Technical Meeting of the Institution

held at

The Institution of Electrical Engineers

Tuesday, November 2nd, 1965

The President (Mr. J. P. COLEY) in the chair

The Minutes of Technical Meeting held on 13th October, 1965, were read and approved.

The President introduced and welcomed Signor G. Contaldi of the Italian State Railways and requested him to read his paper entitled " Signalling Developments on the Italian State Railways."

Signalling Developments on the Italian State Railways

By G. CONTALDI (Italian State Railways)

1. INTRODUCTION

Before describing the present signalling installations of the Italian State Railways, may I take the opportunity of referring briefly to the make-up of the Italian railway network and to the traffic operated on it.

The network has an extent of 10,100 route miles and is sub-divided, according to traffic, overall speed, and type of equipment, into three principal groups (see fig. 1).

(a) Trunk network covering a mileage of 4,750 miles.

(b) Complementary network covering a mileage of 2,400 miles.

(c) Secondary network covering a mileage of 3,020 miles.

Of the total network of 10,100 route miles 4,925 miles are electrified (see fig.2) of which 4,780 miles are on 3000 Volt D.C. and 145 miles on three phase 3,700 Volt A.C., 16 2/3 C/S. The latter is however being changed to direct current.

Of the whole of the 4,925 miles of the electrified lines, 83 per cent. are on the Trunk network, 14 per cent. on the complementary network and 3 per cent. on the secondary network.

The volume of traffic conveyed in 1964 was 18,000,000,000 passenger/miles and 9,630,000 tons/miles of freight traffic, of which 86 per cent. was on the trunk network.

Because of these factors, although the extent of the electrified lines is a little less than 50 per cent. of the total mileage of the network, in programmes for the potential modernisation of the Italian State Railways it was not convenient to

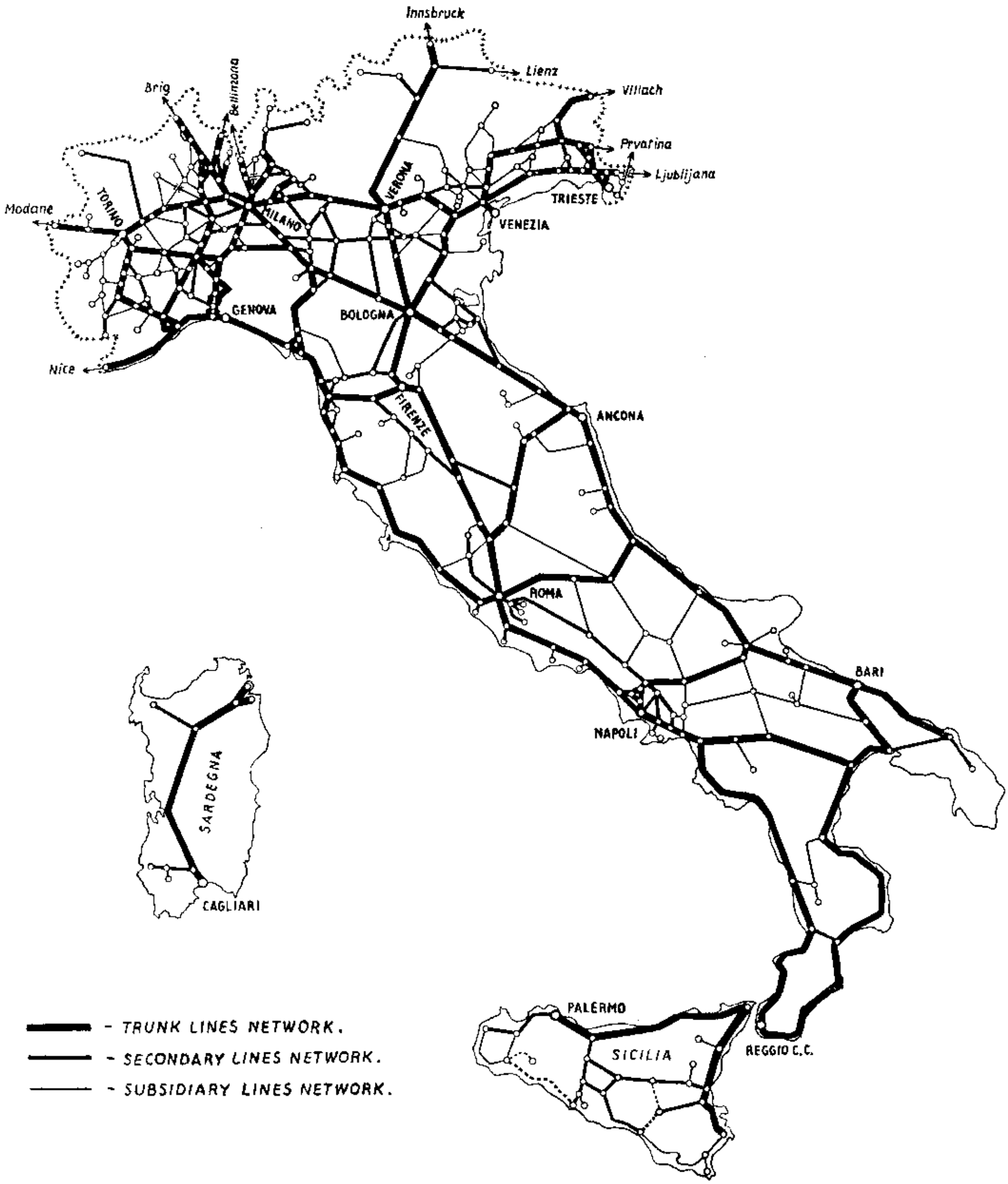


Fig. 1. Italian State Railways network.

undertake large new electrification projects; instead it was proposed to extend the use of Diesel-equipment (a) on a few of the lines on the Trunk network on which electrification would not be very convenient for their locations; (b) on a large part of the complementary network and on those lines of the secondary network which will remain in operation. In fact there is a programme for the closing, in a short time, of about 1,310 miles of line carrying light traffic, principally concerning the secondary network, and at a later time another 1,560 miles concerning the complementary and secondary networks is expected to be closed.

2. SIGNALLING GENERALLY

The colour light signal in use on Italian State Railways is of the searchlight type with lamps of 12 Volt 20 Watt, and this was introduced in new interlockings in the year 1924. From then to the present time there has been a continuous evolution in the method of display of this type of light signal. This evolution has taken place in three successive stages.

(a) The first stage spanned the years between 1924 and 1940, and in this stage semaphore and other forms of signals were replaced by the colour light signal concept. In the Signal Regulations issued in 1940, which superseded those issued in 1928 and 1937, the colour light signal was in fact a configuration of simple lights corresponding to single or double-arm semaphore signals ; the grouping of lights was in a vertical order corresponding to semaphore signals with arms one above the other or as bracket signals either for warning or stop. The indications displayed by the light signals were exactly the same as those of the semaphore signal (see fig. 3), the meaning remaining unaltered.

(b) The second stage, which we call the post-war stage, extended largely from 1947 to 1960 ; it was important in the way the use of colour light signals was developed to provide the most advantageous means of signal indication. This development represented a radical change in respect of previous semaphore signal practice, in that speed indications, rather than direction indications were provided.

In fact, the edition of Signal Regulations published in 1947 showed a radical novelty in colour light warning signals in which the previously accepted type of warning light signal was abolished, and in its place there appeared twin unit signals placed centrally on the post one above the other, no longer to indicate the direction, as in the old signals, but instead to show aspects which according to position of the colours and by the appearance of the steady or flashing lights indicate the reduction of speed required in approaching the next home signal.

The precise aspects shown in the 1947 Signal Regulations are as follows (fig. 4).

1. One yellow light meaning line occupied.
2. Group of lights, yellow and green (steady) warning of line clear at 19 m.p.h.
3. Group of lights, yellow and green flashing warning of line clear at 38 m.p.h.
4. One green light meaning line clear without speed limit.
5. One yellow light flashing* meaning an outer distant indication which could be defined as : "The next signal is at a reduced distance (though never less than 650 yards) from the following signal, which may be showing either occupied or line clear for a diverging route."

(c) The third stage extends from 1960 to the present time, which can be considered as the period of perfecting, and completing the foregoing concept.

The 1961 reprint of the Signal Regulations of 1947 includes the introduction of a 6th warning aspect comprising two yellow lights (steady) positioned one above the other. This new signal is only used in conjunction with a home signal and gives warning of a next signal at stop at an unusually short distance (but still not less than 385 yards), or that the train will be received on an occupied, or very short track. When used in conjunction with a signal for protecting a station this signal must always be accompanied by a red light, above, which always demands a reduction in speed.

The other modification introduced for signals of the first category (homes) was one which necessitated some provision against the inherent limitations of the bracket signals, by which it is not possible to provide an indication of reduced speed if it is not accompanied by an indication of direction, and vice versa, an indication of direction if it is not accompanied by one for a reduction of speed to 19 or 38 m.p.h. for the route signalled.

In addition the bracket signal is costly and cumbersome especially when there are three or more lights. Besides, in actual practice, from its configuration there is :—

1. The impossibility of presenting indication of reduced speed for the routes that contain trailing points.
2. The impossibility of indicating running at speeds above 38 m.p.h. on both branches of a fast running junction.

*This aspect introduced 1954.

