Technical Meeting of the Institution

held at

The Institution of Electrical Engineers

Wednesday, December 7th, 1960

The President (Mr. W. OWEN) in the chair

The minutes of the Technical Meeting held on November 9th, 1960, were read and approved.

The President introduced and welcomed to the meeting Messrs. M. Elias and M. Ahmed (Members), G. W. Gore and A. Calley (Associates), J. Rose (Associate Member) and J. Seed, A. S. Macrae (Students), who were present for the first time since their election to membership.

The President then requested Mr. J. P. Coley (Member) to read his paper entitled "Modern Designs of Signalling Relays."

Modern Designs of Signalling Relays

by J. P. COLEY (Member)

Introduction

Practically all relays which fall into the category of modern designs are of the plug-in type and the majority of the most recent are of the miniature plug-in type. The last statement applies particularly to line relays and other special types of relays used in interlocking circuits, because the question of miniaturising track circuit relays has not yet been seriously studied. Since the principal object of this Paper will be to discuss the transition from the large-size plug-in relay to the miniature relay, relatively little mention will be made of track circuit relays.

Large-size plug-in relays are by now probably well known to all members, since they have been in use in this country for some 20 years, although they have not been extensively employed until about the last 10 years. In pursuing the object of the paper as outlined above, attention will be drawn to certain salient features of the large-size plug-in relay as shown in fig. 1.

The complete relay consists essentially of two basic groups, the first of which comprises the contacts and the second of which comprises the coil and iron circuit. The relay in fig. 1 has the contact group mounted below the coil, but another design by a different manufacturer has the contact group above the coils. In both designs the two groups are mounted on a vertical insulating relay base. The contact spring supports are carried through the relay base and project at the back so that when the relay is attached to its plugboard the projecting contact springs make contact with the connectors in the plugboard. Each connector must be capable of being fitted with two wires and of being individually removable. Each connector must be latched in position so that it can only be removed by means of a special tool. In fig. 1 the uppermost connector is shown in the unlatched and partly withdrawn position.

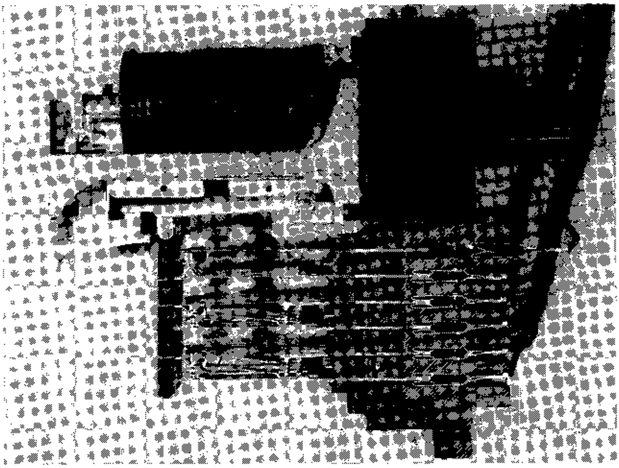

Fig. 1 Photograph of BLIB Relay partly cut away to show a contact spring extension piece engaging with a removable connector

Some 5 years ago, relays of this general type were rapidly superseding the old shelf-type relay. In general the large-size plug-in relays comply with the relevant B.S. Specifications; in particular they comply with all requirements affecting the safe and reliable operation of the relay. In about 1955, however, Signal Engineers began to think that signalling relays were larger and consequently more expensive than seemed really necessary. They realised that conditions had changed since relays to BS.1659 had first been designed; particularly with regard to the fact that, for line relays, the need for great economy in power consumption was no longer so important as it had been in the past. It was further realised that, if the relays could be made smaller, then there would be additional savings such as reduction in cabin space, smaller relay racks, shorter wire runs and quicker wiring. These thoughts have resulted in the fact that the large-size plug-in relay is now being rapidly superseded by an appreciably smaller miniature relay.

Development of a Miniature Relay

Let us now consider the various design features of the large-size relay with a view to seeing which of these can be made smaller.

Relay Output

Under this heading it is intended to discuss what the relay must be capable of doing in external circuits. Consideration shows that the contacts are going to have to perform very similar functions to those being performed by the large-size relay; therefore the lift and the wipe will have to be of the same order as those of the large relay. The working stroke of the armature must allow for adequate lift of both front and back contacts and must also ensure that, when the last back contact is just about to break there is still an adequate opening on the front contacts to prevent the possibility of bridging. These factors lead to the conclusion that the contact openings and hence the complete working movement of the armature must remain as for large size relays.

The principal duty to be performed by the coil and iron circuit is to compress a number of contacts to full pressure and hence the contact pressure required will be another factor determining the size of the iron circuit. If the carbon contacts used on large size relays could be replaced by metal contacts, appreciably lower contact pressures could be used and this would permit the contacts to be compressed with a smaller iron circuit. For reasons which will be discussed at greater length in due course, it was decided to retain the carbon contacts. Consequently the pull in the plane of the contacts cannot be miniaturised.

Coil and Iron Circuit

Early signalling relays were designed for operation from primary batteries and in order to keep the current consumption to a minimum they were fitted with large coils having many turns, since the relay operates on the product of amperes and turns.

In order to miniaturise and at the same time to do the same amount of work in the plane of the contacts we shall need to employ a smaller pole face area and hence higher flux density so that the ampere-turns for the gap between armature and pole face will increase. We shall require to drive the flux through a smaller iron cross-section and through non-working air gaps of small area and this will also demand more ampere-turns. These can only be provided at the expense of more power and since we also want to reduce the coil size this will demand a further increase in power to accommodate the new ampere-turns in less space.

The power consumption of a 1,000 ohm. relay to BS.1659 on a 12 volt supply is 0.144 watts. A cabin with a 1,000 such relays energised simultaneously would be consuming negligible power by modern standards, and the opinion was widely expressed by Signal Engineers that the power consumption of the relay could be considerably increased. It was established that a power consumption of the order of 2 to 3 watts would be generally acceptable.

Fig. 2 Rear view of Plugboard of BL1B relay showing removable connectors in position with wires attached

Spacing of Contacts

Fig. 1 shows a large size plug-in relay in position on its plug board, and on examination it can be seen that the spacing of the contact springs is such that the silver moving contact element is of a greater height than would be required for electrical purposes only, which leads to the conclusion that the contact springs could be placed closer together provided that other considerations permit. In fig. 2 we see the rear view of a large-size plug-in relay mounting base, where we are looking at the honeycomb arrangement into which the removable connectors are fitted, there being one cell in the honeycomb for each contact spring on the relay. Each cell has to be capable of taking a removable connector with two wires attached to it, and also a removing tool. It is apparent that the walls of the honeycomb are designed on the generous side and that therefore, there is the possibility of some saving in space per contact spring by reducing the wall thicknesses. The principal factor which determines the size of each honeycomb cell is the diameter of the wire to be used, and it soon became apparent that if signalling installations were to continue employing conventional wire sizes of about 0.18-in. diameter negligible reduction could be realised in the space occupied by each contact.

The question therefore arose as to whether the overall wire diameter could be reduced and general agreement was eventually reached that signalling installations using miniature relays would be made with wire having the maximum outside diameter of 0.110-in.

Reduction in wire diameter was therefore, the first step to reducing the space per contact spring required on the relay base. It is apparent that if very small wires

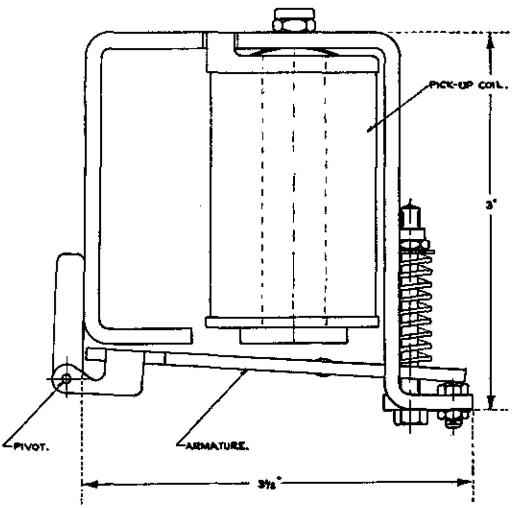

Fig. 3 Drawing of iron circuit of PN1 relay (side view)

were used then the minimum spacing between springs would be determined by the size of the contact tips required. It thus becomes a matter of experiment to see, with the proposed new size of wire and with contact tips adapted to the vertical space available between the springs, whether these tips would be large enough to handle the loads required. Three typical loads which were submitted to life test were:—

(*a*) Three other relays of the proposed miniature design connected in parallel and fed by one contact.

(*b*) D.C. fed 25 watt signal lamp complete with side light.

(*c*) As for (*b*), but fed through a 110/12 v. transformer.

The aim of the life tests was to see that the contacts would operate these loads 1 million times without the wear being such as to produce a serious reduction in contact pressure. The test proved that contacts proportioned in accordance with the foregoing would meet the life requirements.

Fig. 3 shows an iron circuit developed for a miniature relay. Fig. 4 shows the complete relay. The number of contacts to be fitted to the relay has an influence on its design. In this case it had been decided to fit 10 contacts but if it had been decided to fit two vertical rows of 5 contacts either above or below the iron circuit then the space occupied by the contacts would have been narrower than the iron circuit, and hence space inside the relay case would have been wasted. It was found that a more compact arrangement could be obtained, in which there was negligible waste of space inside the case, if the

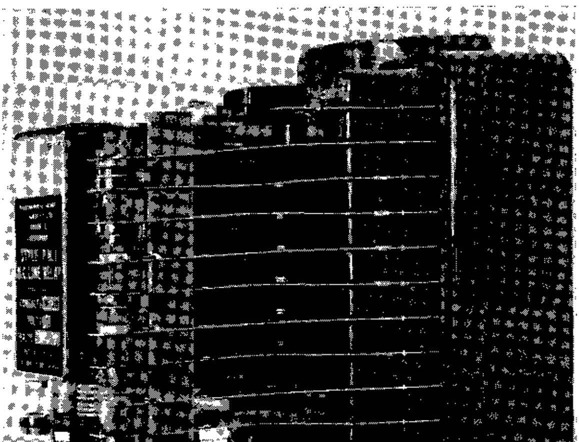

Fig. 4 Photograph of PN1 relay

coil was mounted vertically, and a stack of 5 contacts was placed on each side of it. Had 12 contacts been fitted these would have formed a group, say 4 wide by 3 high, with a width more nearly matching that of the iron circuit, thus the most compact design of a 12 contact relay would probably be achieved with the contact group mounted above or below the iron circuit.

Some further factors to be considered in cost reduction of Signalling Relays

In the foregoing Section a number of factors were dealt with which led to a smaller and therefore cheaper design of relay but we can go further than this in the matter of cost reduction if certain of the requirements of BS.1659 can be eased to reduce the manufacturing time. The principal easements are stated briefly here and will be dealt with in greater detail in a later Section. They are:—

(*a*) The specified difference between the operate and the release voltage is required to be as large as possible so that relays will conform to the figures without special adjustments having to be made during assembly.

