

Loudspeaking Master Station for use on Intercommunication Telephone Systems

The General Electric Company has introduced a new loudspeaking master station (hands-free telephone) for use on its intercommunication telephone system having up to twenty-one substations, of which three may be loudspeaking master stations. This replaces the previous model and, in addition to the modern styling shown in Fig. 1, it incorporates a simple transistor amplifier in the loudspeaker circuit. This ensures clear speech reception, and allows simple and less-expensive cabling between stations.



Fig. 1.—Loudspeaking master station.

New Features

New features incorporated in the new master station that ensure better performance than that of previous models include the following :—

A key to increase the loudspeaker volume, when required.

A higher level of speech from master station to substation due to a more sensitive receiver.

Individual adjustment at any substation from which the loudspeaking volume is consistently too loud or too weak.

Increased volume from the loudspeaker.

The keys have been modified so that the user of the master station now calls a substation by a further depression of the relevant key past the speech position, thus allowing an intermittent calling signal. Previously the “call” and “speak” position of the key were the same and the substation buzzer sounded continuously until the call was answered.

The triple cable required to connect the master station to each substation can be V.I.R. or P.V.C. covered, and need not be screened as previously.

Substation

The substation instruments are of the familiar pushbutton type and can be supplied having a capacity of either ten or twenty lines. A typical instrument is shown in Fig. 2. The handset is of modern design and incorporates a more sensitive receiver than was used in previous models. The instrument is specially designed so that it can either be stationed on a desk or wall-mounted. The three lamp panels associated with calls from a master station are clearly visible under the handset, and the three pushbuttons connected to master-station lines are a different colour to the remainder.



Fig. 2.—Substation.

New Master Station

The new master station instrument is shown in Fig. 1. It consists of an attractive modern-style cabinet 16ins \times 9 $\frac{1}{2}$ ins \times 5ins made of polished walnut and having a scratch resistant polyester finish. It stands on four legs to a height above desk level of 1—1 $\frac{1}{2}$ ins. A row of two 2-way keys gives immediate access to any one of twenty stations, one or two of which could be other master stations and the remainder substations. There are two other switches on the front panel, one giving a two-level volume control and the other for buzzer cut-off, when required. The loudspeaker is located behind a grill in the base of the cabinet, and the height of the cabinet above the desk is such that the output from the loudspeaker is at an optimum level.

Battery Supplies

A 1.5-volt battery and a 4.5-volt battery are required for the operation of the substation intercommunication system, and two 6-volt batteries are needed at each master station.

Performance

The loudspeaker output and the sensitivity of the microphone at the master station are such that a conversation can be carried on easily from anywhere in a normal size office having average acoustic properties. Normally, however, the user will be stationed between two and three feet from the master station in a position from where he can reach the operating keys. The following sensitivity figures are typical of the perfor-

mance of the master station instrument under normal working conditions.

The speech level at a distance of three feet from the loudspeaker with normal output is about 7db higher (*i.e.*, about twice as loud) than for speech from a person talking normally at the same distance. This is further increased to 14db when the "increase volume" key is operated. The distribution of reception around the master station is shown in the polar diagram in Fig. 3.

The level of speech received by a substation from the master station when speaking three feet from the microphone was compared to the minimum level operated by the British Post Office, *i.e.*, that given by limiting local lines at the sending and receiving ends with a 27db junction loss in between. The level of speech received from the master station microphone is 15db better than this B.P.O. limit.