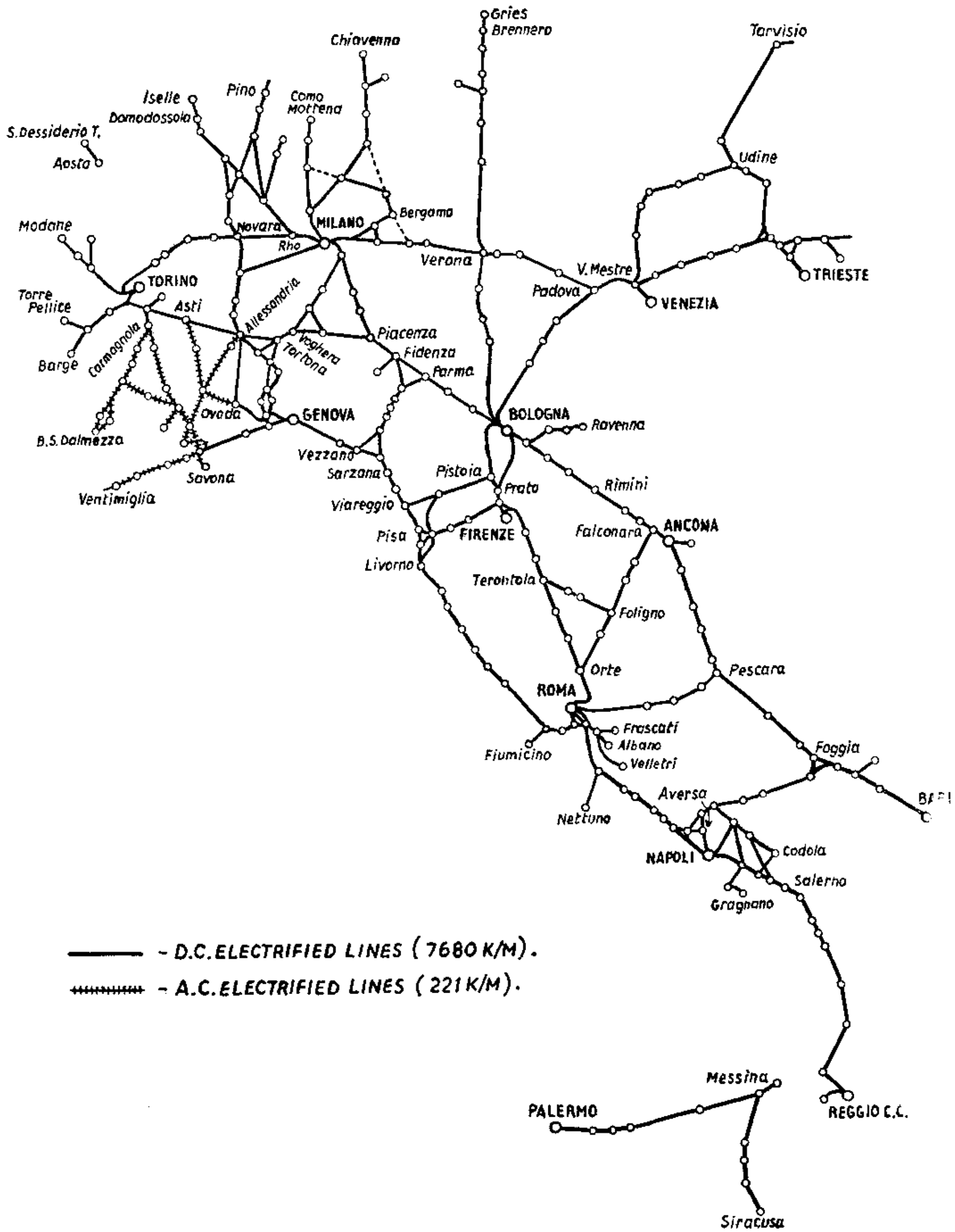


Fig. 2. Italian State Railways Electrified lines.

3. The impossibility of switching over without stopping a train that is being diverted on to the "wrong line."

All the above difficulties have been overcome by a new aspect in signals of the 1st category which is explained in the following example :—

One red light positioned over a green light (fig. 5—Aspect 6), which means line clear for reduced speed of 19 to 38 m.p.h. according to indications received previously. Naturally if the first category (home) signal carries its accompanying warning indications it will show the red light positioned above in any of the 5 restrictive aspects mentioned below, namely :—

(1) One yellow light, steady.
(2) One yellow light, flashing.
(3) Two yellow lights, steady.
(4) One yellow and one green light, steady.
(5) One yellow and one green light, flashing (fig. 5).

The interpretation of signals becomes simple to the driver, presenting a perfect analogy of bracket signals indicating line clear by means of one light or a group of lights lower down. The new configuration of signals in the first category, as shown, is without significance of direction, and is in accordance with what was foreseen from 1947 for warning signals. It lends itself to the ultimate integration which will be necessary for speed-control signalling above 19 and 38 m.p.h.

In a similar way the Italian State Railways' studies have reached an advanced stage towards a new point turnout for high speeds, which will permit running over the turnout at 62 m.p.h. and more.

Before leaving this discussion, may I take the opportunity of pointing out that for the purpose of protection of facing junctions, when the configuration of the distant signal is not sufficient to show the limit of speed (for example, at symetrical turnouts) the signal itself is supplemented by light indicators that show figures or letters referring to the direction to be taken.

3. SIGNALLING INSTALLATIONS

1. Before speaking of modern signalling installations using push button operation (type A.C.E.I.), which have been in use for the past 10 years on the Italian State Railways, may I take the opportunity of making a brief review of the evolution that has taken place in Italy.

The first centralised interlocking to be used in Italy was of a French manufacture, the 'Vignier'; after that the British 'Saxby and Farmer' type was extensively used. The invention in 1883 of the Hydraulic Apparatus by our engineer Bianchi greatly advanced signalling practice on the Italian State Railways. Use of this apparatus extended rapidly until attaining its maximum in 1936 with about 15,000 levers.

This fact delayed the application of electric interlocking until 1923 when the Italian State Railways decided to experiment with this type of apparatus, which by that time was already used extensively abroad.

The systems adopted were those produced by Westinghouse, and the Union Switch and Signal Company of Swissale (U.S.A.) and built in Italy by Compagnia Italiana Westinghouse Freni e Segnali, and those of German design and of identical type, by A.E.G. (German Electrical Works) also built in Italy by O.M.S. (Mechanical Works of Savona). At the end of 1935 there was in Italy a total of about 5,800 levers of electric interlocking apparatus, with individual levers, of which about 3,500 were of the C.I.W.F.S. type and 2,300 were of the A.E.G. and O.M.S. type.

During the 10 years of operation of the above mentioned types of interlocking plants much experience was gained, and certain imperfections found were rectified in future installations. Moreover in connection with the preparation for a vast programme of electrification, the installation, in the near future, was envisaged of a notable number of new interlocking plants, in order to make stations adequate to the new potential of electrified lines.

This induced the Italian State Railways to consider if it was not possible to design a type of apparatus of their own that would incorporate all the best features of each of the types tried out, and realise those improvements that operating experience had suggested. Thus came into being the central electrical apparatus of

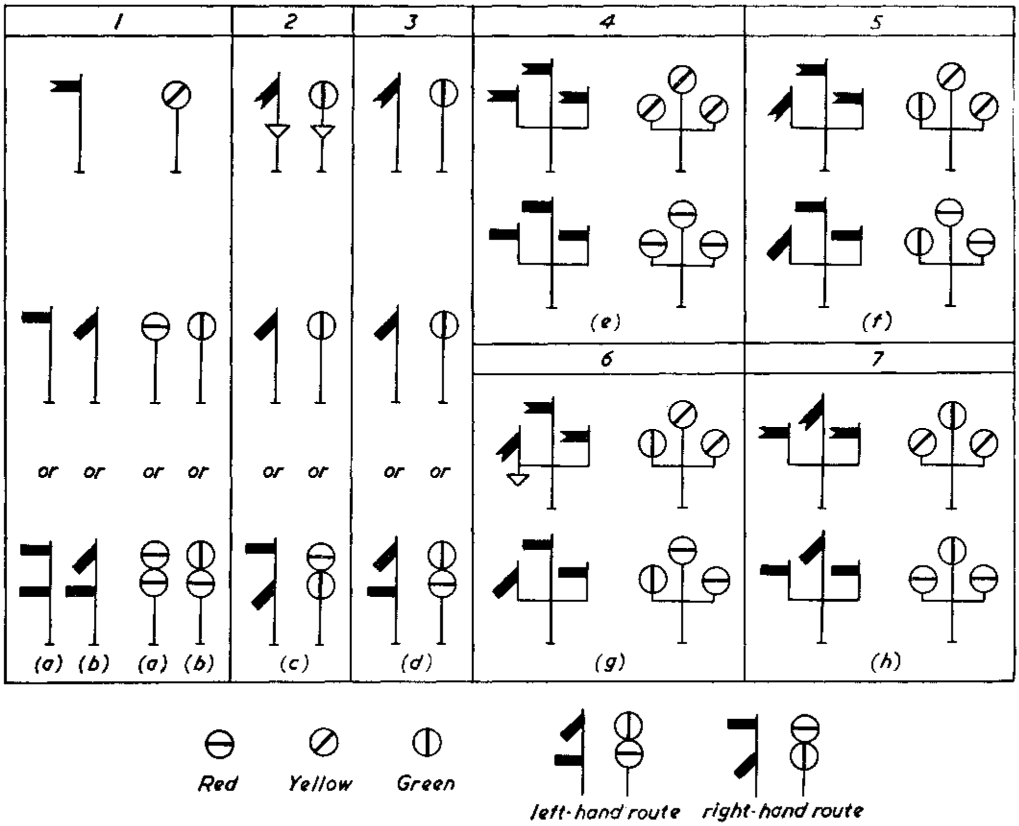


Fig. 3. Signal Aspects: semaphore and colour-light (1940 signal regulations)

Meaning of Aspects

(a) Stop.
(b) Stop, then proceed at 19 m.p.h.
(c) Proceed at speed as indicated in timetable.
(d) Proceed at maximum speed as indicated in timetable.
(a) Stop.
(f) Proceed at 19 m.p.h. on left hand route.
(g) Proceed at speed indicated in timetable on left hand route.
(h) Proceed at maximum speed as indicated in timetable on central route.

the Italian State Railways with individual levers, in which besides unifying the schemes of principle and apparatus were also unified the criteria for the general project of the apparatus, even the method of working. I think it opportune to enumerate briefly some of the features included in the said apparatus, features which have also been retained in our modern push-button apparatus.

1. Employment of double cutting in electrical circuit, and protection of de-energised apparatus by means of neutral closed-security circuit.

2. Total independence between wiring and the actual apparatus itself by means of plug-in features thus permitting the changing of the latter without the necessity of detaching the wiring.

3. Entrustment of all functions (except track circuits) demanded of a relay in a scheme of central electrical apparatus to one sole standard neutral relay, named unitarian.

The Italian State Railway (F.S.) system, between 1936 and 1943, (one standard relay for all purposes) was developed according to a vast programme of new construction and modernisation of equipment, carried out as said before, principally as a result of electrification of our lines, until reaching, in 1945, a total of about 8,000 levers of the F.S. type.

But the said system had the misfortune to come to the forefront at an unpropitious moment, because at the same time new forms of interlocking with

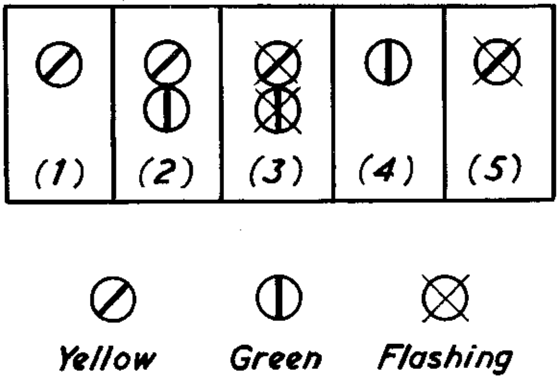


Fig. 4. Signal Aspects: 1947 Signal Regulations.

thumb switches and push-buttons instead of miniature levers, and interlocking through the agency of relays, began to be adopted abroad. News of the introduction of this type of apparatus in England was received in 1938; and this apparatus was quickly inspected and, found to answer to our requirements.