(*b*) Relaxation of stringent requirements for alignment of contacts which results in expenditure of appreciable individual adjustment time during manufacture.

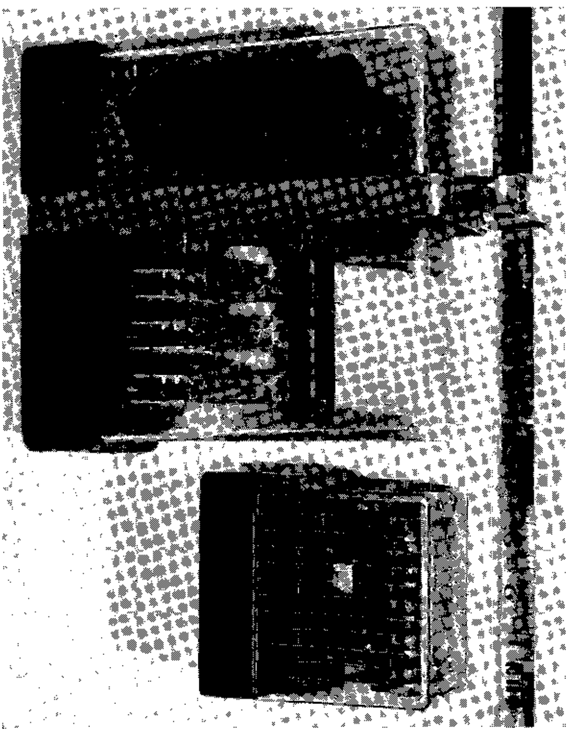

Fig. 5 Photograph showing size comparison of PN1 and BL1B relays

Another significant step to be taken in reducing cost was to change to the use of a contact pair in which at least one of the contacts is domed, this change being made only after considerable life testing had been carried out to prove that the arrangement would be satisfactory. With large-type plug-in and shelf-type relays " line " contacts had been used and appreciable time had been spent during assembly making each contact on a relay substantially light-tight over its length. With domed contacts such a requirement no longer applies.

Another important factor in reducing the cost of relays is the need to manufacture in reasonably large quantities. Fortunately, the Modernisation Plan has resulted in such a large demand for the miniature type relay as to enable modern methods of production to be introduced with a consequent significant reduction in production costs which have at least tended to offset the periodic increases in material and labour costs that have taken place during recent years.

I.R.S.E. Specification for Miniature Relays

The question of miniaturisation and cost reduction of signalling equipment and in particular relays, was first discussed by this Institution at a Meeting on November 19th, 1956 in a general discussion which was opened by Mr. E. A. Rogers. Resulting from this discussion, a Committee was set up by the Council in 1957 to investigate miniaturisation and cost reduction of signalling equipment, and this Committee in turn set up a sub-committee whose duty it was to prepare a specification for a miniature relay. This specification has been completed and is based upon BS.1659 covering conventional relays but there are naturally a number of novel features, the most significant ones being as follows:—

General

The specification covers d.c. neutral line relays of the plug-in type for railway signalling purposes which " may be used for all applications in which the present d.c. neutral line relays covered by BS.1659 (1950) are employed provided that their characteristics are suitable."

The complete assembly is to consist of a relay and of a plugboard into which the relay is plugged.

The Plugboard

The plugboard into which the relay is plugged is to be of the type which provides a separately removable connector for each contact spring and coil connection. This requirement, as already explained, is one of the vital factors in determining the overall size of the relay.

The connectors in the plugboard are to be capable of accommodating two wires each having a maximum overall diameter of 0.110-in. with conductor diameter of 0.044-in.

The design of the plugboard is specified in complete dimensional detail. See fig. 6. The object of this is to ensure that all manufacturers will make precisely the same design of plugboard, and that any relay made by any manufacturer will fit on to any manufacturer's plugboard which happens to be already mounted on the rack.

Contact Materials

Front contacts shall be non-fusible but back contacts may be metal to metal.

Behind this simple statement lies a wealth of discussion and argument. The possibility of using metal to metal front contacts was most thoroughly explored since the use of this type can undoubtedly result in a reduction of the relay cost. It would be unlikely to result in an appreciable reduction in size, since this is largely determined by the size of wire and type of plugboard specified. Metal to metal contacts can weld and many tests were carried out to obtain data on the conditions under which welding may take place. The general conclusion reached was that very heavy currents could be carried when the current was applied after the contact had been closed, without causing them to weld, but that if a contact was closed on to a short-circuit with a 5 amp fuse included in the circuit, then welding could be caused to take place with some degree of regularity. If this occurred in practice the fuse might be replaced without the lineman appreciating that a contact had welded.

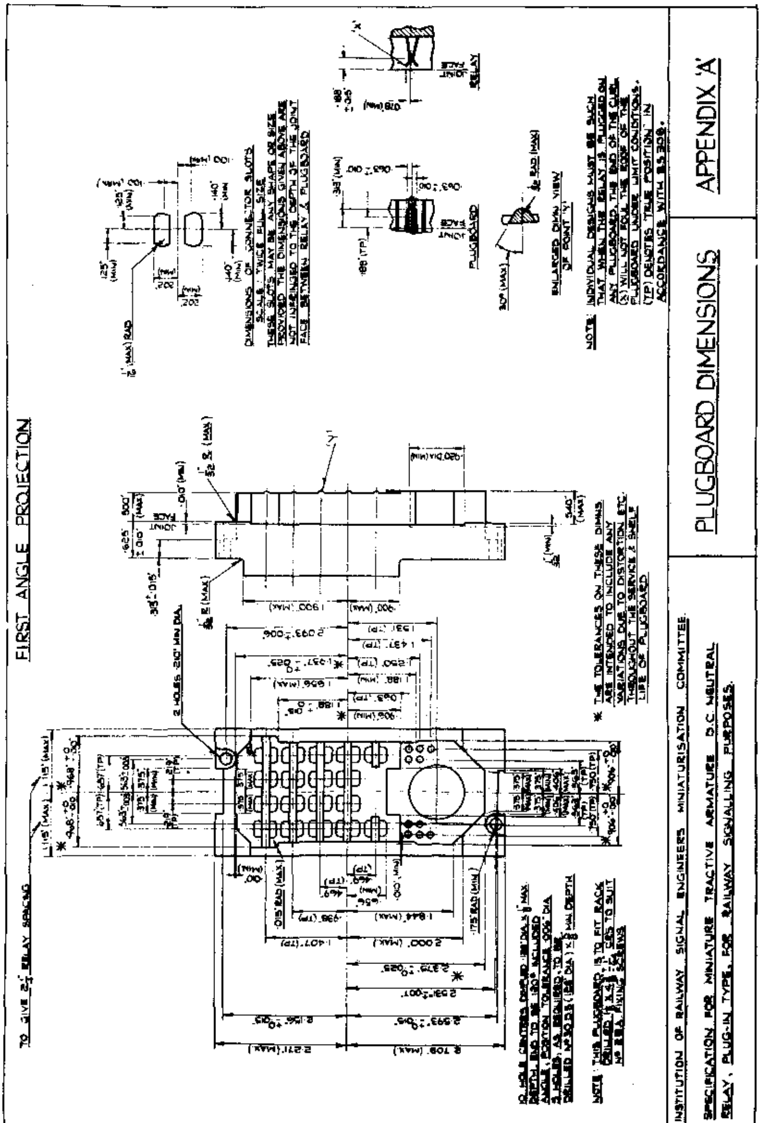

Fig. 6 Drawing of standard Plugboard taken from the Institution of Railway Signal Engineers Specification for Miniature Relays

Although the risk of such welding is relatively slight it was finally decided that non-fusible contacts would be employed, since the risk of welding seemed to outweigh the advantage of a small percentage cost reduction.

The new specification demands that in the event of any back contact remaining permanently closed (e.g. by welding) it shall not be possible for any front contact in the relay to close when the relay is energised at up to 35% in excess of the nominal voltage. This prevents a front and back contact being closed simultaneously thus giving safe but conflicting conditions. It is not easy to make the structure of the relay such as to comply with this requirement if fusible back contacts are used. The simplest answer is to use metal-to-carbon back contacts. In either case the cost of the relay is increased by a small percentage to meet this requirement, the basis of which was introduced into BS.1659 in 1955.

Rated Life and Contact Loading

The relay is to have a rated life of 10^6 cycles where each cycle consists of a pick-up and release operation, when:—

(*a*) Making and breaking a 12 volt circuit having a resistive load with a switch-on surge of 5 amperes, dropping to a maximum steady value of 2 amperes after 100 mS. This arrangement is equivalent to a normal lamp circuit for a S.L. 17 lamp. At the end of 10^6 pick-up and release operations the wear on the contacts must not have permitted the pressures to fall to less than half of the initial minimum value.

With silver to carbon contact combinations it is necessary to ensure that the carbon contact has not worn to such an extent that there is a risk of the silver contact tip engaging with the metallic cup holding the carbon contact and it is, therefore, further stipulated that at the end of the 10^6 operations there shall be a minimum distance of 0.02-in. between the metal element of the contact and the metal support of the associated carbon contact.

(*b*) Each contact is also to be capable of making and breaking for 10^6 operations the current in an unquenched circuit consisting of three parallel connected relays of the type covered by the specification. At the end of this life test the same conditions with regard to wear apply as in (*a*)

It is to be noted that where contact loadings exceed the above then spark quenches must be employed.

Contact Design and Adjustment

(*a*) In each contact pair one of the contacts shall be domed; as already mentioned this reduces adjustment time during manufacture.

(*b*) All similar contacts, i.e. either front or back, shall function approximately simultaneously when the relay is operated or released.

This is an important improvement over BS.1659 which laid down close limits of voltage between which the first and last contacts had to break, and which resulted in the need for accurate and costly adjustment of the contacts to bring them into line. The principal safeguard against a bridging contact in a miniature relay is the requirement that, "when the last back contact is just broken all front contacts must be open by 0.015-in. and vice versa."

Residual Pins

In BS.1659 the actual length of the residual pin is specified, but in the miniature relay specification the requirement is that this residual pin must be so designed that the relay meets the operating requirements through its entire life of 10^6 cycles. For example, the actual release voltage may fall below the specified value if, during a life run, the residual pins become unduly flattened or distorted.

When the length of the residual pin is specified, such as the figure of 0.015-in. in BS.1659, this may be far in excess of what is really necessary for safe operation in an entirely new design of relay. The shorter the residual gap the less is the power required for the movement of the contacts and so, with a given power consumption, a reduction in the residual gap allows a reduction in the size of iron circuit.

Release and Full Operate Voltages

These are defined as follows:—

Release—That condition of the relay when all front contacts have opened.

Full Operate—That condition of the relay when the armature has completed its maximum travel.

A demand for a high value of release voltage results in the need to design a relay with a large air-gap between armature and pole face which in turn raises the ampere-turns and power required to move the contacts so that, once the maximum power consumption is fixed there is less power available for reducing the size of the iron circuit. Furthermore, a high release voltage inevitably means a small difference between release and full operate voltages which in turn will result in the need for individual adjustment to relays during manufacture and hence increased cost.