Operation

In previous models of the loudspeaking master station, satisfactory operation without the use of amplifiers was achieved by using efficient microphones and loudspeakers, and employing separate transmit and receive paths. This simple system suffers from several disadvantages, mainly arising from the fact that speech currents of loudspeaking strength flow from one end to the other, hence precautions have to be taken to prevent overhearing. These include using separate speaking and signalling batteries, separate circuits and screened cables. Another disadvantage of the high level of

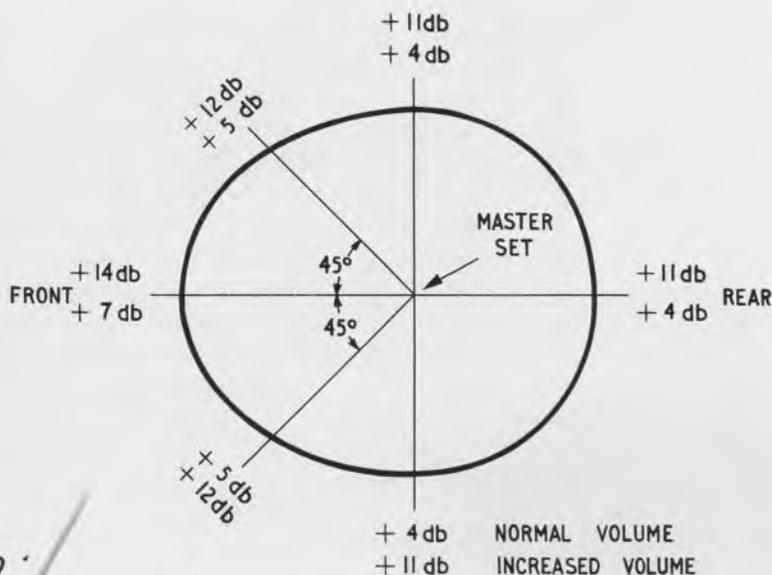


Fig. 3.—Reception polar diagram for master station.

The single-stage amplifier uses two transistors connected in push-pull with a centre-tapped loudspeaker, as shown in Fig. 4. The gain of the amplifier is adjusted to produce the maximum level that gives a freedom from howling when two master stations are connected loudspeaker to loudspeaker. In this condition it is possible for two master station users to hold a conversation provided the ambient noise is low. For general use, however, it is recommended that one of the master stations should use the handset, as previously. The amplifier operates from the 6-volt signalling battery.

received speech signal is that when the master station is using the handset the signal has to be degraded.

These difficulties can be overcome quite easily by transmitting the line speech signals at normal level (*i.e.*, the level that can comfortably be received on a handset), and amplifying them at the master station to the level required to operate the loudspeaker. Previously this would have been uneconomical, but the introduction of the transistor amplifier, which operates from a low-voltage power supply, gives an ideal means of raising the line signal level to the required loudspeaker level.

The 3-wire line connexions between the master stations and substations have been retained to give lamp signalling and to keep side-tone to a minimum. A resistor is connected in series with the transmitter of each handset. This can be changed, if required, to give a signal at the correct level to feed the amplifier for the most satisfactory output from the loudspeaker.

In an intercommunication telephone system including master stations and substations there are three possible types of calls, viz. substation to substation, substation to master station and master station to master station. These will now be considered in greater detail.

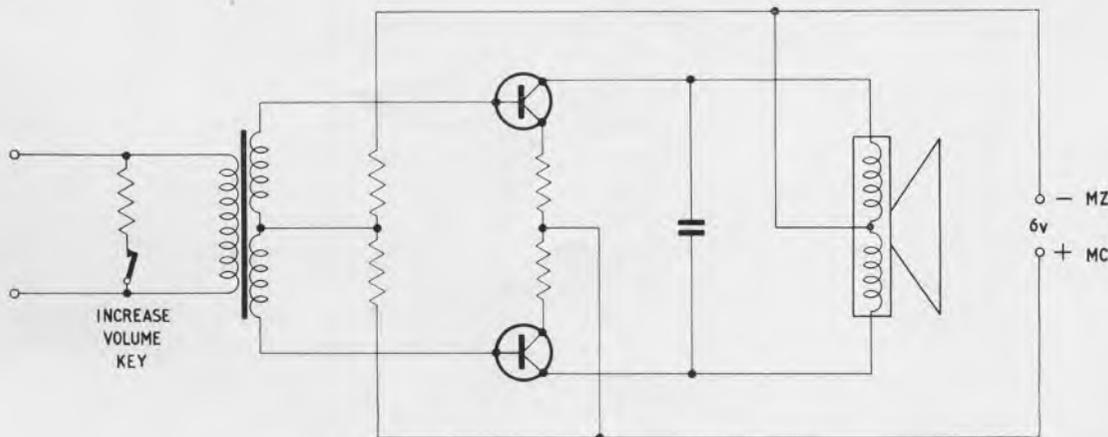


Fig. 4.—Circuit diagram of master-station amplifier.