The studies then started and later interrupted by the last war were taken up again in 1947. This resulted in the introduction of an apparatus using only relays and rotating route switches, based on the type initially adopted by the Westinghouse Brake & Signal Co. in England. It was installed in Italy at some large stations amongst which were Bologna Central, Pisa-Central, Rome Casilina. In the meantime, the spread and evolution of relay apparatus had progressed abroad, and the features of different systems were the subject of discussions between specialists at various international gatherings, and notably at the meeting of the International Railway Congress Association in Rome in 1950.

As a result, notwithstanding the good results obtained from the first installations of relay interlockings with rotary switches for route-setting it was desirable to profit from more recent international experience in advancing towards a solution more up-to-date and efficient. So came about a system of relay apparatus controlled by push buttons, free from patents, to which was given the name of Italian State Railway Push Button Apparatus.

2. *Italian State Railways Push Button Apparatus (F.S.).*

May I point out a few of the objectives aimed at in the design of the new system.

The necessity to have automatic release of controls, and hence the flexibility of freeing of routes, made push-button apparatus desirable. In the earlier systems the use of individual circuits of relays and the combining of routes, brought on complications and extensions of circuits. Therefore, in the new systems it was decided to adopt as far as possible, the topographical form of circuits. In the larger installations it was required to retain the separation of the control desk and the illuminated diagram, already adopted in the first installations of route setting, because combination of their two structures could have produced a control panel in which consecutively used buttons would have been a long way apart. This would have been therefore inconvenient for the operator.

It was preferred to have a system in which a single action is used for the entrance and exit, instead of a separate operation for these, as a direct sequence of having the control panel separate from the diagram and the entrance-exit control less intuitive.

May I go on therefore describing briefly the principal characteristics of modern Italian push button installations.

(a) All interlocking is carried out electrically by means of standardised relays.

(b) The controls are performed by small push buttons.

(c) To set up either running movements or shunting movements it is necessary to press only one, or at the most, two push buttons.

(d) The control initiated by pressing a

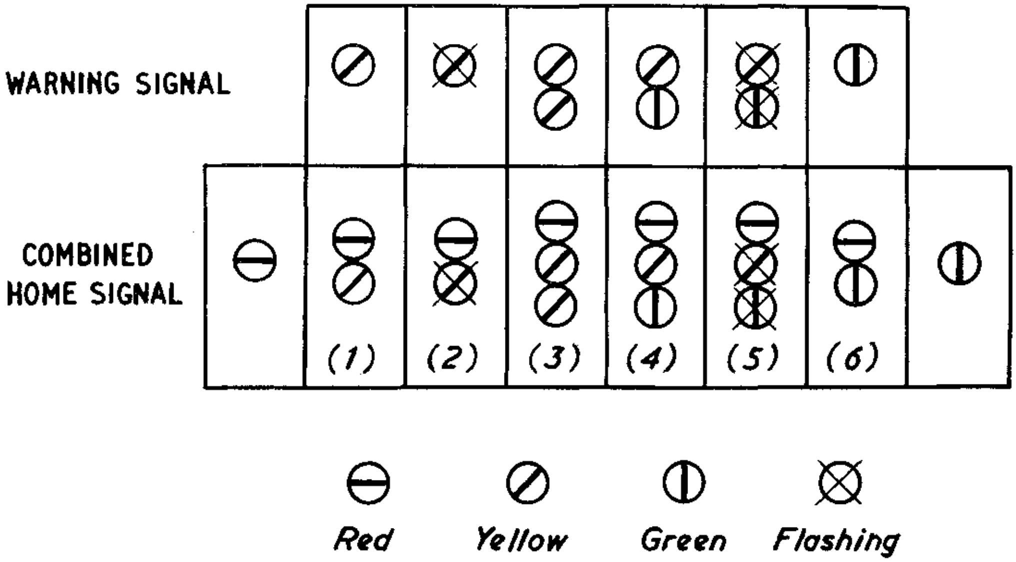


Fig. 5. Warning Signal Aspects.

button becomes effective only when all the required conditions are verified ; otherwise the control initiated is cancelled automatically in releasing the button (this characteristic is called " lost control ").

(e) Routes set up either for running movements or for shunting movements are cancelled automatically as soon as the train passes.

(f) The points locked by setting up, either of a running movement or a shunting movement are released when cleared by the train (sectional route release).

(g) The extensive adoption of topographical circuits that permit consequently the use of pre-wired control units.

The push button installations adopted by the Italian State Railways are closely standardised with regard to the fundamental principles, electric circuit schemes, indications on the illuminated diagrams and on the control desks ; also with regard to neutral, polarised and stick relays etc., and to the standardisation of prefabricated groups of relays for various functions. On the other hand freedom is allowed in design and layout of control desks, according to different requirements.

Thus a few of the larger stations such as Naples, Genoa P.P., Mestre (Venice) and Piacenza are equipped with two separate desks for parallel control between them : the first close to the illuminated diagram for shunting movement, worked by an operator ; the other, situated behind, for running movements, worked by a controller (see fig. 6). In other large stations, such as Novara, Florence S.M.N., Leghorn etc. and in general in all medium sized stations the desks used are in one unit, but with two parts :— one for running movement, and the other for shunting, (see fig. 7).

Such desks are located either in separate signal boxes (though very seldom), or more often in a Movement Control Office sited on the ground floor of the main station. In small stations the control panel assumes such a reduced size, as to be able to incorporate it in the operators' desk which includes the illuminated diagram (see fig. 8).

During the 10 years in which the Italian State Railways push button installations have been in operation, the result has been that of complete satisfaction, their application is continually being extended.

Before terminating this discussion, may I point out a recent adaptation by the Italian State Railways in the use of electrical switching of points, particularly in the fact that the mechanism normally trailable becomes non-trailable by control, but only when a train is travelling on the route in a facing direction at or above 38 m.p.h.

4. AUTOMATIC BLOCK

The use of modern centralised installations has permitted the extending of their range of action, breaking the strict boundaries between station and line installations. This is made possible by a large extension of track circuits, and in particular of Automatic Block either by way of remote control installations, beyond the station protecting signals (intersections, minor locations etc.) or by the better surveillance of the dense traffic occurring in the vicinity of the large railway centres, where there is a confluence of lines. With these principles in mind, the Italian State Railways have made use of a system of Automatic Block with steady current, and based on the use of normal track circuit equipment.

The system is of a type with cyclic control by current inversion ; the cycle of control is obtained with a sequence of three distinct stages of feeding of current of the track circuit, which assumes therefore the characteristic of a true and proper code of transient character. This type of Automatic Block utilises a bipole circuit, which is suitable for short lengths of line generally close to the large centres, and not as a block system on lines on the larger networks. For these the State Railways have changed towards the American system of coded track circuits, either for the well known positive characteristic of this system or as a consequence of the decision taken in the field of cab signalling, of which we will speak later, to bring about the system of continuous cab signalling. The system of coded track circuiting is now in existence on the Bologna-Florence and Rome-Naples route (which I have already mentioned existed before being destroyed during the war), while it is also being put into effect on other important, heavy traffic routes, such as Milan-Bologna, Milan-Genoa, and Milan-Chiasso, on which there will be installed, because of the dense block sections, three aspect colour light signals. There will also be installed

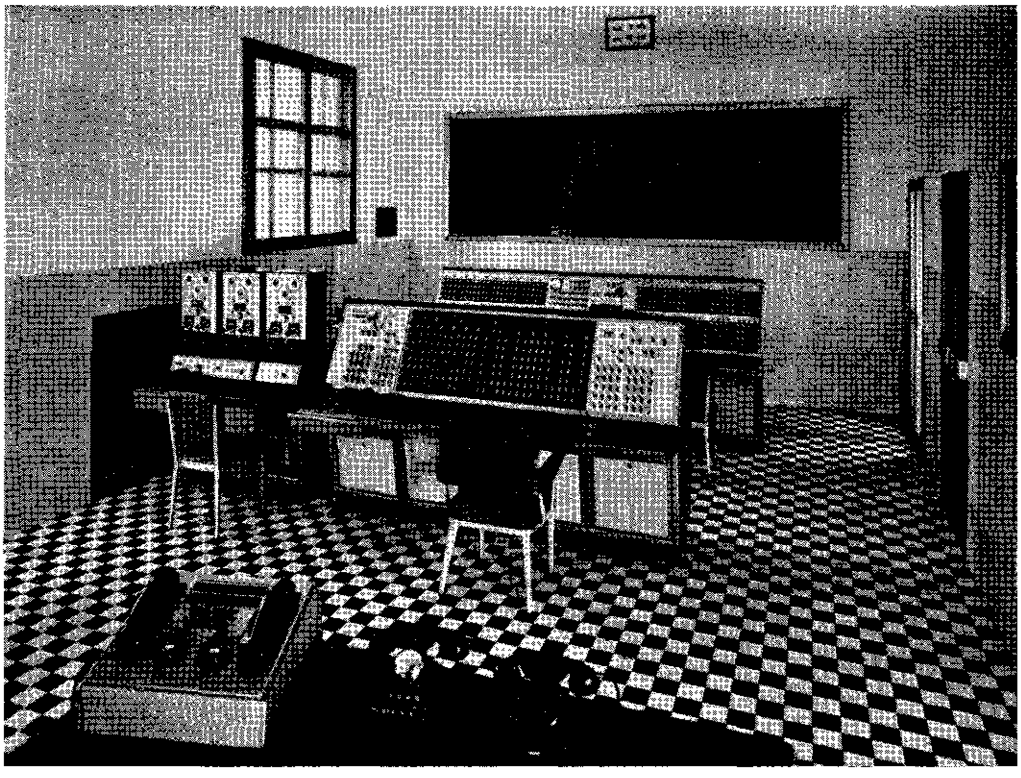


Fig. 6. A.C.E.I. apparatus: Piacenza.