Relays to BS.1659 have a high release voltage requirement in relation to the voltage required to give 1-oz. contact pressure. Fundamentally this is because the BS Specification originally covered a relay which could be used for track circuits or line circuits at will, merely by changing the coils. A high release value is a desirable feature in a track relay to enable track circuits to be as long as possible for a given train shunt, but for line and cabin circuit relays no similar requirement exists. It is only necessary to be sure that the relay will release when the circuit opens. How then can we settle on a suitable value of release voltage? Have we any experience of a general reduction in release values due to mechanical stickiness developing in service in d.c. relays? If we had, then the initial release value could be chosen to take this reduction into account.

In the absence of any such information another approach to the question had to be found and the matter was resolved in the following manner. It was first imagined that a relay to BS.1659 was energised over a contact of another relay. It was then assumed that a resistive leak had developed across this contact of such a value that, when the contact opened, the voltage across the relay fell only to the release value. With the same value leak resistance in series with our higher powered miniature relay, a corresponding value of voltage across the relay was calculated. For a 50 volt relay the release voltage was thus determined to be 7.5 volts.

The full operate voltage has to compress all the front contacts, each contact having at least 1-oz. pressure. It would take an appreciable time to adjust all contacts to 1-oz. pressure within close limits, and so one must cater for tolerances on this pressure. This is achieved by permitting as high a value of full operate voltage as possible so that even a relay with the majority of contacts having high pressure will meet the specification without special adjustments. For a 50 volt relay the full operate voltage is specified as 40 volts at 20°C. ambient.

The release voltage of the miniature relay is thus approximately 20% of the full operate voltage. We cannot compare this value directly with a line relay to BS.1659, because in that specification we are told that the release voltage must be not less than 60% of the pick-up voltage. This voltage, i.e. the value at which the front contacts just make, is usually also the full operate voltage in miniature relays. The full operate voltage of a BS.1659 relay, i.e. the voltage which gives at least 1-oz. contact pressure, is 50% in excess of the pick-up voltage hence the release voltage will be not less than 40% of the full operate value, so that we have halved this figure for the miniature relay while still retaining a satisfactory margin of safety. With these broad limits of release and full operate voltages the majority of relays will be able to pass test with far less need for the special and costly adjustments which were required for relays to BS.1659.

Rated Voltage

The specification states that relays can be called for to be fitted with a winding for 24 v. operation or alternatively a different winding for 50 v. operation. Due to the large currents which would be taken if voltages lower than 24 were applied it was considered desirable that this value of nominal voltage should be adopted as minimum. Many interlocking circuits have large numbers of contacts in series, and consequently, with the larger currents involved on the miniature relays, voltage drop across the contacts may become a serious factor, and to minimise such difficulties it is recommended that a nominal circuit voltage of 50 should be adopted wherever possible.

Power Consumption

The maximum power consumption is limited to 3 watts at rated voltage at an ambient temperature of 20° C. The specification includes safeguards to ensure that when the coil is continuously energised the temperature, at any point of the winding, shall not exceed the maximum permissible value for the class of insulation which is being used, when the relay is operating at an ambient temperature of 60° C., and at the same time is energised at 20% above its rated voltage.

Double Wound Relays

The relay can be called for by the user to have either a single winding or to have two electrically separate windings, both capable of picking up the relay. In the latter case it must be possible to continuously energise both windings at the same time.

Number of Contacts

The I.R.S.E. relay is to be capable of being fitted with up to 16 contacts which are all to be of the independent type. The relay can be called for to be fitted with only 12 contacts or only 8 contacts; in these latter cases the relay base and cover remain the same size, it merely being a matter of omitting some of the contacts. This arrangement leads to a total of 5 standard contact combinations namely, 12F-4B, 8F-8B, 8F-4B, 6F-6B, 4F-4B. The above arrangement has the disadvantage that, 12 contact and 8 contact relays will be more expensive and occupy more space than would be the case with relays designed specifically for 12 contacts maximum and for 8 contacts maximum. This extra cost was considered to be justified in the interests of standardisation.

An alternative suggestion was made by the Author that the relay should have 10 contacts and that there should only be two arrangements namely, 8F-2B and 6F-4B. The less contact arrangements there are the greater is the reduction of the manufacturer's overhead costs with a resulting reduction of relay costs. There would be less wasted rack space but there might, in a few cases, be more repeater relays required. To have made a completely accurate cost comparison of these two alternatives would have involved more work than was practicable and the 16 contact arrangement prevailed.

Size of Relay

The overall dimensions of the plugboard are shown in fig. 6 and the depth of the relay over handle is 7-in. Fig. 7 shows a 16 contact miniature relay and, to the same scale, it shows the dimensions that a large-size plug-in relay would have assumed if it had been de-

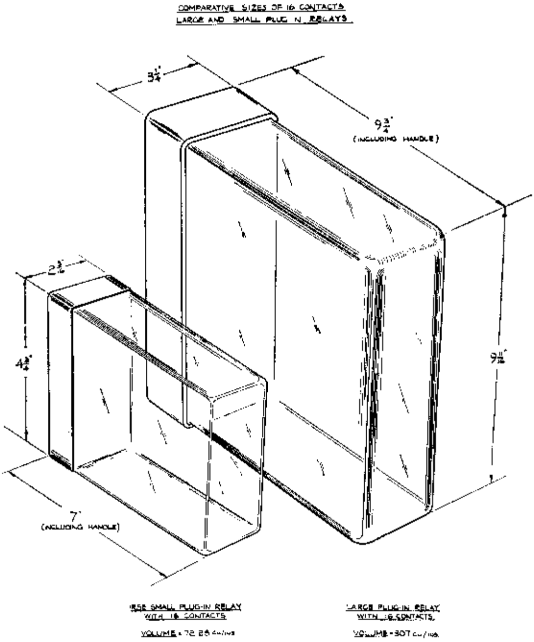

Fig. 7 Drawing showing a comparison of size between a 16 contact large size plug-in relay, and a 16 contact miniature relay, designed to the miniature relay specification

signed for 16 contacts; thus the two designs are strictly comparable.

Further Varieties of Miniature Relays

In an earlier Section the development of the Style PN1 neutral relay was described and it is now proposed to refer to some further types of relay which have been derived from the PN1. A feature of these relays is that they employ the same size of mounting base as the basic PN1, and the same plugboard, while many of the internal components are identical. In some cases the relays and plugboards are twice the size of the PN1 and can, therefore, be accommodated with standard drilling on relay racks in the place of two single width relays.

Slow Release Relay

The neutral PN1 relay is essentially a fast operating relay and to obtain a release lag it is necessary to increase the inductance of the iron circuit by providing two cores, two coils and copper slugs and this arrangement is shown in fig. 8. The release lag at minimum supply voltage is 170 milliseconds.

Slow Pick-up Relay

As shown in fig. 9, this is a double width relay and to obtain a pick-up lag of 600 milliseconds at rated volts it is necessary to have an even more inductive iron circuit than for the slow release relay and this accounts for the change to a double size base.

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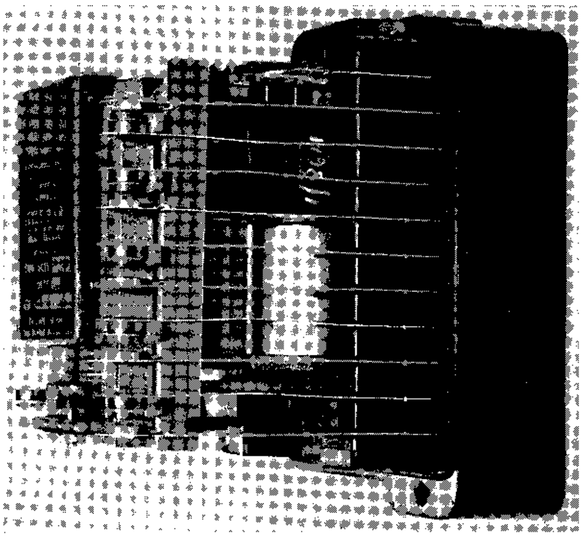


Fig. 8 Photograph of Slow Release Relay (PSR1)

Slow pick-up relays may be used as track relay repeaters to cover the unprotected period between the pick-up of a track relay when a track circuit is vacated and the drop-away of the track relay of an adjacent track circuit, when the two track circuits are traversed by a short wheel base vehicle. In such cases it is not so much the actual length of the pick-up lag which is important, but the difference between the pick-up and release lags, and this relay has been designed to make this difference as large as possible, the release lag having a maximum value of 150 mS.

Magnetically Latched Interlocking Relay

This type of relay is extensively employed in certain Route Interlocking systems and consists of two identical mechanisms mounted side by side on a double width base. In each mechanism the armature can be retained in either of two positions; the de-energised position in which it is held by gravity and return springs, and the energised position in which it is held by a permanent magnet.

Fig. 10A shows a side view of one mechanism with the armature shown in the position to which it has been operated by energisation of the main coil on the left-hand side. This coil can be de-energised and the armature will be retained in position by flux from the permanent magnet which passes through the core of one unlatching coil, across the armature and back via the second unlatching coil. In fig. 10B, the left-hand armature is shown energised and held in position by the permanent magnet, while the right-hand armature is de-energised. There is an interlocking arm between the two armatures which ensures that if the right-hand armature is by some means forced up-

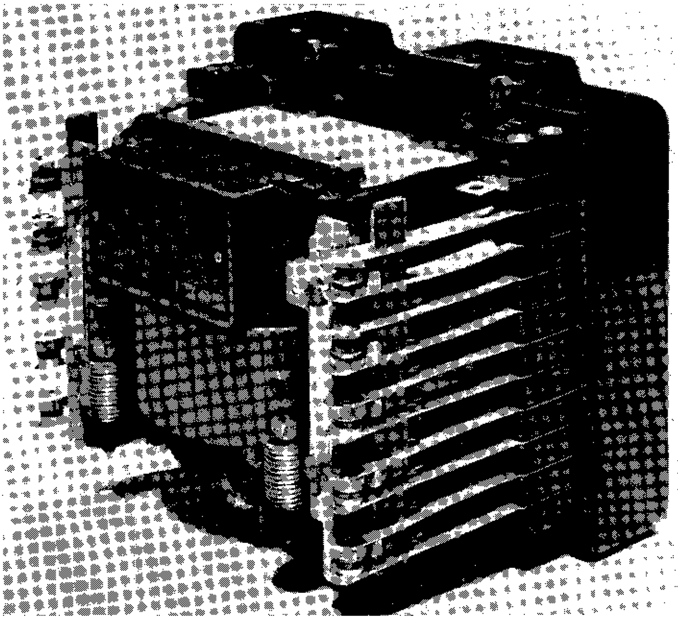


Fig. 9 Photograph of Slow Pick-up Relay Style (PSPI)

wards, then the left-hand armature will be forced to the de-energised position.