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Substation to Substation

The basic circuit elements and connexions for a call between two substations are shown in Fig. 5. It is assumed that station No. 4 is calling station No. 20.

When the handset is lifted at substation No. 4 the home-line springs HL1 and HL2 operate by the movement of the push-key locking plate, and the switch-hook springs break, disconnecting the buzzer. The calling lamps L1, L2 and L3, associated with the three master stations remain connected throughout a call between substations so that a call from a master station will always light the appropriate lamp immediately.

When the handset is removed at substation No. 20, the buzzer is disconnected and the contacts HL1 and HL2 operate. This connects the transmitter and receiver of the called station between the negative speaking battery TZ and home-line No. 20 and allows conversation to take place with the caller who is connected between the speaking-battery positive lead CC and home-line No. 20. When either or both stations replace their handsets the locking bar is withdrawn and in the one case the push-key restores to normal and in the other the home-line springs restore to normal. In each instrument the switch-hook springs make to connect the buzzer to receive the next incoming call.

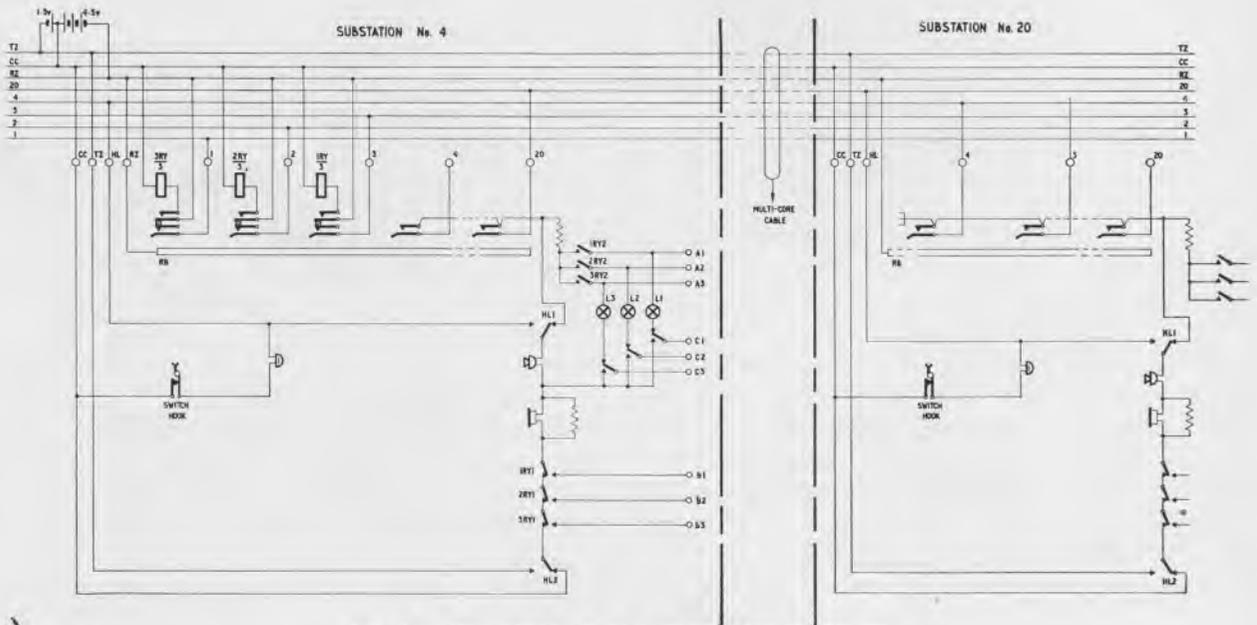


Fig. 5.—Basic circuit for calls between two substations.