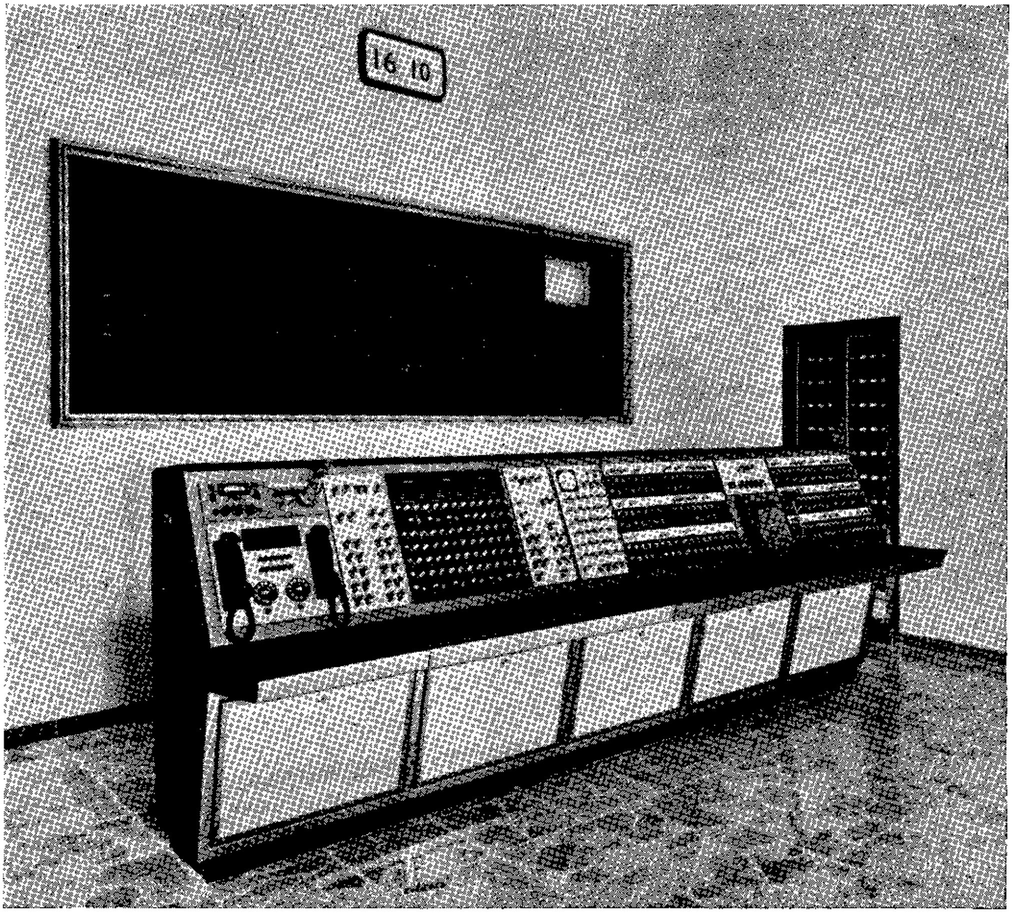


Fig. 7. A.C.E.I. apparatus: Rimini.

" wrong road " block working, limited to working from station to station.

5. C.T.C.

(1) The first application of a system of C.T.C. was that on the complex of railways surrounding Bologna, which came into operation in February 1957. This has provided a good solution to the difficult operating problems, existing in such a complex area of very intense traffic. In fact the ' complex ' of Bologna (see fig. 9 and 10) is one of the most important in the Italian State Railways network, being the point of connection between the railway systems in the North and those in the South of the peninsula. The network includes 10 stations ; the four stations of Bologna itself, one passenger and three freight, and the six stations, which mark the limits of the ' complex ' on the six lines of confluence, and together with eleven intersections, some multiple ones, making a total of 30 junctions and 64 routes.

The ' complex ' consists of some 53 route miles of double track line, with a daily circulation of about 700 trains. The traffic control installation is situated in the building of Bologna's Central Station. From here all intersections are controlled, and they give permission for the clearing of starting signals of stations which send trains into the ' complex.'

The C.T.C. system adopted is like type F, class M, of the G.R.S. (U.S.A.) which has the following fundamental characteristics :—

(a)—Duplex functions, with the possibility of simultaneous transmission of codes of control, and of indication, on two separate lines respectively for the controls and indications. (in telecommunication cables).

(b)—Apparatus for generating of the coded impulse, of progressing of the codes, and of synchronisation between the Central installation and the several outlying locations.

(c)—Control codes consisting of ten coded impulses, with positive or negative polarity of equal duration.

(d)—Indication codes consisting of 20 periods (steps), in each one of which the line of indication can be independently fed, or not. Each period corresponds to a semi-period (Impulse or pause) in the line of control, which has also to be fed with a particular code, without having function of control. (On condition that a simultaneous transmission of control should not be required).

(e)—Automatic starting of the system, either for the transmission of control or indications, with the possibility of estabishing priority for the transmission of a control code to a location in the field, independently of the order in which the various locations are connected in the system.

(f)—The possibility of obtaining from each location in the field a confirming transmission of an indication, independently of the automatic starting of the apparatus, to receive confirmation of the situation of indications in existence at that location. (Operation of indication).

The system, even if today superseded, has demonstrated great efficiency and has fully answered the exigencies of the exercise, notwithstanding the rather lengthy times of transmission, and success is also due to the employment of two central C.T.C.s with simultaneous transmissions in the case of trains following a regular itinerary, and a display of all the relative indications for the movement of a train in the vicinity of a junction and by sub-dividing of each central control of field locations into two parts so far as indications are concerned, so

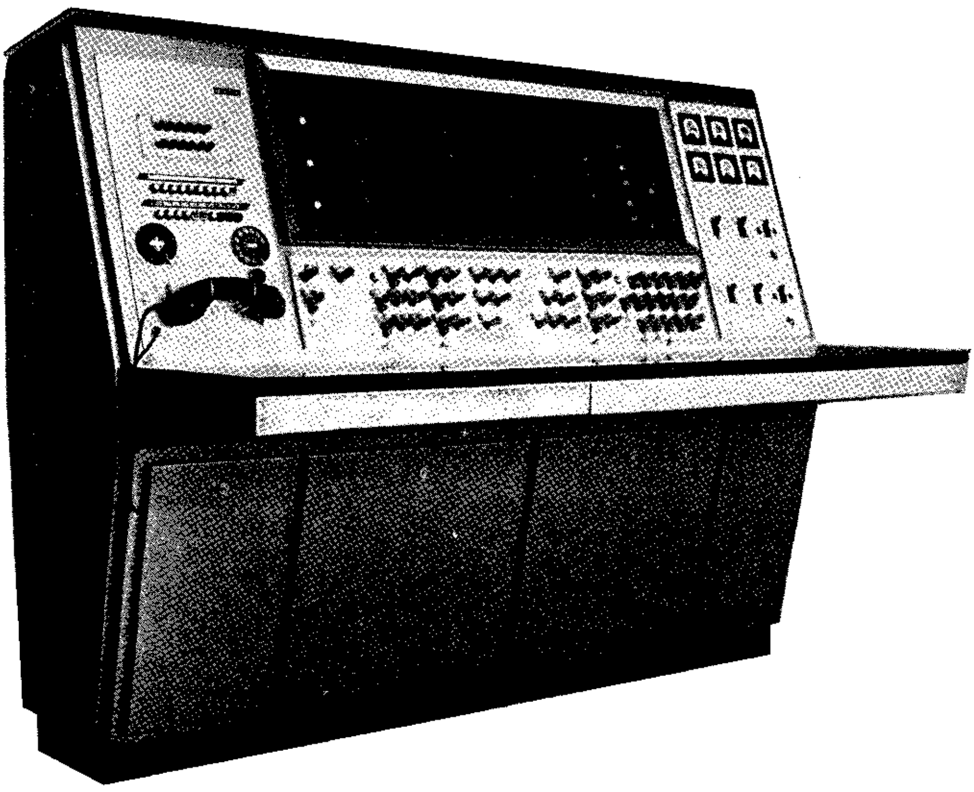


Fig. 8. Type of reduced-size combined control desk.

that indications can be received simultaneously from two locations—one from each group.

The remote control of junctions is arranged according to the control of routes provided for in the central electric interlockings. These latter may be also carried out locally, remaining included in the C.T.C. system, or also with the exclusion of the C.T.C. system in case a fault develops in the same system. The installation of C.T.C. at the Bologna 'complex' forms part of an Automatic system for setting up of routes that has all the character of major interest. Such a system makes possible the working of an installation with one sole central operator, notwithstanding the simultaneous running in the area of numerous trains (up to 20) that are travelling severally on different routes of up to a distance of 10 miles, and incorporating up to 7 junctions.

The system of Automatic control renders possible the control of a route between one station and another of the 'complex' according to a prearranged programme; with only one intervention of the operator at the time to authorise the entry to the 'complex.' The operator must in fact turn only one button peculiar to the whole route, and the formation of the successive partial routes in correspondence with the remote controlled junctions can be followed with automatic progression, little by little, as the train proceeds on its route. The single partial routes become afterwards cancelled by sectional route release.

The total route of a train, characterised by stations of origin and destination, also become registered on the diagram, in appropriate illuminated characters. Such indications are moved, in step with the progression of the train, on the diagram of the line in the successive sections of the route. In normal conditions the operator need only follow the automatic progression of the formation of the route, checking the indications on the illuminated diagram. But whenever the operator himself has to regulate the succession of trains travelling on routes due to conflicting routes and consequent delay at a junction, he has the possibility of suspending the automatic progression of any route set-ups, choosing instead the one that has to be given priority. He may also have to give direct individual control to every partial route, in the event of a fault in the automatic equipment.

(2) Another C.T.C. installation is at present in course of contruction, on the Bologna-Prato line, for a distance of about 12 miles and includes the Great Appenine Tunnel, between the stations of St. Benedetto V.S. and Vernio, on which reversible road working is used.