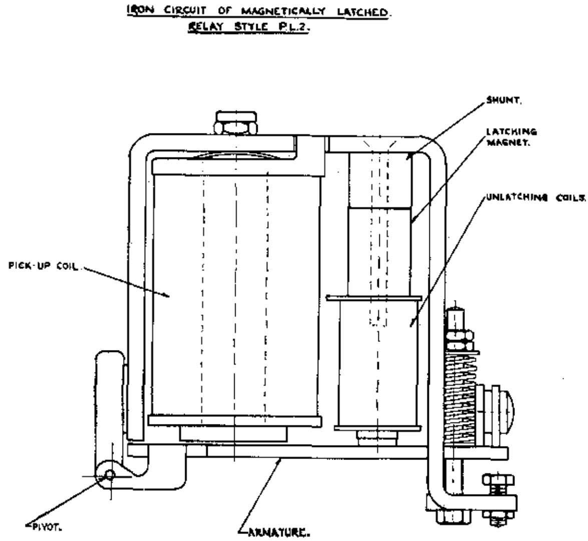
During normal operation the relay is reversed by first of all unlatching the left-hand winding which is done by energising the two unlatching windings which neutralises the effect of the permanent magnet flux, thus causing the armature to release so that the right-hand armature can pick-up when the operating coil for this side is energised. Fig. 11 shows a relay of this type.

A.C. Immune Neutral Relay

Fig. 12 shows an a.c. immune, d.c. line relay of the single width size. This relay will not operate on a.c. voltages of at least up to 2,000 volts 50 cycles. The principles of immunisation of d.c. relays were thoroughly explained in Mr. Sweetenham's paper on, "Signalling Equipment on 50 cycles Electrified Lines," read to the Institution on October 14th, 1959, and will, therefore, not be discussed further here.

Biased-Neutral Relay

The term biased-neutral means that the relay can pick-up on current of both polarities like a neutral relay, but it is biased so that it needs a much larger reverse current for operation than it does current of normal polarity. For example, a relay which operates with 50 v. at normal polarity would require at least 2,500 v. to operate it with the supply voltage reversed. Relays are usually given this biasing feature by the addition of a



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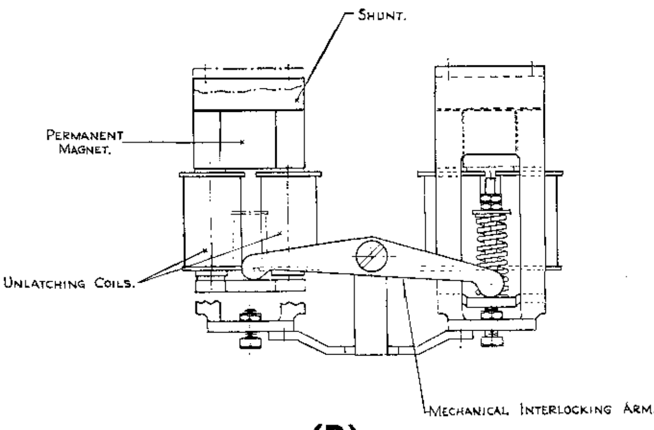

(B)

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Fig. 10 Drawing of views of the latched relay Style (PL2)

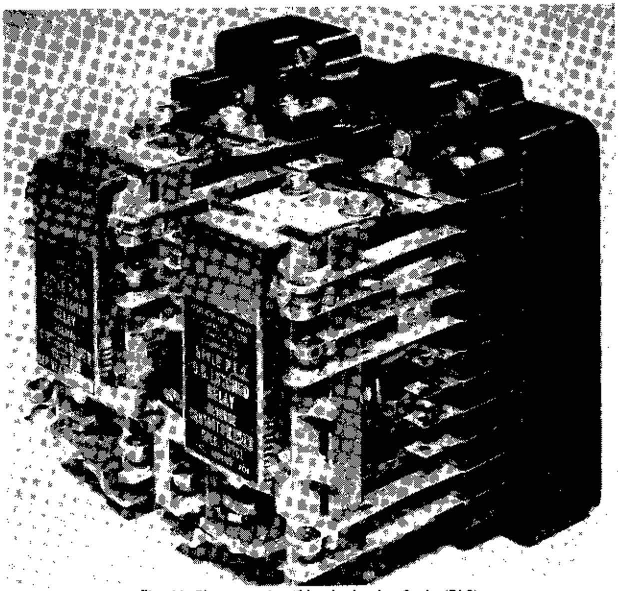

Fig. 11 Photographs of latched relay Style (PL2)

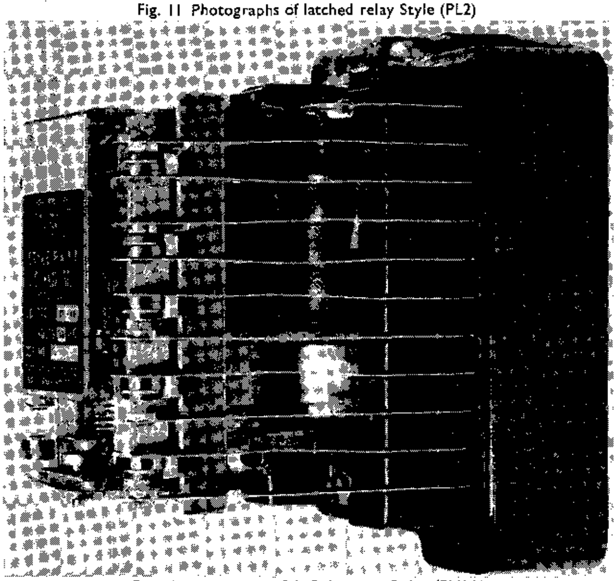

Fig. 12 Photograph of A.C. Immune Relay (PN1A)

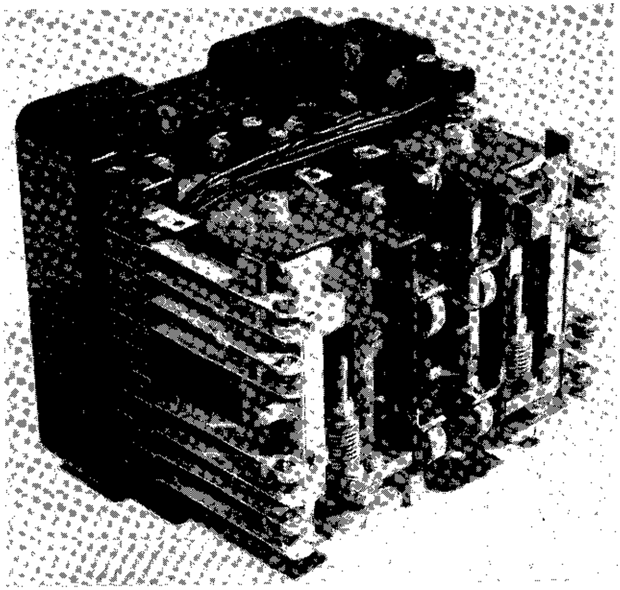

Fig. 13 Photograph of Polarised Point Contactor Relay (PPWR1)

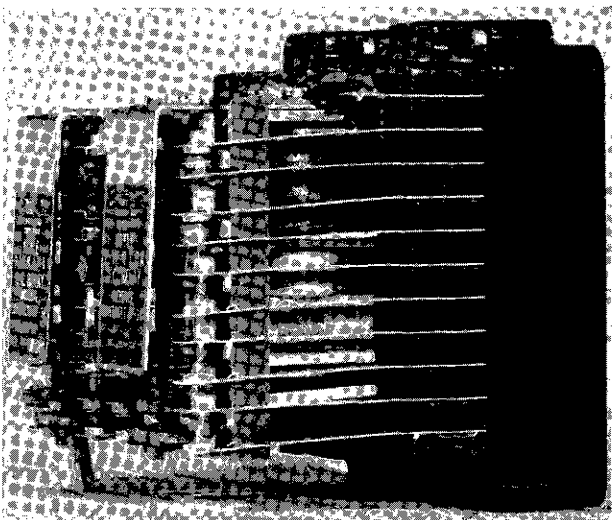

Fig. 14 Photograph of Polarised Three-Position Relay (PWK1BA)

permanent magnet suitably located in the iron circuit. It is a requirement of the design that if the permanent magnet loses its magnetism the relay must be incapable of picking-up with current of either polarity. Such a precaution is necessary since the relay may be used in circuits where reliance is placed on the relay not picking-up when a reverse voltage of normal value is applied.

Two mechanisms of this type when connected in parallel and oppositely poled form a polarised relay in which one mechanism will be operated by current of one polarity, the second mechanism by current of reserve polarity and, with the circuit opened, both mechanisms will be released.

Polarised Point Contactor Relay

Fig. 13 shows a polarised point contactor relay which consists of two biased mechanisms mounted on a double width base and connected as described in the foregoing paragraph: "Biased-Neutral Relay." The mechanisms are provided with heavy duty contacts capable of interrupting the stalled current of a d.c. point machine, although of course they are only called upon to do this under fault conditions. This type of relay may also be made a.c. immune.

Polarised Three-Position Relay

Fig. 14 shows a three position d.c. polarised relay which can be used for purposes such as point indication. This design is also based on the use of two mechanisms, as described in the foregoing paragraph: "Biased-Neutral Relay" and it can also be made a.c. immune

