



2 + 5 EXCHANGE-CONNECTED INTERCOM SYSTEM

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SUMMARY

The system described has been developed to provide access from any one of five telephone stations to either of two exchange lines, with facilities for intercommunication between the stations. The switching requirements for a system of this kind are defined and it is shown that this 2+5 Exchange-Connected Intercom System meets these requirements. The system is described and the general principles of both exchange and intercom operation are outlined with details of the priority and secrecy facilities that are available. Examples of connection of the system for various applications are illustrated and a brief description of the circuit is given

THE IMPORTANT PART played by a reliable and efficient private telephone system in industrial and commercial organisations has long been recognised and a wide variety of equipment

and services has been developed to meet the different requirements for private telephone installations. It was considered that a useful addition to the available range would be an



Figure 1. Station relay-set

intercom system that could be used as a small exchange in its own right and as an additional feature to a p.a.b.x. or a p.a.x.

The system, which should provide the usual seizing and signalling conditions, should be simple in operation, require a minimum of maintenance, and, most important, provide an economic as well as efficient telephone service to the user

The 2+5 Exchange-Connected Intercom System, which gives access from any of five telephone stations to two exchange lines, and provides for intercommunication between the stations, has been developed to meet these requirements.

In an intercom system using key switching, as this system does, the switching operations must be straightforward, logical and unambiguous. There must be no possibility of losing or wrongly directing calls due to an involved switching sequence. In particular, the following requirements are essential

- (a) The action of replacing the handset at

a station must suffice to clear the call to that station. That is, it must not be necessary to restore a key to complete the clearance of a call.

- (b) In transferring a telephone from one line to another it must not be necessary to depress a 'hold' key to hold a call on the first line.
- (c) An audible indication of an incoming exchange line call must be given under any condition on at least one of the telephones.

To meet requirements (a) and (b), a suitable form of interlock between each of the keys and the cradle switch of the telephone must be provided. A mechanical interlock can be designed to perform this function but is necessarily complicated. In the case of the 2+5 System, therefore, a form of electrical interlock is provided.



Figure 2. Common answering relay-set

The telephones are fitted with the normal type of cradle spring assembly and the keys for controlling switching operations are of the simple non-locking type. There is no necessity for these keys to be restored manually so that requirement (a) above is complied with at all times. The interlocking functions are performed by relay-sets, one of which is associated with each station. Each station relay-set contains four relays and is housed in a small cabinet near the telephone instrument. The operation of the interlock is described in more detail later in this article.

Regarding (c), audible indication of incoming exchange calls is arranged to be given at one specific telephone normally but at any other telephone or telephones when necessary. The indication is given even if one exchange line and the intercom circuit are already in use.

OUTLINE DESCRIPTION OF EQUIPMENT

There is provision for a maximum of five telephone stations, each equipped with the special telephone instrument shown at the head of this paper. This consists of a normal automatic telephone instrument, together with six non-locking and one locking keys, and three non-locking push-type keys, two of which have lamp indication incorporated.

The station relay-set associated with each telephone is a small unit housing four 3 000-type relays, a number of resistors, and the interstation cabling terminal strip. See Figure 1.

One of the stations, usually station 5, is designated as 'answering station' for incoming exchange calls and is equipped with an additional relay-set containing the common answering equipment and the transmission feed retardation coil for the intercom line. This second relay-set resembles the station relay-set in size and appearance. See Figure 2.

OPERATION

After lifting the handset from its cradle, the user presses, momentarily, the key associated with the line to which he wishes to establish connection, that is, either of the two exchange

lines, or one of the four other intercom lines, and then proceeds with the call in the usual manner.

While holding a connection on one exchange line, the user may make, or answer, a call on the other exchange line or on the intercom, simply by pressing the key associated with the required second line. This operation holds the original line and transfers the telephone to the selected second line. The user can then perform any of the following operations.