The system includes the two stations just mentioned and that of Precedenze at the mid point of the tunnel. The location of the central control post is at Bologna. The system of C.T.C. adopted is the type 'L' of the G.R.S. (General Railway Signal Co. of Rochester, U.S.A.). It has 'solid' components with character-

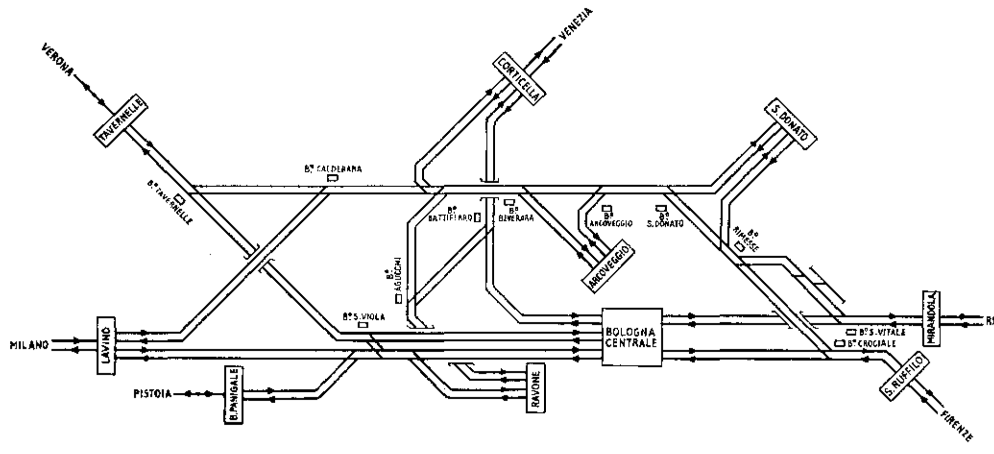


Fig. 9. The 'complex' of Bologna.

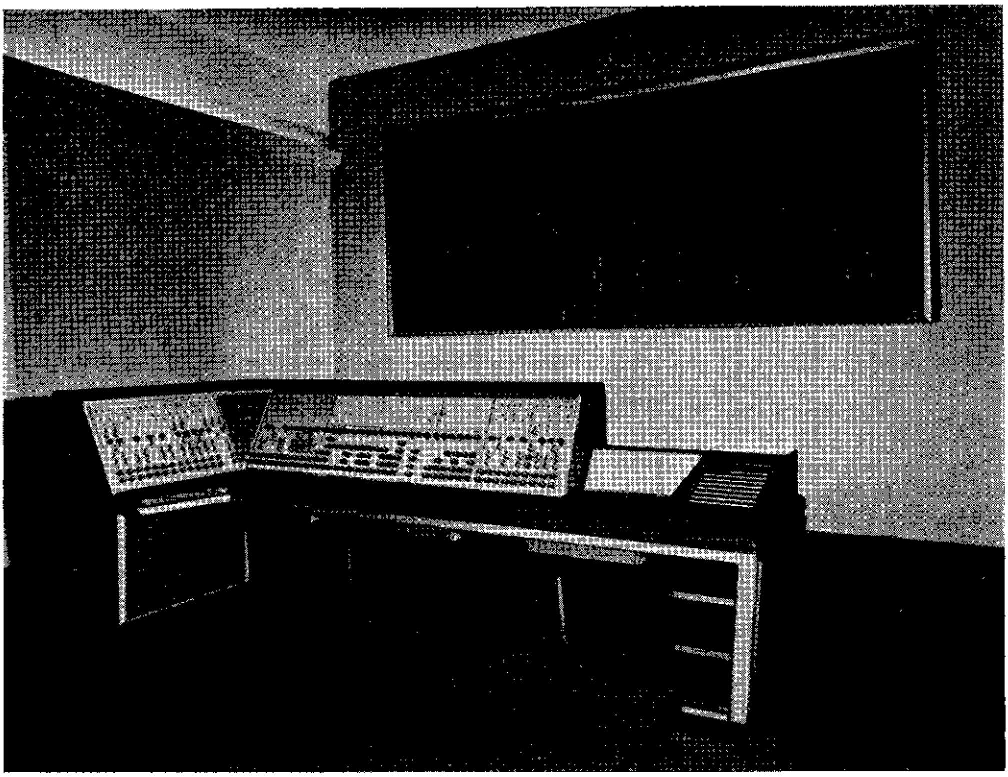


Fig. 10. C.T.C. control panel, Bologna.

istics of high speed (300 bits per second) and efficiency, and with the use of plug-in modules. The system provides for duplex working, (that is the simultaneous transmission of controls and indications) thanks to two independent systems for the controls and indications that utilise the same pair of wires in a telephone cable (fig. 11). The system uses three carrier frequencies, respectively for transmission of controls (6.4 Kcps) for the indications, (8.2 Kcps) and for synchronisation of the office counter and the field counter (10 Kcps). Each carrier frequency is modulated with frequency shifts. The control and indication codes are made up of a series of 16 pulses of high or low frequency. The individual character of every code is determined by the sequence of these impulses of high or low frequency. the first part of which selects the location that is to receive controls or transmit indications.

For the *Transmission of Controls* (fig. 12A) the series of 16 pulses of the code (direct word) is always repeated with an inverted succession (complementary word), so that its validity can be checked in the field location, through the comparison of two received series, before applying the transmitted control to the local apparatus.

Therefore a complete message is formed by two words (direct and complementary), and the relative controls at the impulses of codes received at the field location are applied to the apparatus only after the necessary receipt of completion of the message.

It is of note that to a code of a control there corresponds an impulse of low frequency value, and to a code cancellation (as also when no coding is in progress), an impulse of high frequency value.

For the *Transmission of Indications* the system is of the type using a scanning cycle, and uses two distinct frequencies: one, that of true transmission of indication; and two, that of synchronisation (fig. 12C and B). The time reserved for the transmission of indications for every

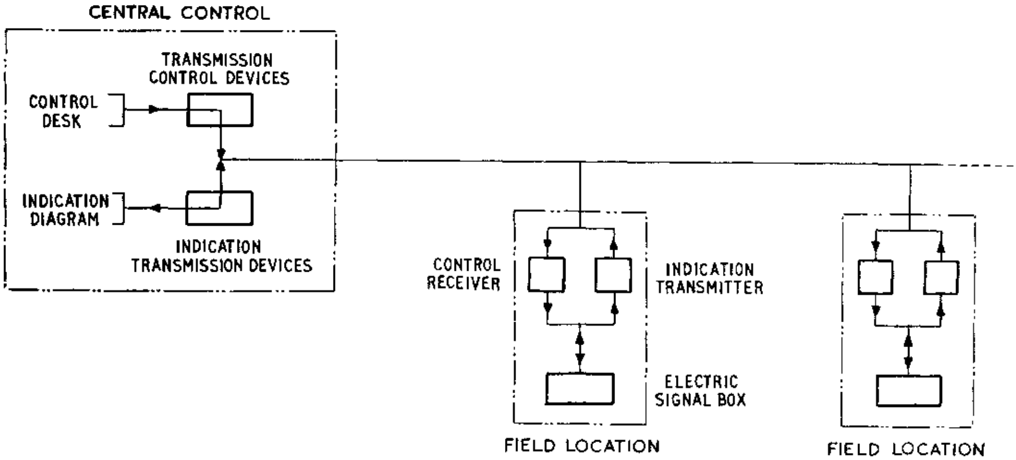


Fig. 11. Block diagram of Type " L " C.T.C.

location is determined by a pair of impulses of the synchronising carrier, in which the frequency for such purpose is successively switched between its own nominal value and a lower one. To each location is assigned a determined number of impulses of the lower frequency. In every field location there is a frequency synchronising receiver which receives and detects the shifts in transmitted frequency from the Centre. When the number of assigned impulses have been received by a field location, a cycle of indication is initiated. The impulses of the indication code received at the central control office can be applied only after these have all been received, and when the identity of the location that is sending the controls has been checked. Such identification is obtained by controlling the first part of the code that identifies the location, just as it has been received, with the corresponding type and number of pulses that have been directly generated from the central control office in relation to the pair of pulses of the synchronising carrier that refer to the station called in the course of the scanning cycle. The system has a maximum capacity of 62 field locations, each one of which can receive and transmit, respectively, 10 controls and 10 indications.

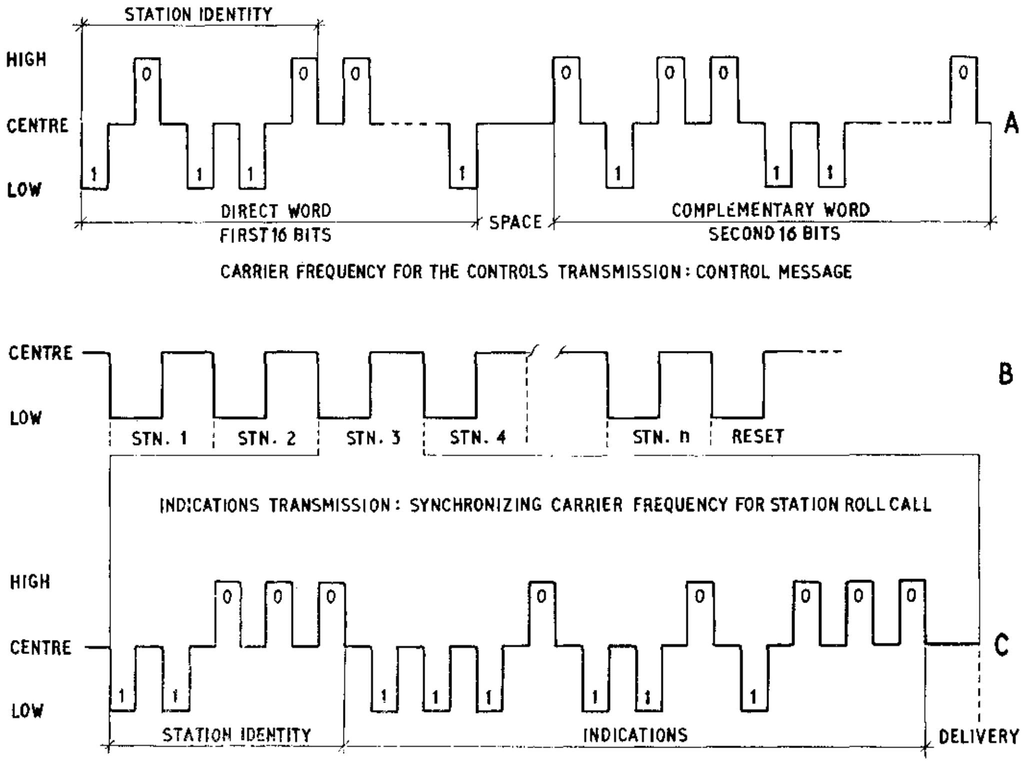
In cases where the number of controls and indications from one field location could be greater in controls and in indications than is transmittable with only one code, the field location is sub-divided into separate units of control and indication that work independently.

With a maximum capacity the time of a control is 0.1 sec., that for the complete scanning cycle is about 4 sec.

(3) Another C.T.C. installation that has already been programmed is for a section of single track over a distance of 81 miles in Sardinia, between Olbia and Macomer on the " *linea dorsale sarda* " that joins Olbia and Cogliari. The choice of the most convenient system to be used is now being studied, and probably it will be of an electronic type. It should be noted that the adoption of C.T.C. on this line will be made in the interests of operating practice and economy. The present system of control by central dispatcher is now insufficient for the present traffic—a traffic which should ultimately increase, due to the intensified relations between the island and the Continent. Furthermore the adoption of the system of working by local dispatcher could have been a very expensive annual working and because of the environmental difficulties, not easy of realisation.