Fig. 15 Relay Room with large and small plug-in Relays

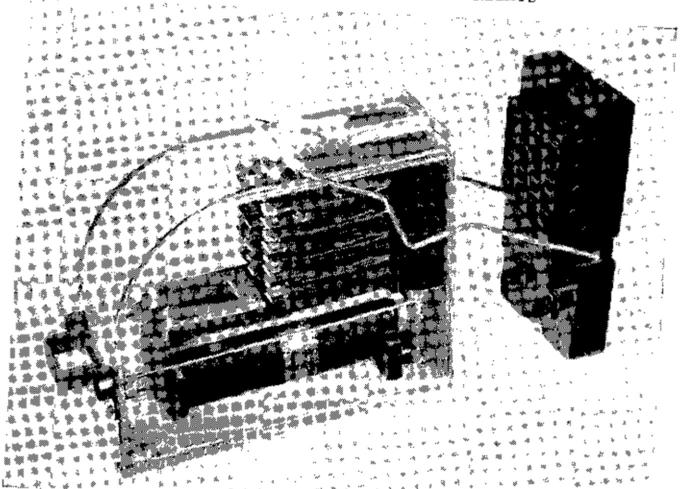

Fig. 16 AEI-GRS Style AS Neutral Relay

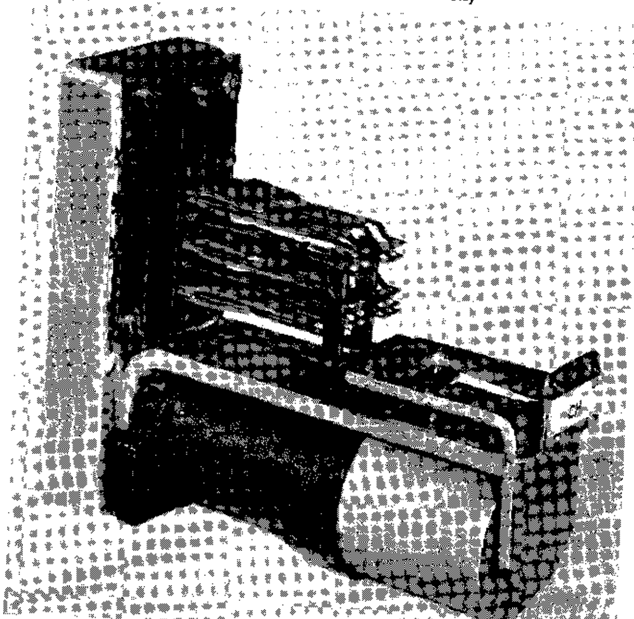

Fig. 17 Immunised AEI-GRS Miniature Relay type A1

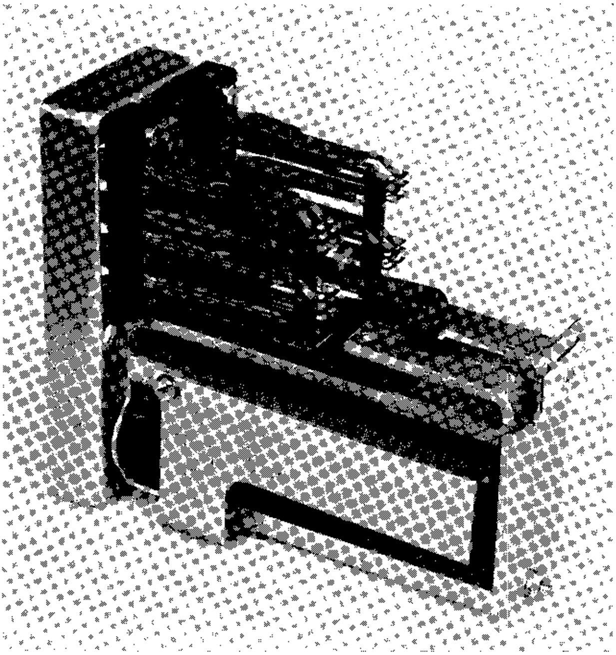

Fig. 18 AEI-GRS Magstick Miniature Type A1

Some other Designs of Miniature Relays

Fig. 16 shows the AEI-GRS type AS Neutral Relay complete with plugboard. This relay like the W.B. & S. Co. Style PN1, was designed prior to the publication of the I.R.S.E. Specification. It is approximately the same size as the Specification relay. Fig. 17 shows an Immunised AEI-GRS Miniature Relay type A1, and fig. 18 shows the AEI-GRS Magstick Miniature type A1.

Fig. 19 shows the S.G.E. Miniature Neutral Relay and fig. 20 the same relay enclosed in its cover. Fig. 21 shows the relay attached to its plugboard with a tree of wires coming away from the board. This view also shows the retaining device which will be attached to all plugboards for holding the relay in position. To remove a relay the retaining device is pushed to one side pivoting about its fixing on the plugboard. The plugboard is shown in fig. 22, this board having been manufactured to the I.R.S.E. requirements shown in fig. 6, while fig. 23 is a rear view of the relay showing how the connections from the contact springs project out at the rear to act as plugs when the relay is engaged with the plugboard. This relay can be fitted with up to 16 contacts as required by the I.R.S.E. Specification, and a particular feature is that the armature and the frame are both castings, produced in high grade magnetic materials by a special process, the frame also serving as a magnetic return circuit; this eliminates bending and forging processes within the magnetic circuit.

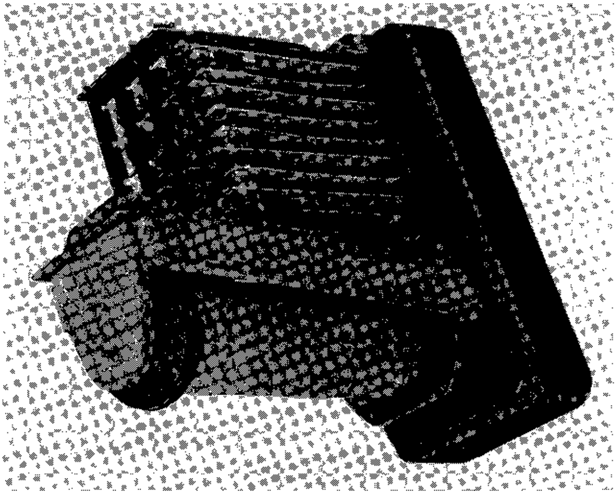

Fig. 19 S.G.E.Co. Miniature Neutral Relay

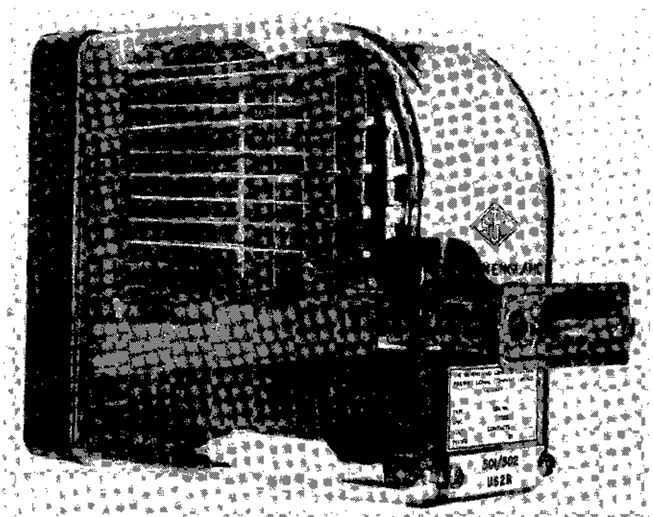

Fig. 20 S.G.E.Co. Miniature Neutral Relay with cover

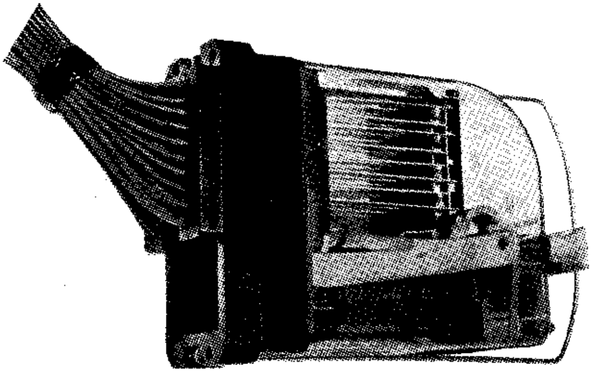

Fig. 21 S.G.E.Co. Miniature Neutral Relay rear view with Plugboard

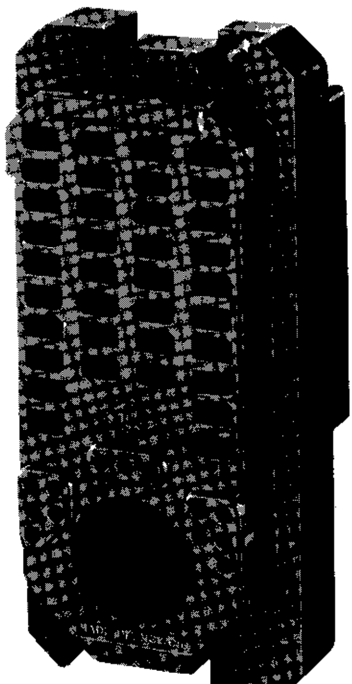

Fig. 22 Plugboard for S.G.E.Co. Miniature Neutral Relay

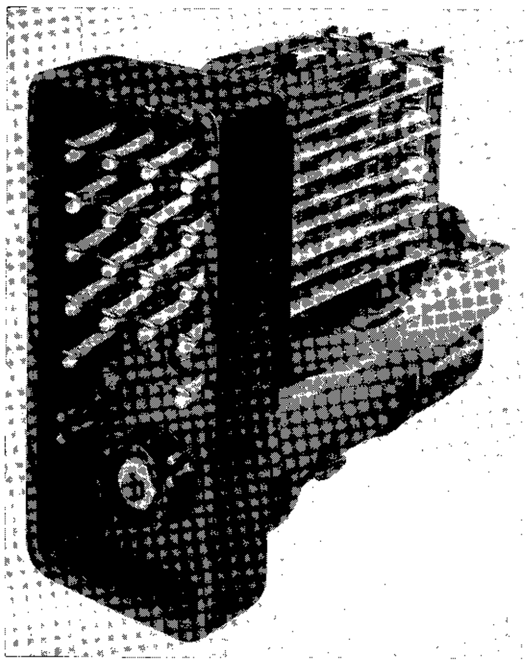

Fig. 23 Rear view of S.G.E.Co Miniature Neutral Relay

In the same range as this S.G.E. Neutral Miniature Relay there will be Immunised, Slow-Acting, Double Wound, Magnetically Latched, Magnetic Stick and Neutral Polar Relays, etc.

Acknowledgments

The author wishes to thank the Westinghouse Brake and Signal Company for granting permission to publish this Paper and to thank The Associated Electrical Industries—General Railway Signal Company and The Siemens and General Electrical Railway Signal Company for the information and photographs contained in an earlier Section, and finally he wishes to thank his many colleagues who have rendered so much assistance in the preparation of the Paper.

DISCUSSION

Mr. Rogers. I should like first to thank Mr. Coley for a very informative paper presented at a most appropriate time. The task of making fundamental changes to the established and classical design of signalling relays is one that must be approached with great caution, since the phenomenal record of safety and reliability which the older type of relay has achieved is one that is envied by many other engineers. However, relays are being used increasingly in circumstances much less onerous than those for which the original specifications were framed and, as part of the drive to reduce signalling costs, a smaller and cheaper relay has become very desirable.

Further, it is now public knowledge that a system of solid state switching for safety circuits has reached a stage when an operational trial is to be undertaken. The comparative costs of the two systems cannot yet be assessed but it is clear that, for the first time, the relay is faced with direct competition in vital circuits and, if the comparative simplicity and flexibility of relay circuitry is to be retained, the relays themselves must be competitive in cost and size.

As Mr. Coley has indicated, the I.R.S.E. Specification has been completed and is now under consideration for formal adoption by the British Transport Commission. The paper has given a most instructive survey of the main features of the specification and I would particularly draw your attention to the section dealing with operating voltages. The author has indicated the factors governing the choice of values and it should be noted that the minimum release voltage in proportion to the nominal circuit voltage is very little different from that permitted under B.S. 1659. Here, for instance, a 1,000 ohm relay used on a 12 v. circuit was permitted a release value of 50% of the minimum pick-up voltage, this often being as low as 4 volts.

The requirement in the new specification that no front contact should "make" if any one of the back contacts became welded arose from the wider latitude now permitted in the alignment of contacts and is a necessary proviso in a safety type relay.

The number of contacts to be provided proved, as the author states, to be highly controversial and the final decision catered for a very flexible arrangement while using only two basic contact pile-ups.

Although the adoption of the new specification will mean the abandonment of one or two very excellent miniature relays that are already in production it is hoped that, in the long run, complete standardisation will confer compensating benefits.

Mr. Kubale. Mr. President and Gentlemen, in thanking Mr. Coley for his excellent paper I would say that he has made the question of relay design appear very simple, and looking at some of the so-called miniature relays one might think that the relay designers have not gone as far as they could have done in miniaturising them. Many of us have seen relays very much smaller than what is today considered a miniature relay for railway signalling purposes. Mr. Coley has explained the basic reasons which led to the present design and has shown that in regard to considerations of safety, contact openings and clearances, all of which have a bearing on the overall size of the relay, these features are very much the same in the miniature relay as they are in some of the present larger types of plug-in relays, thus maintaining the same degree of security with the new relay as with the former types.