- (a) Release the call on the second line and return to the call on the original line
- (b) Release the call on the original line and retain the call on the second line
- (c) Press an intercom key to ask another station to take over the call on the original line and then return to the call on the second line.

Keys and Lamps

Exchange Line Lamp Indications

Each exchange line key is illuminated by an inbuilt lamp in a single assembly, the lamp being visible through the translucent coloured key button.

The lamps associated with the lines give signal indications as follows

- (a) A steady glow at all stations during an exchange call, serving as a busy indication.
- (b) A 'winking' signal at all stations on an incoming call until the call is answered.
- (c) A 'winking' signal at a station where the user is holding the line while making a call on another line. This 'winking' signal becomes steady when the user returns to the 'held' line.

In addition to the two exchange line keys, and the five intercom calling keys, the telephone is equipped with three other keys designated C (cancel), R (recall), and X. The functions of these keys are as follows

Cancel Key

The cancel key enables the user to release one exchange line during call transfer operations without losing the other exchange line, or to release a line without replacing the handset.

Recall Key

The recall key is used for those functions normally performed by the push button fitted to a p.a.b.x. telephone instrument. It provides the operator recall facility, dispensing with the need to 'flash' the cradle-switch. It can also be used for controlling 'priority cut-in' on certain types of p.a.x.

X Key

This key, which is not used for telephone switching purposes, is of the locking type, and when depressed causes an audible indication of incoming exchange calls to be given at the selected station, by the buzzer fitted inside the telephone instrument.

The answering duties for the five telephones connected to the system are normally performed by the last station of the group. An exchange line call may be transferred to any required telephone by means of instructions passed over the intercom line. The X key at the 'answering station' is left operated as long as the station is attended. During unstaffed periods, however, the X key is restored and this causes the incoming call signal to be diverted to another telephone, designated as a 'secondary answering station'. The X key at this station need not be operated.

It can be arranged for the user at *any* station to receive an audible announcement of incoming exchange calls by depressing his own X key. This is a useful facility if, for example, the telephone is attended out of normal working hours. An audible indication of incoming exchange calls continues to be given at the normal answering station and a visual indication of incoming exchange calls is still given at each station.

Intercom Calls

An intercom call is established by the removal of a handset, and the operation of the appropriate intercom key to sound the buzzer at the called station. The call is answered by removal of the handset from its cradle, no key operation being necessary.

As there is a common speech path for intercom purposes, two separate conversations cannot be held over it but all stations can join in as a conference facility. The stations required to join the conference would have to be called in sequence by the operation of the appropriate intercom keys.

A user speaking over an exchange line, can acknowledge a call from another intercom station by depressing the 'home' intercom key to connect his own station to the intercom circuit. This applies a 'hold' condition to the exchange line in use, while the intercom call is answered. Relay operations in the station relay set cause the exchange line lamp at the 'holding' station to wink as a reminder that the exchange line is 'held', meanwhile the line lamps at the other stations glow steadily, to indicate that the exchange line is occupied.

The user returns to the exchange line by re-operating the exchange line key when the intercom call has concluded.

Calls to Exchange Lines

The caller removes his handset and depresses one of the exchange line keys momentarily to connect his telephone to the line. The call then proceeds in the normal manner. The associated exchange line lamp glows steadily at all stations to indicate that the line is engaged.

Calls from Exchange Lines

No. 5 station is usually used as the answering station for incoming calls from exchange lines.

An incoming exchange line call is answered by removing the handset and depressing the key indicated by the winking lamp. This action causes the appropriate exchange line lamp at each station to glow steadily.

Transfer of Exchange Calls

Incoming or outgoing exchange line calls on one station may be transferred to any other station by depressing the appropriate intercom key. The exchange line is 'held' and the winking

lamp signal given at the transferring station.

At the wanted station the buzzer is sounded, and on answering, the called party may take the exchange line call by operating the appropriate exchange line key. The call transfer operation is now completed and the transferring station handset may be replaced.