6. CAB SIGNALLING AND CONTROL OF SPEED ON THE ITALIAN STATE RAILWAYS

(1) The problem of repeating signal indications in the locomotive cabs has for a very long time been the concern of the Railway Administration, with regard to such means for increasing the safety on lines carrying very frequent and fast traffic, and where climatic conditions can result in difficult seasonal periods that impair the visibility of signals.



CARRIER FREQUENCY FOR THE INDICATIONS TRANSMISSION

Fig. 12. Type " L " C.T.C. system.

In step with the studies undertaken by International bodies such as U.I.C. and O.R.E. Italian State Railways are also working towards solutions of this problem, which is now of maximum urgency. One notes that the problem is particularly complex and delicate, entirely new to our business. It is also in continuous evolution in other railways administrations, with whom we are in touch either as regards reference to experience of operating or for the technical methods of installation.

(2) The systems of cab signalling foreseen by the Italian State Railways are as follows :—

(a) Continuous indication signals in the locomotive cabs.

(b) Intermittent indication of signals in the locomotive cabs.

(a) *Continuous indication* of the signals in which the train receives continuous information from the track ; the system considered by the Italian State Railway network is similar in characteristic to the American " Cab Signal " system, and is realisable on lines equipped with the automatic block with coded track circuits, of a type already in operation on the direct Bologna-Florence line and on the Rome-Naples line, and is in the process of being installed as previously mentioned, on the Milan-Bologna, Milan-Chiasso and Milan-Genoa lines.

This gives a high degree of safety and is of great efficiency with the possibility of revealing opportunely in the locomotive cab of eventual changing to the clear aspect of the signal ahead, and after the passing of a warning signal at line blocked. On the contrary it allows a limited amount of information. The information is obtained aboard the train by means of mutual induction between the coded track circuits and a suitably mounted receiver on the locomotive.

(b) *Intermittent Cab Signalling System.* In this case the information is supplied only at specific points on the line. In fact the fixed apparatus that transmits the information is installed only in the proximity of signals, or other single points, and the information transmitted is various, depending on the indications that must be supplied to the driver.

The means for transmitting the information to the train is based on mutual induction between the track units and the receiver on the locomotive. The system has the advantages of not being connected to any particular line equipment, and of offering a great wealth of information. Finally it allows, with the greatest simplicity, the conveying of information regarding temporary operations, such as speed restrictions, the need to lower pantographs and so on. On the contrary the intermittent nature of the information transmitted to the train represents an element of reduced safety.

(3) Taking account of the characteristics of the two systems of cab signalling, and of the fact that in the Ten Year Plan a great extension of the use of automatic block is foreseen on the principal lines of the network, it has been decided to adopt both systems to the extent indicated in the map reproduced in fig. 13 thus :

Trunk Network—Lines of major importance, equipped or to be equipped with Automatic Block with coded track circuits: Continuous cab signalling (Lines " A ").

Trunk Network—Lines of lesser importance, without Automatic Block :—Intermittent cab signals (Lines B1 and B2).

(4) In step with the problem of cab signalling there has been taken into consideration also, the control of speed of the trains. In effect all the systems of cab signalling are equipped with an apparatus that would actuate the automatic braking of the train—if the driver does not, within a determined time from the receiving in the engine cab of an indication of a restricted aspect, show by appropriate action that he has taken note of such an aspect and duly obeyed it in the handling of the train in accordance with the indication conveyed. This apparatus constitutes the first control of the driver's action. But it however, cannot avoid in the case of subsequent fault on his part, in passing a signal of the first category (home) at " line blocked," or lack of compliance with the limit of speed imposed by the aspect displayed by the signal itself.

To prevent such a possibility of error, one can adopt the 'Speed Control' in combination with the cab signalling. This control can be put into practice in various ways. Actually a study has been made of the system of continuous control of speed. This consists of the continual verification of the braking distance, in continuation of a restrictive indication of the warning signal, if the speed of the train at every successive instant is not above that limit, from which it should start the braking to permit the train to stop before the succeeding signal set at line blocked, or to limit the speed to a determined level for the passing of the same signal. The first information of the system is based on the continual comparison, in the signalled zone, between the actual speed of the train, and that theoretically determined by the 'programmer,' which sets it out with suitable method on receipt of appropriate information from the track and, according to a 'logical' predetermination of the warning signal aspects, so actuating automatically the braking of the train whenever the rail speed exceeds the determined limit of the programmer, which limit is decided upon according to the percentage of braked weight of the train.

In the Regulator Plan for equipment of the network with cab signalling and which is shown on the map (fig. 13) the inclusion of speed control is foreseen on the lines equipped with continuous cab signalling (line B1).

7. PROTECTION AT LEVEL CROSSINGS

The number of level crossings on the Italian State Railway network is very large. Actually three are 15,300 in operation classified as below :—

(1) Remote Controlled	6100
(2) Controlled at the gate	3576
(3) Open and Unattended	1272
(4) Private	4352

From the above data one notes the large number of remotely controlled level crossings existing in Italy. It is, however, useful to bear in mind that such a system of protection although open to discussion under various aspects, is that which has

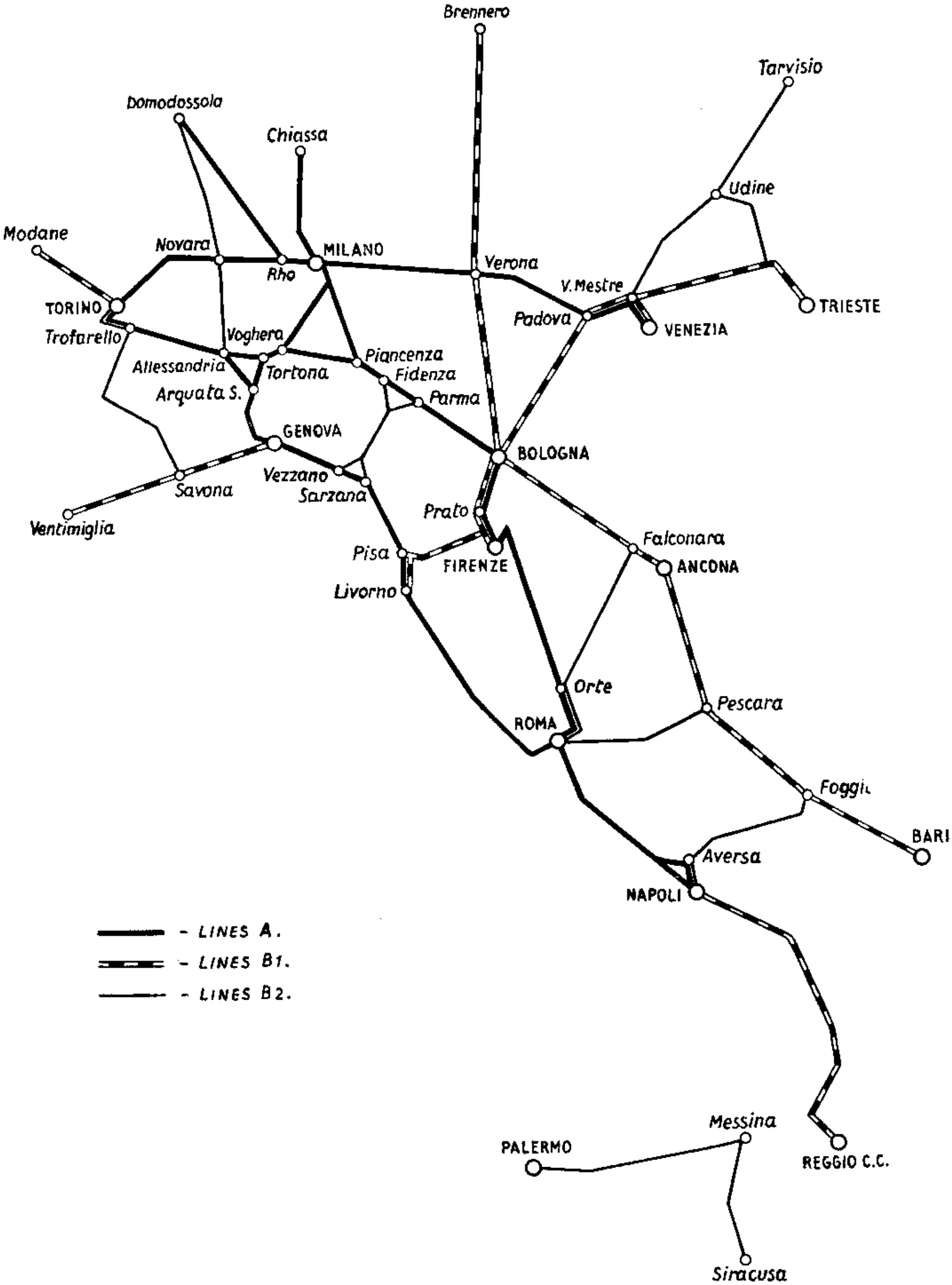


Fig. 13. Installation of Automatic Block and cab signalling.
Lines A: Continuous cab signalling.
Lines B1 and B2: Intermittent cab signalling.

permitted the Italian State Railways to protect with limited expenditure of operation a large number of level crossings previously open and unattended, which are, as also shown by U.I.C. statistics, by far the most dangerous. Nevertheless the proportion of open and unattended level crossings in Italy, is less than in other European countries. Of the total of 1272, only 300 are situated on the trunk and complementary network. The measures put into use on the Italian State Railways, to improve the conditions of working of level crossings, especially those of increasing traffic, are various according to whether it is a remotely controlled or locally operated level crossing.

(A) *Level Crossing—Remote Controlled.*

(1) The replacement of single wire transmissions with others of double wire or electrical means.

(2) The provision of space for refuge for vehicles eventually remaining imprisoned between the lowered barriers.

(3) Installation of illuminated signals facing towards the road, to assist the audible preannouncing of the closure of the barriers.

(4) At a certain number of level crossings worked by remote control, which are out of sight of the control post, a great improvement in operation has been made possible by using closed circuit television. Up to 31st December, 1964 the provision of the preceding points has been made at about 700 level crossings out of the 6100 ones existing, in particular 50 installations have been equipped with television.

(B) *Level Crossings Controlled at Site.*

With regard to the level crossings controlled at site the aim that Italian State Railways is proposing to reach, especially for those situated on lines of heavy traffic, is that of regulating the closure by the movement of a train. The measures adopted, if necessary vary in function depending on the location of the level crossing in respect to the stations and can be separated into two main categories.