I wish to support Mr. Coley's remarks regarding the testing and setting of relays at currents which will just allow the energised contacts to make and again at currents which just prevent these contacts from breaking. These conditions are not experienced in normal operation and I believe that their use originated in order to obtain a measure of the condition of the relay as affected by frictional forces and the retentivity of the magnetic circuit.

The adjustment of relays using such measurements is a costly item in their manufacture and would seem to have little practical result at the present time when relays can be made to have the energised contacts make at a relay current which also develops full contact pressure. This is not a new solution and is one which manufacturers have been endeavouring to have adopted for a considerable time.

In view of what Mr. Rogers has just said about the possible competing alternatives to electro magnetic relays I wonder whether in a few years time the Miniaturisation Committee will be told that the factors of safety to which they have designed relays today are too generous and thereby demanding relays much smaller than can be allowed at present.

Some of Mr. Coley's illustrations show how the question of wiring to the relays is associated with the miniaturisation of the relay and it is found that the wiring must also be made smaller to accommodate a larger number of wires connected to a relay plugboard which is considerably smaller than has previously been used.

I must pay tribute to the work of the

Miniaturisation Committee, as Chairman of which my relatively easy task was to gather the people together and to set them to work. The Committee produced the specifications and Mr. Coley has explained very well indeed what has been done. He did not tell us how difficult it was for a committee consisting of representatives of three manufacturers and several railways, all with different views, to come to agreement, and I think it was a major step forward firstly to agree on the design of the plugboard and afterwards to complete the technical specification of the relay. Nevertheless the specification has been completed and issued, and I think it is to the credit both of the Council of the Institution that they acted upon the suggestion of one of the Institution's Members and formed the committee and also to the Members of the committee that the specification has been completed, and I feel that Members of the Institution should consider with satisfaction that the Council has seen fit to embark on that important work which may lead the way to similar activities in the future.

Mr. Shipp. In reading this paper, and looking at the many illustrations it contains and particularly at the array of relays which the Author has brought for us to see tonight, I feel one cannot help being impressed by the fact that even before the new specification is issued, the signal industry has produced not only a miniature DC neutral relay but a range of variants of it, and when we look at those displayed we see how uniform they are.

The first of these to be produced was the basic neutral relay, and then to meet the many other functional requirements we see there has been evolved from it a wide variety all of the same height and depth, and varying only in regard to their width. We see there are but two widths, one being exactly double the other, so permitting a common mounting rack to be used with a uniform drilling of fixing holes.

I feel that this uniformity in size could not have been secured unless much forethought had been given in the first basic design to all the possible ways in which it would need to be adapted subsequently to provide a complete range of relays required in modern signalling installations.

Mr. Coley has made a point in his paper that in the new specification, the plugboard has been fully designed to achieve interchangeability between relays from different manufacturers, and he has said this evening that that does circumscribe the design of the relay itself.

I would like to ask Mr. Coley whether in the preparation of the new specification, which covers a neutral relay only and no variation of it, a corresponding degree of forethought has been given to the basic design to permit it being adapted equally well to provide a range corresponding to those he has on display with comparable uniformity to permit a common rack to be used for all types.

Mr. Ryan. In the case of the original plug-in relay, one of the features that was greatly desired was the biasing feature. It was considered imperative that we should have this on the plug-in relay, but when we have gone over to miniature relays, the biasing is left out. Why has the Council and their Committee dropped this biasing feature? If it was so vital, why have we departed from it in the actual miniature relays?

I am interested in the standardisation, but I notice in the pictures of the standard base, there was very little room for the interlocking—so that you cannot put a wrong relay on a base—the space is very small. Can we reduce in the standardisation, the number of interlocking requirements? Is it vitally wrong if you put a 50 volt relay into a 24 volt plugboard? Is it so greatly vital that you must get interlocking because it seems very remote that you would have the particular relay of 50 volts when you have a 24 volt system. So it doesn't seem really necessary to have a big variety of interlocking pins and so on. It is a difficult factor for the manufacturers to ensure that interlocking arrangements are always correct.

Mr. Openshaw. I would like to be associated with previous speakers in congratulating Mr. Coley on his most interesting paper.

Concerning point contractor relays, he stated in the paper that the heavy-duty contacts are capable of carrying the stalled current of a d.c. point machine, and earlier he said that this relay is designed on the basis of a wire of 0.110-in. diameter.

It seems to me that a wire of this type is insufficient for carrying a current of that magnitude, and I would like to ask Mr. Coley what type of wire he considers suitable for this purpose?

Mr. Cardani. Mr. President, Gentlemen, would Mr. Coley please add to his already valuable paper, by giving us the benefits of his thoughts on how relay design is affected by the variations that the relay will be subject to in service.

I also think he asked whether we could not abandon the requirement that if a back contact becomes welded, then the front ones should not close, because he hinted that it would be a safety-side failure. I rather think that one reason against it is that it would restrict the flexibility to mesh circuits. I think we should have to look very carefully for possible sneak feeds, and that could perhaps lead us to a lot of duplication of contacts.

Lastly, I would like to say that I am quite sure that this paper is a most valuable one, particularly for our Student Members. It is an admirable paper in that respect.

Mr. Tyler. Mr. President and Gentlemen, I am rather interested in a remark made by Mr. Shipp regarding the series of relays which had previously been designed by Mr. Coley prior to the drafting of the I.R.S.E. specification. I think that for the record I should mention that these relays were designed as a result of pressure from the users, which culminated in a certain Presidential Address several years ago. This was followed afterwards by the discussion opened by Mr. Rogers which resulted in the I.R.S.E. specification.

I feel that the users should take a little credit for the manufacturers designing miniature relays.

I would like to know from Mr. Coley whether he considers the remaining types of relay which are necessary for a signalling system, can be designed without much further work on specifications. We have now, a standard specification for a line relay. It will be necessary to provide other specifications for the other types of relay which are required.

I would like to know whether Mr. Coley considers this to be a particularly involved matter and whether it will take a great deal of time.

There was one comment on design about which I would be rather interested to have Mr. Coley's views.

I noticed on the magnetic latch relay, the core of the main coil was very much nearer to the fulcrum that the original relay, because it was necessary to allow room for the permanent magnet. Does that have much effect on the operating characteristics of the relay?

Another point—and this particular comment shows a little of the discussion which went on in the Committee—is that Mr. Coley has not quite been convinced about the number of contacts. When the number of contacts came to be settled, it was necessary to consider all signalling systems because it is not only one firm's system which is going to be used with the relay. I believe I am right in saying that after taking a very detailed analysis of a number of different circuits, it was found that the 16 contacts was the right number.

Another matter which was discussed: was the question of silver to silver contacts and welding. I know Mr. Coley carried out some tests which prove conclusively that it was possible to weld two silver contacts. He also proved that it was possible to weld a double-break silver contact.

I would like to hear from Mr. Coley whether as a result it could be said that Continental signalling was unsafe because relays using that type of contact are usual in the continent, also if we could bring ourselves to accept a metal to metal contact, would not the cost of relays be materially decreased?

Mr. Langley. I would like to ask Mr. Coley why no provision has been made for opening the circuit, as has been done on some previous designs of relays?

It does seem now that if it is necessary for any reason to test the relay, one has to withdraw a contact and there does seem to be a risk of damaging the tag and possibly causing a short circuit between two contacts.

I was interested also to see the introduction of a spring and I would like to ask Mr. Coley what would be the effect of a broken spring.

With regard to the reduction from 50 volts to 7.5 volts mentioned, if it will hold up at 7.5 volts, are we not actually introducing a reduction of safety here? One could imagine, I regret to say, a possible false feed on the circuit so that when the relay should be de-energised, it would still be maintained by a false feed of 7.5 volts.

With regard to the protection against welding of back contacts, it does seem that if we were to omit this requirement, we would have to increase the circuit proving, and it may be that a reduction of cost in this respect would be balanced out by an increase in cost of proving.

Reference has also been made to the wiring to the base of the relay, and mention has been made of soldering, but of course, although tags are used, they themselves have to be soldered to the wire or crimped. Now presumably that is the choice which the engineer has to make—whether to have them soldered or crimped, and furthermore, if he does have them crimped, it does seem that there is a call for some measure of standardisation in the type of crimping that is employed.

Mr. Riddle. I would like to add to what previous speakers have said in praise of Mr. Coley's paper. To me it ranks as one of the most carefully thought-out works which we have had before us for a long time, and it will remain as a valuable means of reference for the future. There is one aspect of this matter of relay miniaturisation which has not been touched on this evening, either in the paper or the discussion. This is the matter of heating problems which might conceivably arise now that we have the possibility of packing together many more relays in a given space on the relay rack, with each relay taking some five to ten times the electrical energy of the older and larger relays. If the fullest advantage could be taken of the rduced dimensions of the new standard miniature relay to mount them side by side, row upon row, all touching, a temperature rise might occur towards the middle of the group which is rather higher than we are used to in railway signalling circles. Actually the condition has not yet arisen so far as I am aware because the separate rows of relays have had to be spaced sufficiently to give room and access to the large number of wires which issue from the rear of the plugboards. Any information which Mr. Coley can give on this aspect of the subject would be welcomed.

Mr. J. E. Candler (*communicated*). Fashions occur not only in clothes and car styling but even in engineering, and electronics are now very much in fashion.

It is important for we engineers engaged in signalling to keep alive to new developments, but it is equally important to keep a true sense of proportion in applying new and older techniques.

Mr. Coley's excellent paper is about a wide new range of relays which, from one line, can control up to 16 circuits with ample inherent safety and robustness, both mechanical and electrical. These relays can go straight into established signalling circuits and survive reliably without additional protection, and they are cheaper than their predecessors.

There is not yet even in sight an electronic equivalent to relays having all these qualities.

Otherwise, would this Institution have worked on a Relay Specification, and would canny manufacturers have sunk so much time and money in plant to produce modern relays?

Electronics are "wizard" for controls and computing, but useless without something more mundane to do their bidding, just as our bodies have brains which, if not electronic, are at least electrochemical, but still need limbs and hands to make them effective.

I am not alone in trying to emphasise that electro-mechanics must not be neglected. In the current I.E.E. Journal for November, the first article, on page 626, deals with the concern of our Universities "*to correct* the unbalance of student interest, which has recently been predominant in electronics".

What is Mr. Coley's experience regarding views expressed above, and would he agree that more signalling people could very well show a technical interest in the apparatus they use, other than when occasionally it lets them down, perhaps through overwork!

Mr. L. J. M. Knotts (*communicated*). The work done by Mr. Coley in relay design is well known and the first prototype "miniature" relay was shown to me in Scotland where it was given due consideration and subsequently approved for use there where it has since been installed in considerable numbers. I would like to acknowledge the detailed work put in on the development of miniature relays by the various manufacturers and there are now a large number in use in Scotland and elsewhere on British Railways. There is no reason to doubt that they will prove as reliable in service as their predecessors and while no doubt the next decade will see new techniques in which electronic development will become the order of the day as an inevitable evolutionary development, the work put in on the design of the new relays is, as I see it, an extremely helpful step in assessing still further the potentialities and designs of devices which will in certain directions eventually supersede them since a number of factors as set before us by Mr. Coley relating to performance characteristics such as contact tolerances, current carrying capacity, heating and maintenance considerations are all relevant to development generally in this field.