If the exchange line call is not accepted by the wanted station, or the intercom call is not answered, the transferring station re-operates the exchange line key, to reconnect his own telephone to the exchange line.

Calls on Both Exchange Lines Simultaneously

While speaking on one exchange line A, it is possible to make or answer a call on the other exchange line. This facility enables the user to make an enquiry call when, for example, one exchange line is connected to the public telephone system and the other to a p.a.x.

With a call established on exchange line A, depressing the key for exchange line B transfers the telephone to that line and holds line A. At the same time the winking lamp signal is given as a reminder that a call is being held.

With calls on both exchange lines simultaneously, the user may proceed as follows

- (a) On the completion of a call on exchange line B, operate the cancel key to release this call then press exchange line A key to re-connect his telephone to that line.
- (b) Press an intercom key, and ask another station to take over the call on exchange line B, then operate the cancel key to remove the connections to that line, and finally re-operate exchange line A key, to re-establish the connection between his telephone and that line.
- (c) Clear the call on exchange line A and retain the second exchange line call, by operating the key for exchange line A, then operating the cancel key momentarily to release the line, and finally pressing the key for exchange line B to re-establish the connection between the two telephone instruments.

Secrecy

A series 'secrecy' facility is provided on exchange lines so that when connected to an exchange line, station No. 1 disconnects stations 2 to 5, similarly, station No. 2 disconnects stations 3 to 5 and so on.

Intercom calls are not secret from other stations, but are secret from calls made through the exchange lines.

MISCELLANEOUS

Inter-station Cabling

Connections between the stations are made at the station relay set and require a total of 17 conductors. A 9-pair cable, tapping-in to all intermediate stations is normally used for this purpose.

The cable length from the first to last station is limited by the need to keep the resistance to a maximum of 50 ohms. This is equivalent to, for example, approximately 3 000 ft. of 20 lb/mile cable.

Exchange Line Length

The system will work over the length of line specified for the public exchange, or p.a.x., to which it is connected.

No series or shunt equipment is connected to the exchange line during conversation apart from the answering telephone.

Power Supply

Two versions of the equipment are available, one for use on a 50-V and the other on a 12-V d.c. supply

A 50-V supply may conveniently be taken from an associated p.a.x., and a 12-V supply may be derived from either dry cells or an eliminator.

APPLICATIONS

Many different arrangements for connecting the 2+5 exchange-connected intercom are possible to suit particular requirements and