When push-key No. 20 on the substation No. 4 instrument is depressed into its locked position, the home-line springs HL1 and HL2 restore to their original positions and connect the No. 4 substation to the No. 20 home-line. On further depressing the push-key past its locking position, negative potential (RZ) from the ringing battery is connected, via the ringing bar RB and the No. 20 key to the No. 20 home line and hence to the buzzer at substation No. 20 and return on the common battery positive line CC. Should substation No. 20 be engaged on another call, the switchhook springs will be open and the buzzer will not sound.

Thus, the speaking and calling circuits require one wire per substation plus three common battery wires connected between each substation in a multiple cable. It is evident from Fig. 5 that if two substations call a third station at the same time all three parties can converse, but if a calling station is called by a third party, no connexion is established until the first caller replaces the handset.

As the speaking circuits are over one wire and a common, a limited amount of overhearing can occur, dependent on the resistance of the common speaking

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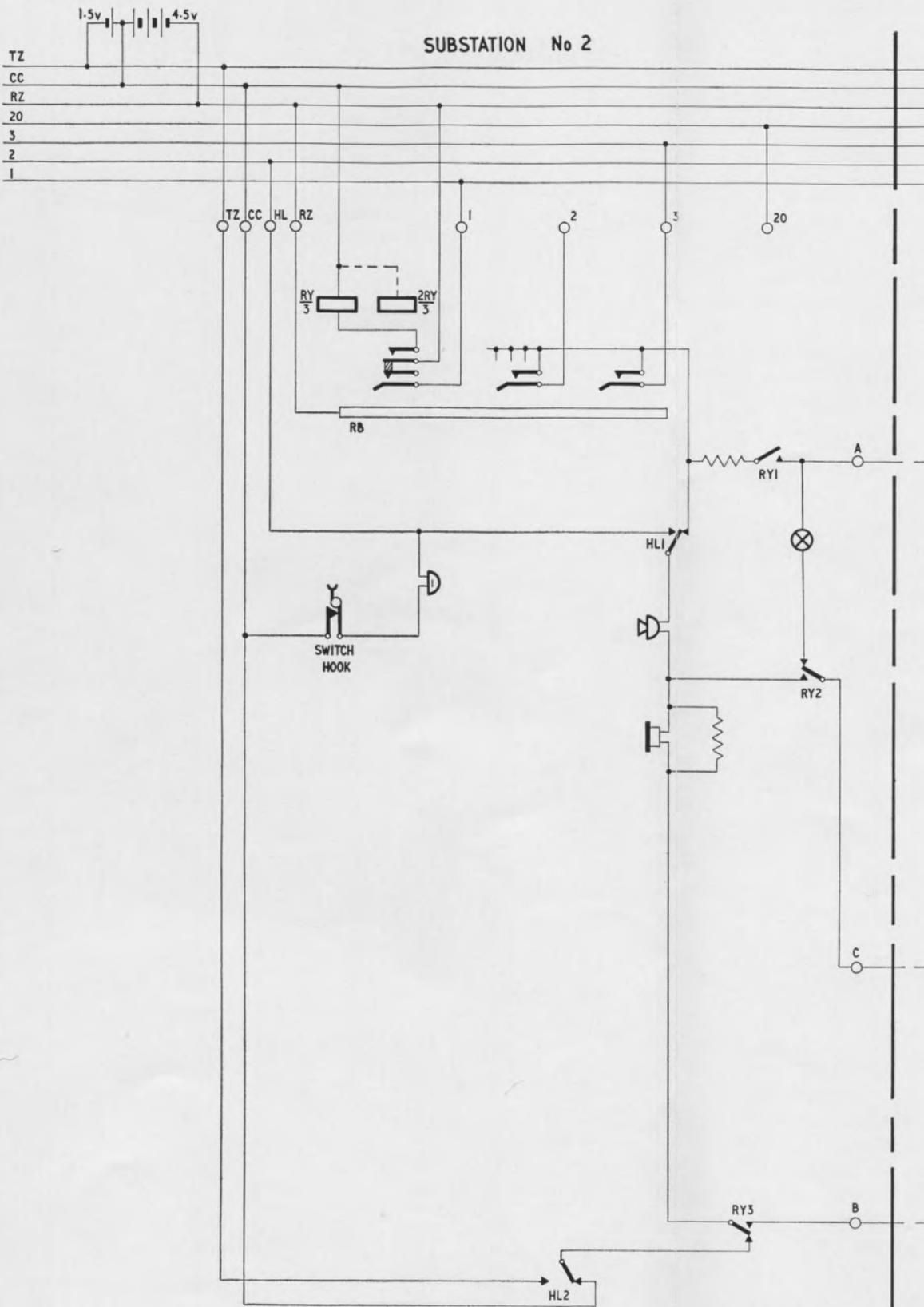