The Author's Reply:

Mr. Rogers, Mr. Candler and Mr. Knotts all refer to the use of electronic devices which provide circuit switching without contacts or other moving parts. Mr. Candler draws attention to the fact that electronics have become very fashionable these days, which is perfectly true, but it does not necessarily follow that these electronic devices are going to sweep relays away in the next few years, because I feel that it is not a foregone conclusion that it will be cheaper to use the electronic devices in place of relays.

Mr. Kubale draws attention to the fact that the new miniature relay is not as small as it is possible to make a relay, and I would like to confirm that in my view his remarks, to the effect that the factor of safety of the new miniature relay is not appreciably below that of relays which have been in use for many years, are correct and largely accounts for the relays still being relatively large, Mr. Kubale draws attention to the difficulties that the Committee must have met in drawing up this specification. It is true that it was a very large task to undertake, especially the provision of the fully detailed standard plugboard. In order to achieve this plugboard all three manufacturers had to have designed and developed to quite a high degree, the relays which they were going to fit on to this plugboard, because once the plugboard is settled then the base of the relay is settled within very narrow limits, and the internal design of the relays is also prescribed to a very large extent. The manufacturers had to do this relay development work while the specification was being prepared, thus a certain amount of anticipation of final requirements of the specification had to be done and sometimes steps had to be retraced, when a wrong guess as to what these requirements would be had been made. Although the specification has taken some years to produce, when one bears in mind that a completely new type of relay has been developed in the process and that a high degree of co-ordination between three manufacturers has been achieved, then I feel that the time factor has not been unreasonable. We were very fortunate indeed to have Mr. J. F. H. Tyler as our Chairman, who was succeeded in the latter stages by Mr. E. A. Rogers; these gentlemen did an amazingly good job in welding everybody together to produce this specification.

Mr. Kubale said that the Institution might be proud of this specification that has been produced and I think it is interesting to note that in fact, the last time the Institution did anything like this was in 1924, when a Committee decided that 3- and 4-aspect colourlight signalling should be the standard for this country.

Mr. Shipp asks whether in preparing the I.R.S.E. Specification any forethought has been put into the design of the basic neutral relay to enable it to be adapted to provide all the other types which are required to make up a complete range. Now to design a complete range of relays takes a matter of years and obviously to achieve the very best design of basic relay you design the whole range before finally deciding on the detailed design of your basic relay. The time to work on this ideal basis was simply not available so that a compromise had to be reached. The manufacturers were able to draw on their knowledge gained from having already designed some relays of a miniature range. With this knowledge the relay designer was able to design a relay to the new specification, bearing in mind what the future requirements were going to be and at least having some idea of how he thought he would be able to achieve those requirements. Perhaps in some instances carrying out some preliminary tests to see whether those basic ideas showed sufficient promise to indicate that eventual success could be achieved. I do not anticipate any serious difficulty in achieving a range of relays based on this neutral relay specification.

Mr. Ryan asks why the biasing feature has been omitted on the miniature relay. Certain of the large size plug-in relays were provided with biasing magnets which had two advantages; first of all it provided a means of holding the armature down to compress the back contacts and secondly, by putting two relays of this type in parallel and oppositely connected as described in the paper, it was possible to provide a 3-position polarised relay. Experience showed that in the first place the cost of adding the permanent magnet was appreciably in excess of the cost of a return spring, and secondly, that relatively few of the mechanisms were used in the form of 3-position polarised relays, hence it was considered more practical to use a return spring for the standard relay and the range will be extended to include a biased mechanism which will be used in polarised relays.

With regard to the question of interlocking, Mr. Ryan suggests that it is not necessary to interlock relays of different voltages, but in view of the fact that if a 24 v. relay is plugged into a 50 v. system, serious damage can be done to the windings, such interlocking seems to be desirable. In the case of plugging a 50 v. into a 24 v. supply, the relay would not operate and perhaps appreciable time might be wasted before the lineman realised why it was not operating, whereas if it is interlocked in the first place, possible serious delays may be avoided. Mr. Openshaw raised the question as to how we deal with point machine currents, since wires of only 0.110-in. diameter are too small; the answer to this question is that the neutral relay will not be carrying point machine motor currents over its contacts. The point must be borne in mind, however, when the specification for point control contactors is being considered; point motor currents may have to be taken over two connectors in parallel.

Mr. Cardani raises the question of the vibration that the relay will be subjected to in service, and queries the effect of this upon the design. Speaking of miniature relays which have already been designed prior to the introduction of the new specification, it is true to say that no special steps in the design have had to be taken to overcome any vibration difficulties, but the design has been checked by submitting it to vibrational and impact tests. The new specification has a clause in it which will stipulate the tests which must be applied for type-approval in the future. With regard to vibration and impacts during transport, it is of interest to point out that miniature relays have much lighter and smaller moving parts than their large-size predecessors which, therefore, appreciably reduces the risk of troubles in transport. On occasions, with the old shelf-type relays, almost incredible things have happened to relays during transport, but with miniatures, although we have despatched from our works in two years almost as many of these as the number of shelf-type relays despatched in the previous 30 years, we have had no trouble whatsoever due to transport.

As Mr. Tyler says the credit for the introduction of miniature relays goes principally to the users. Although perhaps, the manufacturers might claim that, until the users started to question the appropriateness of the existing B.S. Specifications, the manufacturers were restricted to designing to those specifications.

On the question of the time which will be required for producing specifications for more relays in the range, I feel that in several months it should be possible to prepare specifications for a further three of four types of commonly used relays such as slow pick-up, slow release, a.c. immune, etc. Basically these relays will have to comply to the existing specification, but a few requirements will have to be added according to the purpose of the relay. For example, in the case of the slow release relay, the time lag must be determined; this must be long enough to bridge the open time of contacts on all manufacturers' relays when measured under the worst conditions. The open time is the period between the opening of the back contacts and the closing of the front contacts, and is longest when a relay is picking up when that relay is only just energised at its minimum voltage.

Mr. Tyler was quite correct in observing that on the magnetically latched relay the core of the main coil was very much nearer to the fulcrum than with the basic neutral relay. Moving the core in this way does slightly reduce the efficiency of the main iron circuit, but the increase in power consumption due to this is not serious. This is a good example of the point raised by Mr. Shipp, regarding the effect of other relays in the range upon the basic design. Thus the basic design of the neutral relay had to be large enough so that the core could be moved back in the way shown on the latched relay to accommodate the permanent magnet and the release windings. Mr. Tyler asked whether continental signalling systems are unsafe because they use silver-to-silver contacts. The answer to this is, no; but there are certain very special reasons for this negative answer. In the first place on the continent they use a relay of special design which has a very long stroke for the armature and which is so arranged that if a contact does weld, the whole mechanism must hang in an intermediate position with one of the other contacts closed. Thus if the relay is energised and a contact becomes welded, and then the relay is released, one of the back contacts will close. This fact is made use of in the circuit design because every relay is proved released before the next stage in the sequence of operations can be commenced. This means that a considerable number of back contacts is needed and that the circuits become very complicated. From the point of view of economics, I very much doubt whether in the long run the continental system is any cheaper than the simple relays and circuits used in this country. Mr. Langley is concerned about the disappearance of the test contact, and I can only advise him that it was left out because it did not seem to be economically justified. It makes the relay larger and therefore, more expensive, and there is the cost of the contact itself on top of that. Circuits can be opened relatively easily by extracting the removable connectors. A number of installations using relays without test contacts have been brought into service during the past 18 months, and no difficulties have been experienced. Mr. Langley felt that there was a risk of a false feed of 7.5 v. getting on to the relay and holding it energised when it should be released, but surely the same remark can be made to whatever voltage one selects as being the minimum for drop away. As Mr. Rogers points out in his remarks, the old shelf-type 12 v. relays could be held energised by a 2 v. false feed. 2 v. is 1/6th of the supply voltage in that case and 7.5 v. is approximately the same fraction of a 50 v. supply.

The effect of breakage of the return spring is that the back contacts will not be fully closed. Under these conditions the moving springs on the relay will force the armature down to the stage where there is no pressure left on the front contacts, and then the weight of the armature will open the front contacts.

The specification and the plugboard design permit either soldered or crimped connectors to be used.

Mr. Riddle mentions that if relays with relatively high power consumption are spaced very close together then possibly the heat may not get away and excessive temperature rises ensue. No problem has been met in this way because it has been found that relays can only occupy about 50–60% of the rack space, the remaining space being required for wire trees.

The **President** moved a very hearty vote of thanks to Mr. Coley for his excellent paper and this was carried with acclamation.

Australian Section

The Annual General Meeting of the Section was held on March 12th, 1960, at Albury: it was attended by over thirty members from the various states. The following office bearers were elected for the 1960 session: *Chairman,* Mr. G. F. Wooley; *Vice-Chairman,* Mr. J. R. Daley, Mr. W. E. Gardner; *Past Chairman,* Messrs. W. F. Barton, F. Stewart, D. J. Vernon; *Committee*: Messrs. E. D. Archer, L. H. Arnold, A. J. Everingham, R. E. Fuller, H. A. Honnor, F. E. Jones, F. W. Maitland, L. F. Martin, G. de P. Terry, G. G. Wilson; *Honorary Auditor,* Mr. R. G. Fox; *Honorary Secretary and Treasurer,* Mr. E. C. Mongor.

Following the declaration of office bearers for 1960, Mr. G. F. Wooley, the re-elected Chairman, expressed regret that protracted illness had prevented Mr. J. R. Daley from filling that office. He hoped that a recovery of health would enable Mr. Daley to accept that position next year.

Mr. E. W. Dennison, late of South Africa, and now resident in Queensland, was welcomed as a new member of the Australian Section.

Announcing that the Byles and Calcutt Trophy was to be awarded to Mr. N. F. Reed for his paper entitled: "Modern Railway Signalling in Great Britain and Europe", which was read at the technical meeting in Sydney on November 20th, 1959, the Chairman expressed pleasure that the award was being made to one of the younger members and congratulated the author on the thoroughness of preparation and able manner in which the paper had been presented.

After other business had been completed, a paper entitled: "The Albury to Melbourne Standard Gauge Railway", was read by Mr. G. F. Wooley. The paper dealt with the many considerations associated with the planning of the 4-ft. 8½-in. gauge single line on this 191 mile section; including the C.T.C. system to be adopted, crossing loops, road and rail grade crossings, and pole line requirements for power distribution, C.T.C. and signal controls and communications. The reading of the paper was followed by considerable discussion.

On the following morning, the party proceeded by parlour coach from Albury, into Victoria, along the Hume Highway, calling in at Barnawartha, Chiltern, Springhurst and Bowser, to inspect works in progress on the standard gauge line. Lunch was taken at the Commercial Hotel, Wangaratta, and afterwards, a pleasant run was made to Myrtleford in the foothills of the Australian Alps. After refreshment at the Buffalo Hotel, the return trip to Albury was made through Beechworth and Yackandandah.