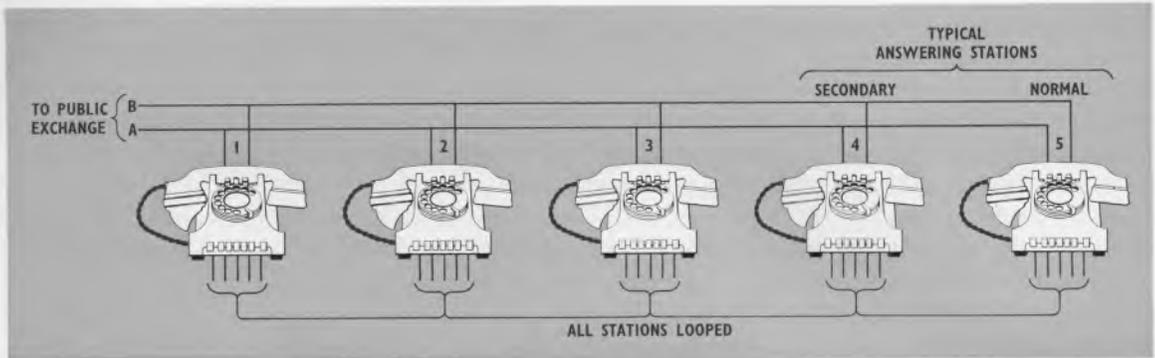


Figure 3. Intercom with connection to two public exchange lines

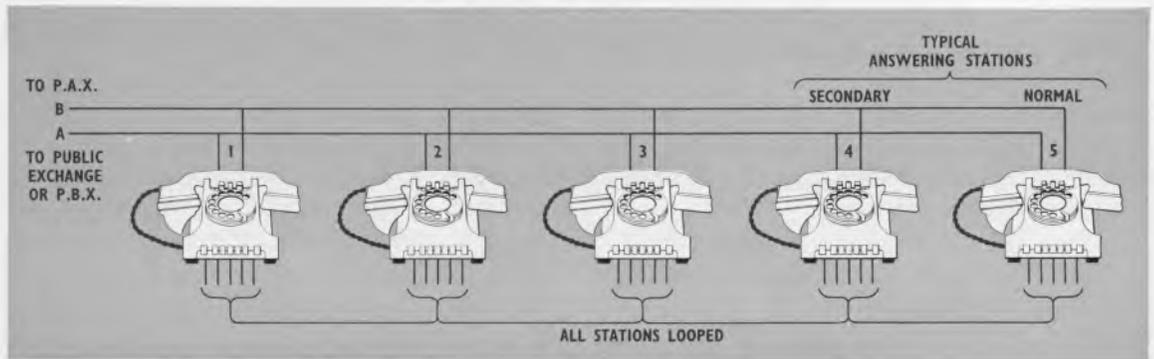


Figure 4. Intercom with connection to one public exchange line or p.b.x. and to one p.a.x.

some of these are illustrated in Figures 3 to 6.

In the arrangement illustrated in Figure 3, each of the five stations has access to the two public exchange lines, with intercom connection to each of the other four stations.

Figure 4 shows a similar arrangement but with exchange line A serving the public exchange or p.b.x., and exchange line B serving a p.a.x.

The variation shown in Figure 5 provides secretarial service for two principals and two secretaries. Either secretary can answer for either principal and either principal can take over calls for the other principal. The exchange lines may each serve either a p.a.x. or a public exchange.

Figure 6 shows another arrangement which provides exchange-connected intercom service

for one exchange line, A, and five stations, together with an individual direct p.a.x. line to each station on line B.

These examples indicate the versatility of the 2+5 exchange-connected intercom in meeting different requirements.

CIRCUIT OPERATION

The circuits of the common answering equipment and a typical station relay set are shown in Figure 7. The circuit of the station relay-set is symmetrical, so that, whatever sequence of exchange lines is followed the pattern of key operation does not alter. Relays A and AH are