(1) *Level Crossings Protected by Signal.*

Installation of an electro-mechanical connection between the mechanism of closure of the barriers and the signals of the stations or of the intermediate block posts of the semi-automatic block. In this case the announcement of the approach of trains can be given by whatever communication, or signalling that would indicate to the crossing keeper the moment in which closure of the barriers must be effected. This last operation subordinates the clearing of the signal.

(2) *Level Crossings not protected by signals.*

In these cases there does not exist an electromechanical connection between the mechanism operating the barriers and the signals; but the announcement of the approach of the train is made directly by the train. (Automatic Announcement). In this category there are included the level crossings provided with closing apparatus automatically worked by the trains. (Automatic half-barrier).

Recently the Italian State Railways has been introducing a system of closure of level crossings on the movement of the trains, which although not being strictly classifiable amongst those protected by signals is in practice included with them. The system consists of an optical or acoustic indication of the approach of a train, transmitted by the station nearest to the keeper at the level crossing, who before closing the same level crossing, transmits an electrical confirmation of compliance, which is that which permits the clearing of the signal of the station. In this way, although the crossing keeper may have given consent for clearing the signal at the station, he has the opportunity of delaying the closing of the level crossing, if conditions at site should make this desirable.

Up to 31st December, 1964 there have been completed 1200 installations of electro-mechanical connections between level crossings and signals; 81 automatic level crossings—10 by automatic announcement, 20 of closing by confirmation of compliance.

Automatic Semi-barriers.

The automatic semi-barriers installed in Italy, are constructed by the Italian Company of Westinghouse under licence from American Consolidated W.R.S.S. (Western Railroad Supply Company). The first two were put into service in 1957 on the Bologna-Piacenza and Bologna-

Rimini lines. They consist of 2 semi-barriers, each one of which disengages half of the carriageway in the direction of vehicle movement and gives 2 illuminated signals placed on the same stand, which when operated flash alternately with the frequency of 1 second.

The control of the semi-barriers and that of the illuminated roadside signals becomes actuated automatically by means of the action of trains or by a track circuit, (actually 50 installations) or by electromechanical treadle of a French type 'Silec' (actually 31 installations).

The varied phases that constitute the complete operative cycle are as follows:—

1. Pre-warning: "a," lasting 5 sec. (7 sec. in certain cases, including lighting of signals and ringing of electric bells.
2. Operation of Half-Barrier: "b" lasting 10 sec.
3. Margin of Safety: lasting 30 sec.—(a & b)—corresponds to the interval between closure of the semi-barrier, and the arrival of the train at speed.
4. Opening: lasting not more than about 10 sec., including the following:—silencing of bells, raising of barrier, and then the switching off of the signals.

To the total time of control of 30 seconds, one adds in general an increase equal to 1 second for each 10 ft. above the length of the crossing (47 ft.). Depending on the circumstances, on lines of two or more tracks, it might be desirable to maintain the closure after the passing of the train, when an approaching train travelling on the other track is within a pre-determined distance. This is achieved by means of approach apparatus, placed generally at one half the distance of the controls. In case of level crossings situated near stations, at a distance such that the point of control falls in the zone between signals of the same stations, the action of control of the level crossing becomes determined by conditions of operation inherent to the movement of trains in the vicinity of the station. In the use of automatic Semi-barriers installed on the Italian network it is envisaged that announcement and disclosure of any failure or abnormality that has occurred in the passage of a train shall be made at the nearest station. Three types of alarm are proposed.

(*1*) *Alarm type* (*A*). Announces the lack of closure or the non-energisation of some relay. It is the most dangerous fault which when announced carries with it the instruction to trains not to exceed 2½ m.p.h. and to be prepared to stop short of an obstruction in the vicinity of the level crossing, until the fault has been attended to or eliminated.

(*2*) *Alarm type B.* For the loss of main power supply and cutting-in of the stand-by.

(*3*) *Alarm type C* that announces the prolonged closure—above 5 minutes—of the semi-barrier. If the event is due to a traffic movement, no precaution must be taken. If due to a fault one must adopt the precautions as for Alarm type A. The control of automatic level crossings situated on lines in operation with Automatic Block, is relieved by means of high frequency circuits (A.F.O.) which are superimposed on the circuits of the block without necessitating further block joints.

Automatic installations with illuminated signals only.

This type of installation which does not provide any positive indication to the user of the road, other than that of the approaching of a train (two red lights flashing alternately), has found limited use owing to the danger derived from irresponsible action of road users.

8. PROGRAMME OF DEVELOPMENT OF SAFETY INSTALLATIONS AND LEVEL CROSSINGS

With appropriate legislation brought out in 1962, the Italian Government has allotted for the five years 1962 to 1967 a sum of 800 milliard lire for a modernisation plan for the Italian Railways network, of which 54.3 milliard lire refers to the section covering signalling installations and the safety of level crossings.

The principal works foreseen in the said section, which are already in an advanced state of realisation, are the following:—

(a) Development of the trunk lines Milan-Bologna, Milan-Genoa and Milan-Chiasso by means of the installation of automatic block by coded track circuits and continuous cab signalling with modern interlocking at stations that are now without.

b) Development of the trunk lines Verona-Brenner, Bologna-Rimini-Ancona, Grosseto-Leghorn and Carmagnola-Ceva with the replacement of semaphore signalling with those of colour lights and the installation of modern interlockings in the stations.

(c) Installation of intermittent cab signalling on the Bologna-Padua line.

(d) Development of the complementary lines, Milan-Mortara, Castelbolognese-Ravenna, Genoa - Ovada - Alassandria, Rome-Sulmona, Battipaglia-Metaponto, Bari - Taranto - Reggio Calabria and Palermo-Alcamo D. with the substitution of colour light signals for semaphores, the institution of manual electric block and the standardisation of safety installations in stations.

(e) Development of the junctions of Genoa, Milan, Alessandria and Rome, with the installation of Automatic block on lines concerned, of push button interlockings and of remote control.

(f) Development of the Sardinian main ridge Cagliari-Olbia by means of the installation of push button interlockings remote control apparatus automatic block, and of C.T.C. These last two provisions will only be installed on the Macona-Olbia section of line.

(g) Development of the Milan marshalling yard with working by automation of the operation, in the " OPERAZIONI DI LANCIO."

(h) In addition to the development works reported above, the five year plan contemplates also the replacement of a large number of safety installations and signalling of the type now outdated. In the level crossing section in particular there is assigned the sum of 17.5 milliards of lire, of which 6.4 are for replacement works and 11.100 millions of lire for technical improvements to level crossings that remain in operation.

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DISCUSSION

Mr. O. S. Nock opening the discussion said he felt sure that their uppermost thoughts that night were of gratitude to the Italian State Railways in general, and to Signor Contaldi in particular, for all they had done for the Institution that year. Twice within the last eight years they had been able to hold their summer convention in Italy, and they had been able to see, at two most interesting periods, the gradual evolution of the plan of modernisation of the signalling. But that night was the first occasion on which they had enjoyed at a general meeting a paper describing the work as a whole. Mr. Nock felt sure all would agree that it was a magnificent effort on the part of Signor Contaldi, not only to prepare the paper, but to come and deliver it in person, in English, and to be prepared to answer the many questions which he thought would be put to him later. He had had more opportunity than the great majority of members to study the paper, and perhaps he owed them an apology for the late appearance of the advanced copies; naturally Signor Contaldi prepared the draft of his paper in Italian, and like all the Italian trains in which Mr. Nock had travelled that year, it arrived dead on time. But then, of course, there was the job of translation. Mr. Nock went on: 'Signor Contaldi's English is much better than my Italian, and I am going to confess that at times we had a bit of a struggle. But with the help of several members of the Institution and an Italian-speaking, though entirely non-technical friend at Chippenham we have managed it, and I hope that we have succeeded in conveying in English what Signor Contaldi intended.' Later on they received, very gratefully, from Signor Contaldi an English translation of his paper, which was of great help in clearing up some of the points on which they had been uncertain, and in correcting some of the passages where the translation had gone wrong.

The paper itself was of exceptional interest in a number of ways. It was fascinating to have maps like those in Figs. 1, 2 and 13, which showed so clearly the overall plan of what the Railway Administration was going to do, and to see how the new signalling and train control methods were being applied to the Italian Railway network as a whole. Such overall planning would inevitably raise feelings akin to envy in the hearts of most British signal engineers and railwaymen in general. His own comments on this paper were fairly general, and there would no doubt be others who would wish to take up with Signor Contaldi points of interest in the methods he was using for track circuiting, for remote control, for cab signalling and speed control of locomotives. For his own part Mr. Nock found his references to the introduction of reversible road working very interesting. They had seen some of this during the summer convention in the signalling through the great Appenine Tunnel. It was a feature of railway operation on the continent of Europe that was being gradually increased, and he would like to ask Signor Contaldi whether the signalling arrangements which provided for reversible road working have been considered towards the changing of routes, which were at present double-tracked, to a single track with passing loops at appropriate places, or to the changing of sections where there might be three or four running lines to no more than two. Today considerable savings in railway operating and maintenance costs were to be realised if one could run the traffic on less tracks by making better use of each line of way. This, of course, was coupled with the extension of remote control and the bringing of large areas of the railway network under single centralised control panels. This practice was gradually being applied in Great Britain and it was evident from Signor Contaldi's paper that similar work was being done in Italy, as he had so lucidly described in relation to the railway network of Bologna. The reduction in the number of running lines was a natural development from the extension of Centralised Traffic Control, and he would very much like to know whether any programme in this direction is planned in Italy.

So far as the signalling itself was concerned, while we, as signal engineers, were all deeply interested in how it was done, and in the interesting and advanced techniques that were being used, it was after all the 'end-product' that counted, and where railways were concerned, the end-product was, of course, the efficient punctual running of the trains. Quite apart from the journeys connected with the summer convention that year he had the opportunity of further extensive travel on the Italian Railways, and he would like to say there that every train in which he travelled, and some of them were timed at very high speeds, arrived at destination exactly on time. He did not think one could have better commendation of the Italian railway signalling than that.

Signor Contaldi replying said that he wished to thank Mr. Nock very much for his kind words about the efficiency of the Italian Railway System and the paper prepared by himself.

As regards signalling arrangements for reversible road working, he agreed, for his own part, with him about the general conceptions that were the basis of their performance. But in the peculiar case of the installation of this kind provided on the stretch of line between S. Benedetto and Vernio, running completely in a tunnel for a length of about 12 miles; in the middle of which there is the "Precedenze" station, he wished to point out that its purpose had been to allow for single track operation during maintenance work on the track, the tunnel and the overhead line, as well as to permit the use of the two tracks on the same direction in order to ease traffic in particular conditions.