Mr. J. R. Daley died on April 21st following a long illness. An obituary is given in Institution Announcements. Mr. W. E. Gardner was appointed Vice-Chairman to fill this vacancy.

At the meeting in Sydney on July 15th, an interesting address was presented by Messrs. G. McGregor and G. Sparkes, Senior Planners in the N.S.W. Railways Department, entitled: "Electronic Data Processing". The meeting was well attended and the address was accompanied with a practical demonstration of the machines.

Advance copies of the technical papers read at the Institution's meetings in England have been received throughout the year with appreciation, and members are again reminded that the English Committee welcomes questions and comments at any time.

No candidates were presented for examination this year.

In the examination for Graduate Membership held in Brisbane on October 17th, 1959, the candidate was unsuccessful in passing.

Bristol Section

The Annual General Meeting was held on April 25th, 1960, at Bristol with the retiring Chairman, Mr. R. C. Taber, presiding. The membership then totalled 103, an increase of 17 members since the previous Annual General Meeting, and at the end of 1960 a further ten Technician members and one Student Member were elected.

The elected Committee for the 1960–61 Session was Messrs. H. E. Edwards, W. F. Faux, A. D. Fleet, B. H. Grose, G. Pothecary and R. C. Taber. From these members Mr. B. H. Grose was elected Chairman, and Mr. H. E. Edwards, Vice-Chairman. Following three years' continuous service the Hon. Secretary and Treasurer, Mr. G. D. Miller retired, and the Committee appointed Mr. P. G. Law to take up these duties. Mr. Taber thanked Mr. Miller most sincerely for his services to the Bristol Section.

Since election to Chairman, Mr. B. H. Grose has left Chippenham to take up an appointment with the British Transport Commission, but has fortunately been able to continue to discharge the duties of Chairman of the Section.

Following the Annual General Meeting Mr. J. V. Nicholson of the Western Region read his paper on "Single Line Working". Many queries were raised regarding local variations of single line equipment during the discussion which followed.

In addition to this meeting, seven other technical meetings have been held, three at Bristol, three at Chippenham and one at Newport.

At the meeting held on January 26th, 1960, the Section was pleased to welcome Mr. S. D. Concha of the N.E. Region who presented his paper, "Lifting Barriers at Level Crossings in accordance with the requirements of the Ministry of Transport and Civil Aviation". At the end of the paper, a film was shown of the use (and misuse) of lifting barriers in France.

On February 29th, Mr. F. Edwards of the Operating Department Newport gave his paper "Rules and Regulations as applied to Signalling". He outlined the need for comprehensive regulations, and stressed particularly the far-reaching effects of interruption to working which could result from quite minor signalling failures. The desirability of rapid communication between trainmen and signalmen was stressed if delays due to failures were to be minimised.

On March 17th at Newport, and again on March 29th at Chippenham, Mr. R. H. Stapely of Western Region, Reading, gave his paper on "Structure and Equipment Design". This paper was followed with interest, especially since many members attending were concerned with manufacture, and a keen discussion followed.

The first meeting of the 1960–61 Session on September 26th, 1960, included Mr. O. S. Nock's (W.B. & S. Co.) paper, "Signalling from the Driver's Point of View". It was felt that this paper, already presented in London and elsewhere, should be heard by the Bristol Section, since it does describe in great detail the operating realities which must be borne in mind when designing theoretically "ideal" signalling schemes. On this occasion the Section was pleased to welcome several members of the local Running Department.

The programme card included a visit to Margam Marshalling Yard, but due to difficulties in arrangements this had to be postponed until 1961. There was very considerable support for the proposed visit and a good outing is therefore anticipated in the New Year.

On November 21st, 1960, the Section was honoured by the presence of the President, Mr. W. Owen, who addressed the meeting following the paper by Mr. M. le Sueur, Western Region, Reading, entitled "Work Study as Applied in a Railway Signal Department". This paper promoted much discussion especially from Western Region personnel, many of whom had been "Work Studied" !

The final meeting of the calendar year comprised the showing of several films on railway subjects, including a most interesting release by B.I.C.C. Ltd. entitled "Power to the Pantograph".

The year's meetings were attended by an average of 43 members, all meetings attracting about equal numbers. With increasing membership and a wide variety of interesting papers, the Section looks forward to continued and increasing support.

Rhodesian Section

The first Annual General Meeting was held on January 7th, 1960 and fifteen members attended, Mr. D. H. Constable, Vice-Chairman was in the chair. The following were elected as Committee members by ballot: *Chairman*, Mr. A. Baker; *Vice-Chairman*, Mr. D. H. Constable; *Secretary/Treasurer*, Mr. J. O. Shaw; *Committee*: Messrs. W. H. Dawkins, E. H. Welch and L. A. Dickens.

Mr. Nicholls, Technician Member, then presented a paper entitled "Maintenance of Railway Signalling Equipment". This paper, the first read to the Rhodesian Section, was well received and produced interesting debate.

The reading of the paper was followed by the showing of three films, "Sentinels of Safety", "A Cautionary Tale", and a short Federal News shot of C.T.C. installations in Rhodesia.

On Monday, June 13th, 1960, the Section was visited by Mr. J. C. Kubale, Past President. Mr. Kubale addressed the section on "Automatic Yards in Britain". Twenty-eight members and 23 guests were present, and many questions were asked and answered. A B.T.C. film, kindly brought out by Mr. Kubale, entitled "A Report on Modernisation" was shown, also lantern slides. These were very much appreciated.

York Section

The Sixth Annual General Meeting of the Section was held at York on April 13th, 1960, with 116 members present. Mr. R. J. Quin was in the chair. The reading of the annual report referred to the high standard of papers which had been presented. Three students, Messrs. L. P. Allan, A. E. Durham and D. F. Ringrose were congratulated on being awarded grants from the Thorrowgood bequest.

The Committee for the Session 1960–61 remained unchanged, viz. Messrs. A. F. Wigram and G. G. F. Halliwell (Members), R. J. Quin and J. M. Reed (Associate Members) and A. P. Croskell and D. Tough (Technician Members). Mr. J. M. Reed was elected Chairman, Mr. D. Tough, Vice-Chairman and Mr. W. D. Cowl, Honorary Secretary and Treasurer. Mr. J. M. Reed was installed as Chairman by his predecessor, Mr. R. J. Quin.

Following his installation, Mr. Reed delivered an inaugural address in which he laid emphasis on the rapid expansion and improvements in Railway Signalling and the opportunities offered at the Technical Meetings for obtaining information and for discussing and criticising the papers read. He gave a very interesting general review on aspects of signalling together with his personal ideas on various points. The address was illustrated by slides. A lively discussion followed in which 25 members joined.

A dinner/dance and entertainment was held at Betty's Café, St. Helen's Square, York, on March 4th, 1960, at which 109 members and friends were present. The function was honoured by the presence of the President of the Institution, Mr. D. G. Shipp, and Mrs. Shipp. After an excellent dinner, dancing and very diverting entertainment fully completed a very enjoyable evening.

Two visits were made. The first was on May 4th, 1960, to the Works of the Hepworth Iron Co., Hazlehead, near Sheffield, manufacturers of earthenware materials including cable troughs and Post Office ducts. Forty members attended who were able to inspect the manufacturing arrangements. The second visit, on September 24th, 1960, was to the Wilmslow Signalbox on the British Railways, London Midland Electrification, and was arranged by courtesy of Mr. E. G. Brentnall, Chief Signal & Telecommunications Engineer, London Midland Region. Thirty-eight members attended who thoroughly appreciated the excellent arrangements made by Mr. P. F. Shute, Divisional Signal Engineer, Hunts Bank, Manchester, and his staff, who were responsible for making this a most enjoyable and instructive visit.

The first Technical Meeting of 1960 was held on January 13th, with Mr. R. J. Quin in the chair. Fifty-six members attended. This meeting was honoured by the presence of the President, Mr. D. G. Shipp, who took the chair during the reading of the paper and the ensuing discussion. The President said it gave him great pleasure, firstly, to be present at the meeting and, secondly, to be able to introduce a colleague, Mr. E. J. Harris, of the Westinghouse Brake & Signal Co. Ltd. to read his paper on "Modern Trends in the Design of Signalling Apparatus". This was a very interesting paper, indicating the modern inclination of scientific thought on development compared with the "trial and error" practice of former days. Seventeen members contributed to the discussion.

At the meeting on February 11th, 1960, the Chairman, Mr. R. J. Quin, introduced Mr. E. R. Gentles, British Railways, York, who gave the first of two talks on "Layouts and Circuits for Electric Point Operation". Without a formal paper, the speaker presented a very full description of the arrangements with an excellent display of slides. Following this the Chairman spoke about "Primary Cells—Problems, Types and Applications" which was illustrated by slides. Fifty members were present and 20 contributed to the discussion which followed the two addresses.

A meeting was held on March 8th, 1960, with Mr. R. J. Quin in the chair. Mr. D. Greenfield, British Railways, York, read a paper on "Telephone equipment on the Newcastle Signalling Scheme". This was a very comprehensive paper, including details of the train announcements, various telephones and circuits, telecommunications apparatus room, V.H.F. radio for the parcels collection and delivery service, etc. The paper was much appreciated by the 48 members present and 13 joined in the ensuing discussion.

The first meeting of the 1960–61 Session was held on October 13th, 1960, with Mr. J. M. Reed in the chair. Fifty-six members were present. Mr. D. Peverley, British Railways, York, read a paper on "Development in Mechanical Signalling Equipment". Major developments referred to were Mechanical and Electrically operated level crossing barriers and gate toe motors for level crossing gates. Many other interesting developments in signal and point apparatus, etc., were also described. Fifteen members joined in the discussion.

A meeting was held on November 15th, with Mr. J. M. Reed in the chair, with an attendance of 52. No papers were issued but two addresses were given, the first by Mr. A. Moss, British Railways, Darlington, on "The problems of an S. & T. Maintenance Inspector" and the second by Mr. G. C. Hawkins, British Railways, Darlington, on "The Problems of an S. & T. New Works Inspector". These familiar and topical subjects raised an interesting discussion to which 19 members contributed.

At the meeting on December 14th, 1960, the York Section was honoured by the President, Mr. W. Owen who was present. After the formal business of the meeting, Mr. J. M. Reed invited Mr. Owen to occupy the chair for the paper and discussion. The President expressed his pleasure at the opportunity of visiting the meeting. Since his arrival he had been interested to learn that the gentleman who had made the President's badge of office and presented it to the Institution was a former Assistant Signal Engineer of the N.E. Area of the former L. & N.E. Railway, Mr. F. Horler. He then introduced Mr. A. F. Wigram, Chief Signal & Telecommunications Engineer, North Eastern Region, British Railways, York, who gave his address on "The Modernisation Plan and its challenge to the Signal Engineer". The members enjoyed Mr. Wigram's informal and entertaining address on the wide aspects of his subject. One hundred and six members were present and 19 contributed to the discussion.