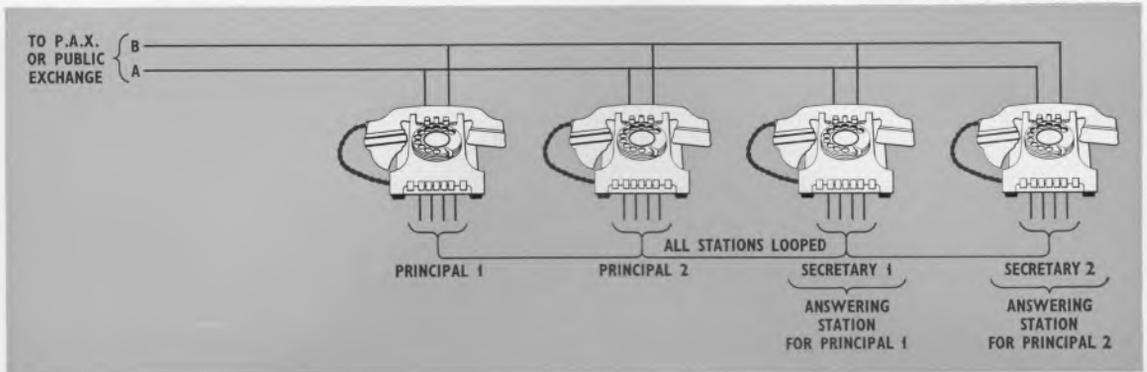


Figure 5. Secretarial service for two principals and two secretaries

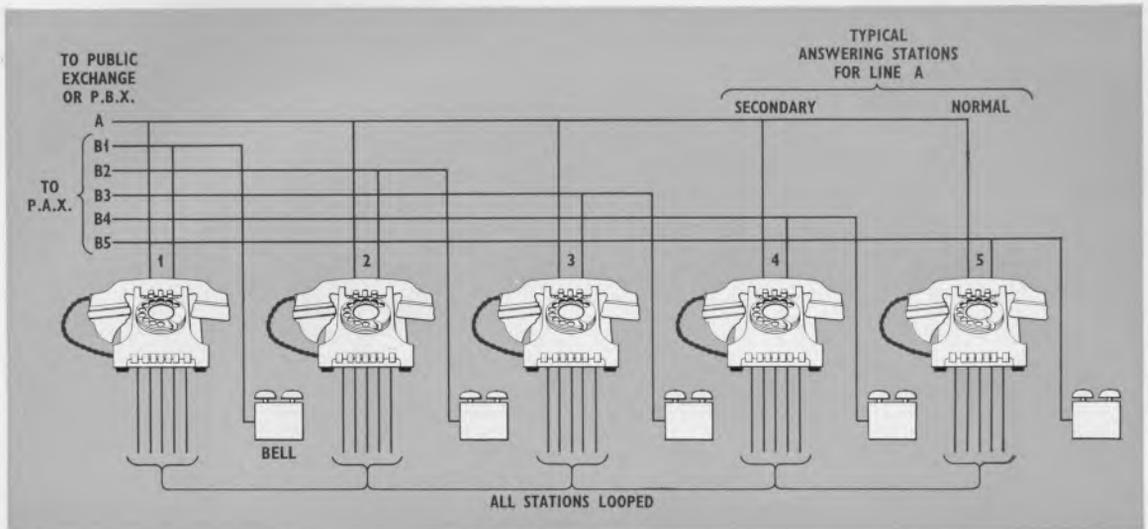


Figure 6. Intercom with connection to one public exchange line and individual connections to p.a.x

associated with exchange line 'A', relays B and BH with line 'B'. Operations affecting relays A and AH will, similarly, apply to relays B and BH.

Incoming Exchange Line Call

It is assumed that the incoming call is for station 1 and is on exchange line 'A'

Ringing current from the distant equipment is rectified in the common answering equipment

and operates relay RA. The capacitor across relay RA maintains the relay operated during the 'off' periods of ringing.

Relay FA operates in circuit with the line 'A' lamps LA at the station telephones and operates relay FB.

Relay FB operating, lights line lamps LA, completes a buzzer circuit to the answering station and short-circuits relay FA to release it slowly