Fig. 6.—Basic circuit for calls between

battery wires CC and TZ and the inductive coupling due to the unbalanced circuit. The extent of over-hearing is minimised by using a larger gauge for the two battery wires and limiting the permissible maximum overall length of the cable to 400 yards.

Substation to Master Station

The substations are connected individually to each master station by three-wire cables, and the circuit arrangements (shown in Fig. 6) are such that there is absolute secrecy on all calls to and from a master station. One relay per master station is required at each substation to effect the changeover of the substation handset from the intercommunication system to the master system. These relays are located in the substation terminal boxes. Each substation push-key associated with a master station is fitted with an extra springset to operate the relay.

Fig. 6 shows the basic circuit elements for substation No. 2 to call master station No. 1 by pressing push-key No. 1. Depressing this key operates relay RY, and contacts of RY changeover the handset to the master system lines A, B and C. Further depression of the push-key applies the signalling battery RZ over home-line No. 1 to operate the buzzer in the master station. The loop through the substation receiver across lines B and C lights the lamp L2, which indicates that the caller is substation No. 2.

The master station answers the call by operating key No. 2. This disconnects the calling lamp and operates relay R. Contact R1 disconnects the buzzer, while R2 and R3 changeover the circuit from the handset to the microphone and loudspeaker, and R4 connects the battery supply to the amplifier. The circuit is then completed for conversation to take place.

