╱ | | + | ⊕ | $+_a$ | − |

FIG. 10