When relay FA releases, it extinguishes line

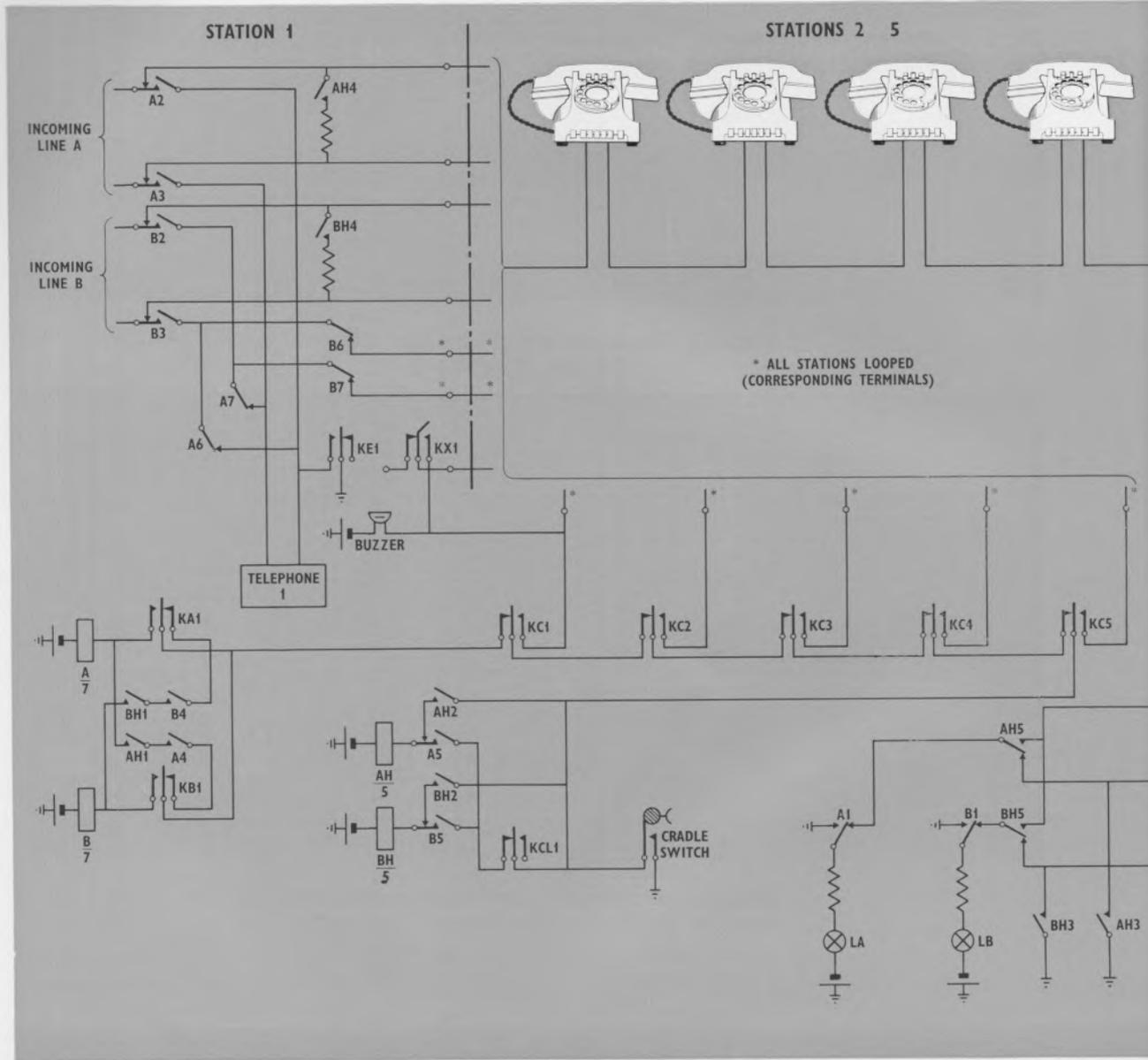
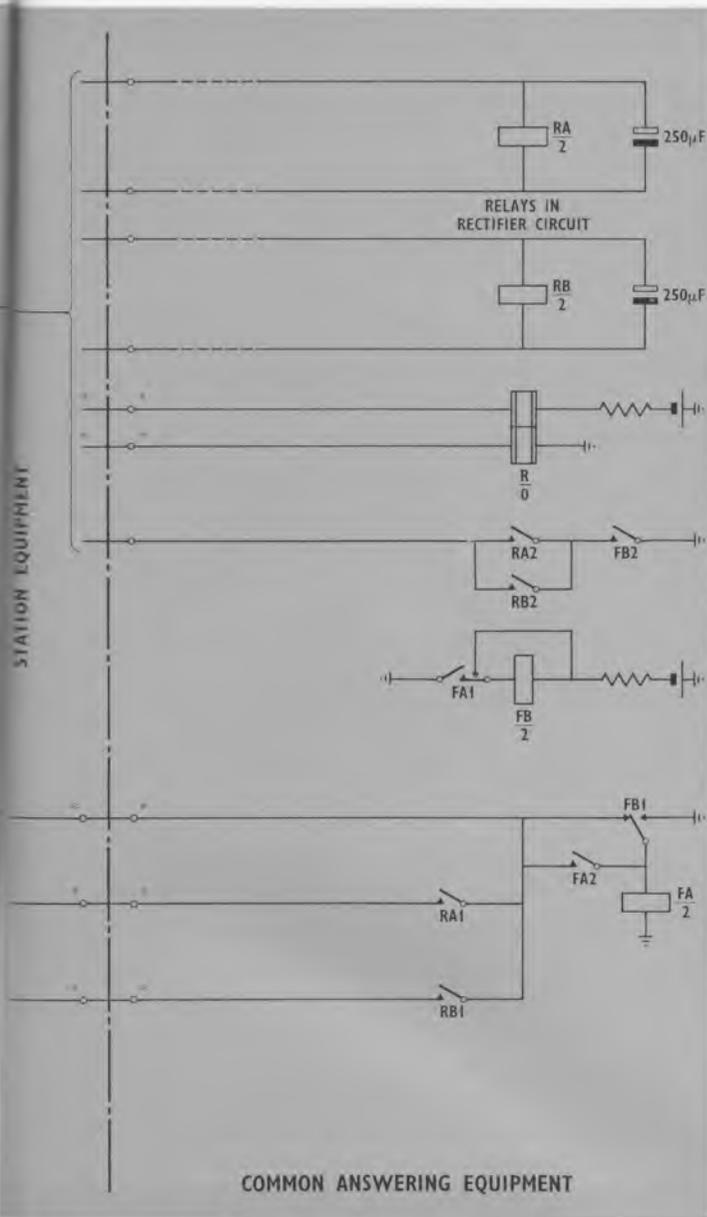