The case of the line "Dorsale Sarda" was quite different; there a C.T.C. installation was to be put into service, in order to enable the actual operating system to be maintained, with a more intense traffic, without involving expensive civil engineering works and increasing the number of operating staff required.

Mr. D. S. Jewell said that he thought the Italian State Railways had an administration something of the same size and importance as British Railways. The wide and comprehensive paper of Signor Contaldi's, was a noteworthy effort as it embraced the whole field of signalling in Italy. There were obviously some differences between their conclusions and those of our own, but there was probably a great deal that was common ground. Everything had not been easy for them and they had a lot of electrification. The differences between their findings and our own were interesting, and he thought that indicated individuality and different ways of thinking things out which was important, and a very good augur for the future.

Although he was ready to defend standardisation, they could obviously have too much, and if, as in Italy, they saw different solutions with the same results, then he thought that was a good thing.

For instance it seemed that searchlight signals were standard, no doubt for good reasons. Searchlights were not in favour generally on British Railways. One of the results of employing searchlights must have meant that in many cases a driver was running at quite a considerable speed past a string of searchlights starting with red at the top, and he did not think they themselves would like that very much, though it might have advantages. For instance he assumed they did not have any phantom indications with searchlight signals.

The multiplicity of aspects was something to which they were not used in Great Britain. If they were going to have higher speeds and more positive control of speed levels to meet speed restrictions, the question would arise with British Railways signalling as it stood as to whether it was really fair to give the driver a wayside green signal and yet have more restrictive signals in the cab corresponding to the various speed limits, and still leaving the driver looking out at a wayside green signal. He understood that in Italy, when they applied those intermediate speed controls, they would at least have the signal outside showing something more restrictive than green.

He then congratulated Signor Contaldi on the way he had covered all the many developments that were going on, and said he was most interested to hear of the developments with train control. He had no idea that Italian State Railways had progressed so far.

He thought the choice of the intermittent system, presumably to reduce the cost on secondary lines, might not turn out very practical in the end. If they were going to have speed control, and perhaps the speeds away from the trunk lines were high enough to justify a great deal of speed control, then the intermittent system virtually became continuous. Nevertheless that was where the interest lay. The Italian State Railways were developing a particular way of dealing with that problem, and it would be interesting to see the outcome.

He would like to second Mr. Nock in congratulating Signor Contaldi on this very wide paper and the way in which he had delivered it, in order to show them everything that was going on in Italy. He was sure they would be able to look forward to going back to Italy to see the results of their works.

Signor Contaldi said that he would, firstly, point out that in the signalling system employed by the Italian State Railway, each group of lights must be regarded as a unit with its own meaning : that is the group of lights yellow and green (steady) was a warning signal that indicated the reduction of speed to 19 m.p.h. in approaching the next home signal.

When a first category (home) signal carried accompanying warning indications, it might have added at the top a red light, the only purpose of which was to remind the driver of the reduction of speed required at the site, according to the indication displayed by the distant signal.

From the foregoing it followed that it would never happen, in the cab signalling, that there would be a difference between the wayside signal aspect and the one repeated in driver's cab.

Referring to the Italian State Railway programme of extending the intermittent cab signalling and the speed control on secondary lines, if he agreed with Mr. Jewell in his assumption that a speed control did not associate easily with an intermittent cab signalling system, he did not agree on the other hand completely with him that the foregoing system must virtually become continuous. In fact it was necessary to have supplementary information for the release of a programme only in the areas of the signals. He thought that another means of overcoming the problem might be the use of release buttons to be operated by the driver under special cautions.

Mr. M. E. Leach said that he would like to add his congratulations to those of previous speakers in admiring Signor Contaldi's marathon performance in a foreign language. He had to admit that if he had found himself in a similar position the results would have been disastrous!

He had one or two points which were not very clear and he was sure Signor Contaldi could clear them up. Mr. Jewell had already raised the point on the number of signal aspects which could be displayed to the driver, and it seemed to him that many of them were somewhat complicated. In Fig. 5, for example, perhaps Signor Contaldi could confirm that the combined home signal displayed a red light at the same time as the combination of coloured lights shown under Items 1, 2, 3, 4, 5, 6. In other words, if they took Item 5, was it correct that there was a red light, a flashing yellow light, and a flashing green light, all shown at the same time? If so, he thought that would seem to be rather confusing.

He then asked what method of proving was used to ensure that if it was intended that a yellow and green light were displayed together and the yellow light went out, say because of a bulb failure, the green light which would be a less restrictive aspect was not left displayed on its own. That was a difficulty which always arose if an aspect consisted of a yellow and a green light displayed together.

His other point concerned the level crossing protection section at the end of the Paper. When they were in Livorno this year he was very interested in the closed circuit television installation at the level crossings, and he asked Signor Contaldi if any special lighting of the crossing was necessary after dark to enable the road to be properly seen, and also what happened if the weather was foggy? As far as automatic half barriers were concerned, what happened to the margin of a safety referred to when a train travelling at less than the maximum speed approached the crossing. Was any form of speed discrimination used to equalise the margin of safety?

Perhaps Signor Contaldi could also enlarge on the method of working when a second train on another track was approaching an automatic half barrier crossing whilst the barriers were lowered and before the first train was clear. Could he say what was the philosophy behind the placing of approach apparatus at half the distance (presumably from the crossing) of the normal control point for that purpose.

Signor Contaldi, replying to Mr. Leach, said that he could only repeat what he had already said in answering Mr. Jewell about the interpretation to be given to the twin unit signals. As regards the method of proving used to prevent the less restrictive aspect (green light) being displayed, if the yellow light of a yellow-green signal goes out, due to the failure of the bulb, he would point out that in that case the bulb of the green light was automatically extinguished.

So far as the closed-circuit television installations at the level crossings were concerned, he could confirm that a special lighting of the crossings was necessary after dark. If the weather was foggy, and cameras were obviously not capable of covering the area sufficiently, no measures were taken, owing to the fact that the television installations were regarded only as subsidiary means for the operating people.

Finally, relative to the automatic half-barriers, the margin of safety (15 seconds) was naturally that needed for the fastest train on the line.

Mr. H. W. Hadaway said that previous speakers had made mention of the efficiency of the Italian State Railway system. He was fortunate enough to attend the recent Convention and he could subscribe to that statement—in fact at one time he found it a matter of great comfort! There was the case of the great Appenine tunnel with its reversible road working. Travelling in a train at 80 m.p.h. one could imagine another train travelling just as fast in the opposite direction on the same road, and due to be switched at one of the intervening crossovers. It was a startling thought, and Mr. Hadaway admitted that during such a run he kept telling himself: " This is a very efficient system!"

Signor Contaldi, in his diagram on Fig. 9 referred to the complex of Bologna, and as Mr. Hadaway understood from his description in his paper, this was worked by a C.T.C. form of control, with but one operator standing in reserve. He would like to ask him if he would indicate the nature of the programme arrangement which operates the C.T.C. control, and the form of agreement by which the operating people accept that the very large layout could be operated by one man. Referring to some points of detail in his paper, one was his reference to the circuit system as being double cut. He would like to ask him if he could give some idea of the precautions that were taken to preserve the insulation of both poles, and the nature of the detection arrangements that were employed.

A second point was the automatic release of routes which, as he understood it, was instantaneous, following the passage of a train. While he could accept that this was a safe thing to do on many parts of the system he wondered if it was as all-embracing as his description would lead them to believe, bearing in mind that parts of a railway system included many track connections and crossings which had little use, and therefore there was always the possibility of a track circuit " bob " occurring for the last wheels of a train, or a light locomotive.

He referred also to the point mechanisms which became non-trailable above 38 m.p.h. This was a type of point mechanism with which he was not at all familiar, and what he would like to ask was, did that mean that below 38 m.p.h. which he would regard as a relatively high speed, the points were treated as trailable points, and in fact would not have a facing point lock. How was this speed decided, and how in fact was it measured?

Further to the point of the one man at Bologna: obviously some very careful consideration has been given to the operating requirements in the provision of alternative desks. Would Signor Contaldi tell them if there was any kind of agreed formula with the operating staff to give the answer as to how much a signalman could do.

Following the point made by Mr. Leach he would also like to ask about the use of television. As far as he was aware it had been restricted to level crossings. Was it possible in the future that television might be extended to other operating uses? And finally, could a life of the installations that were being put in be indicated?

Signor Contaldi, replying to Mr. Hadaway, said that in the C.T.C. installation at the complex of Bologna the programme arrangement which operated it was formed by a chain of relays, each corresponding to one of the routes that might set up. Each relay of the chain had the function to determine a part of the route.

That installation, that naturally had enabled a great number of operators to be saved, had been accepted without difficulty by the operating people; nor had it been necessary to apply any special means of persuasion!

With regard to the double cutting used in Italian signalling circuits, each wire was protected by a plastic covering with high insulating resistance, and for each group of circuits at the same voltage an earth detector was provided.

The third point raised by Mr. Hadaway, referring to the automatic release of routes, was very important. Certainly, in each large interlocking, there were some track circuits which, having little use, might permit untimely release. The Italian State Railways had taken special notice of this matter, and now they were adopting special track circuits, fed by impulsive voltage, capable of perforating the film of oxide formed on the track.

Referring again to the C.T.C. installation at Bologna, there was not any kind of formula which immediately gave the extent of the area that could be operated by one signalman. It depended upon the type of installation, and upon the particular conditions of operating.

Mr. Hadaway had also asked if the speed of 38 m.p.h. below which the facing point mechanisms were trailable, was not too high. Certainly it was a relatively high speed; but the operating results on the Italian State Railways had proved that that limit was not dangerous.

He would add that the above mechanisms became non trailable by means of an electromagnet, that was operated automatically when a route, containing facing points to be passed at 38 m.p.h. or above, was set up.

On the other side, he would also remember that till a few years ago the principles adopted by the Italian State Railways in this matter were completely different, using in any case trailable mechanisms either if operating facing points or trailing ones.

Regarding the last question raised by Mr. Hadaway he could answer that at the moment there was no programme to extend the use of closed circuit television in railway installations, and that up to that time it had been impossible to indicate the life of installations of that kind used at the level crossing, due to the relatively short time they had been installed.

The President, Mr. J. P. Coley, in concluding the meeting expressed the appreciation of all members present to Signor Contaldi for his efforts, and a hearty vote of thanks was passed with acclamation.