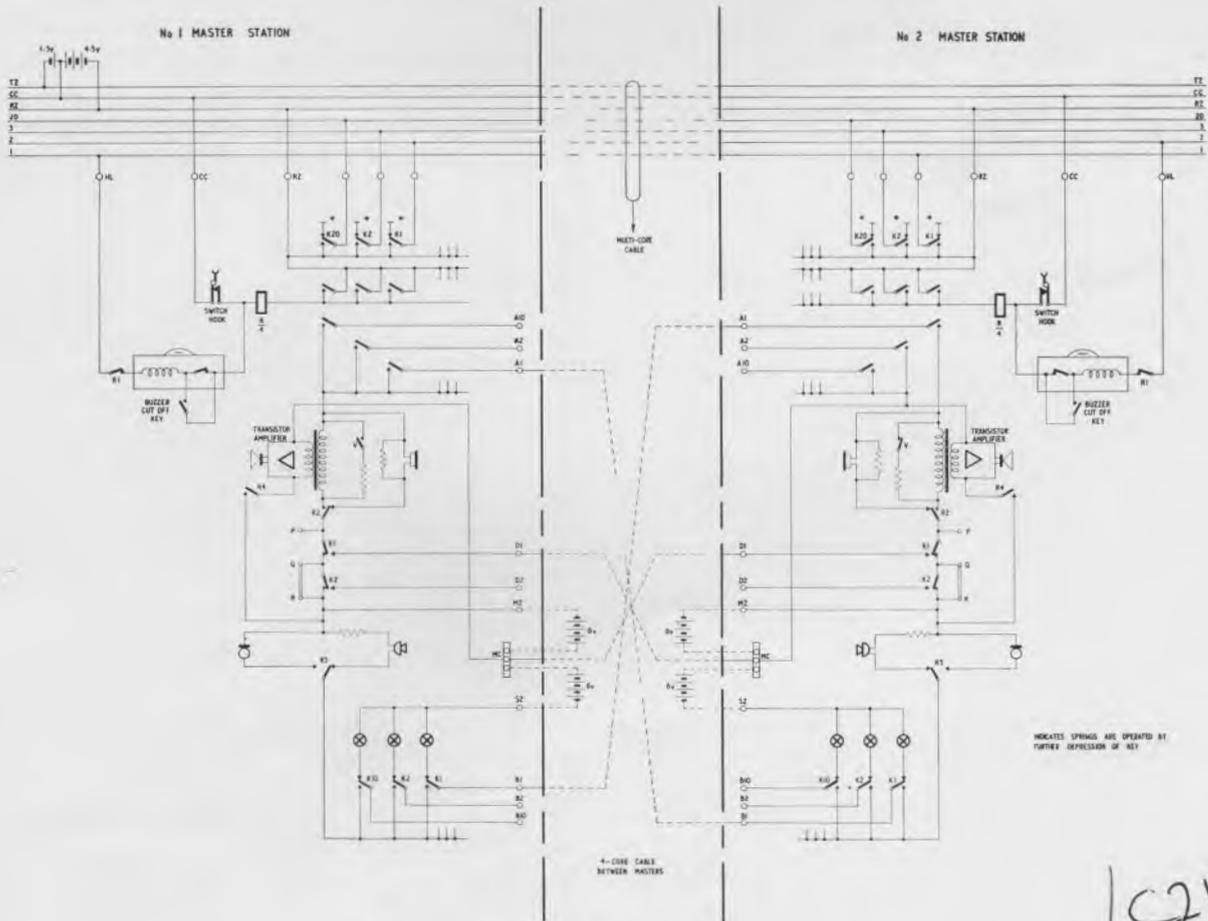


Fig. 7.—Basic circuit for calls between two master stations.

Output from the loudspeaker is normally quite adequate, but a key V is supplied which, when operated, disconnects a 33-ohm shunt and gives a higher output to cater for very weak signals, or noisy locations.

When the master station calls a substation, he operates the appropriate key. Further operation beyond the normal locking position connects signalling battery to operate the buzzer at the substation. At the substation the lamp L also lights. If the substation is engaged on another call, the calling lamp will still light to indicate the incoming call from a master station, but the buzzer will not sound due to the break in the circuit at the switch-hook springset.

To answer the call from a master station the substation must both lift the handset and depress the appropriate press-key to complete the connexion. If the master station user desires a private conversation, he can lift the handset. The opening of the switch-hook contacts releases relay R and contacts R2 and R3 switch the circuit back from the loudspeaker and microphone to the handset.

Master Station to Master Station

When two or three master stations are included in a system, a 4-wire cable is required to connect any two,

as shown in Fig. 7. Where there are two master stations, the strap PQ is removed in each instrument, and where there are three master stations, both straps PQ and QR are removed. In the resulting 4-wire circuit between stations, each pair provides a separate speaking battery and listening circuit between them.

Referring to Fig. 7 master station 1 calls master station 2 by operating key No. 1 as before. To provide satisfactory loudspeaking conversations in each direction it is necessary to have some form of switching at the master stations, either manually or voice-operated. This adds considerably to the cost of a system, and in this simple intercommunication equipment is not considered necessary. It is recommended, therefore, that on calls between two master stations, one station should use the handset, and it is conventional that this should be the caller. However, even with this equipment, it is possible to carry on a limited conversation with both stations operating on the loudspeaker under favourable conditions. At master station 2 the buzzer sounds and the calling lamp associated with station 1 lights. Master station 2 answers the call by operating key No. 1, which disconnects the lamp and operates relay R, which functions as described above, and connects the two stations for speech.