Figure 7 Common answering equipment and station relay-set circuits

lamps LA and short-circuits relay FB to release it slowly

When FB releases, relay FA re-operates and re-operates relay FB.

This interaction between relays FA and FB continues during ringing to give an intermittent buzzer action at the answering station and flashing of line lamps at all stations.



The attendant at the answering stations replies by removing the handset and depressing key KA1 to operate relay A, thus transferring his telephone to the line from the intercom circuit,

making the line lamp glow steadily, and disconnecting ringing. Relay AH also operates to hold relay A and apply steady potential to the line lamps at the other stations through the station loops.

As the call was for station 1, the answering station attendant depresses key KC1. This operates the buzzer at station 1 and also releases relay A at answering station. Relay A normal, transfers the telephone from line 'A' to the telecom speech circuit which is energised from the retardation coil R. Meanwhile, line 'A' is held by the AH4, operated, loop and the line lamp LA is reconnected to the relay FA, FB interaction circuit to give a flashing signal on the line lamp (at answering station only).

When station 1 answers, it accepts the exchange line call by operating line key KA1 to operate its relays A and AH. This disconnects the telecom line and answering station, and connects line 'A' to station 1. Replacing the telephone at the answering station releases its relay AH but its line lamp remains lit through the station loops.

Outgoing Call to Exchange Line

At any station, removing the handset and operating line key KA1 or KB1, will seize the appropriate exchange line. Dialling and progress of the call are then normal. Should a dialling error be made, the line can be released by momentary operation of key KCL1 which releases relays AH and A. On re-operating the line key, dialling can recommence.

Calls on Both Exchange Lines Simultaneously

With an incoming or outgoing call on line 'A', another call from the same station can be originated on line 'B' by operating line key KB1. This causes line 'A' to be held by releasing relay A, and the relay FA, FB flashing circuit will be applied to line 'A' lamp, while line 'B' lamp will glow steadily through contact B1 operated.

To return to line 'A' call, cancel key KCL1 is operated to release relays B and BH, then the line 'A' key is re-operated to re-operate relay A and reconnect the telephone to line 'A'.