June 29, 1943. R. M. KALB 2,322,851

MAGNETIC SWITCHHOOK

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FIG. 1

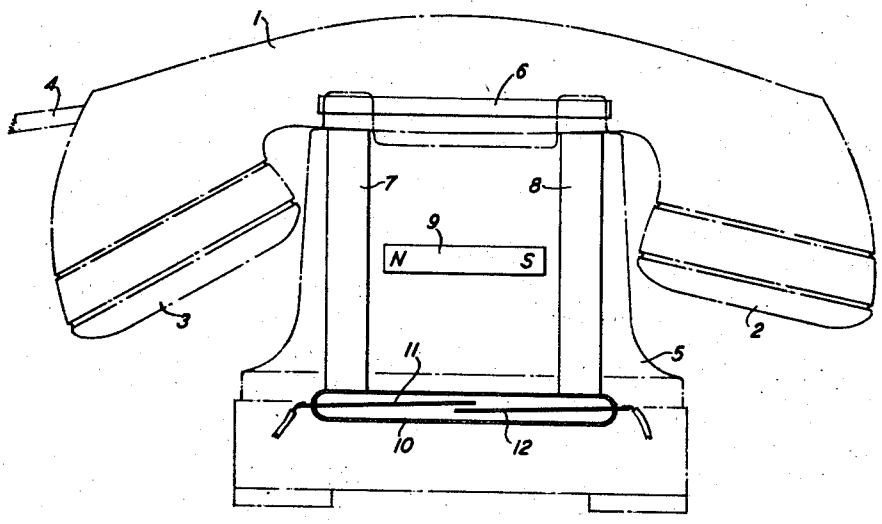

FIG. 2

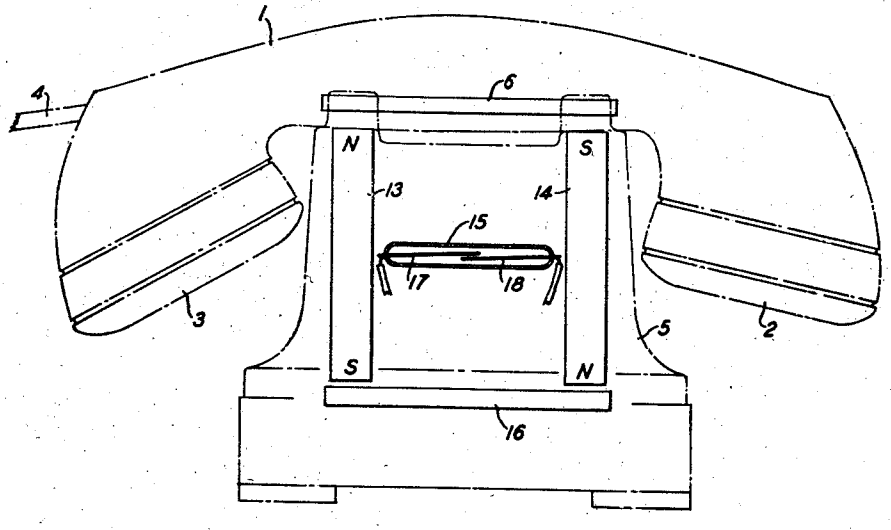

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FIG. 3

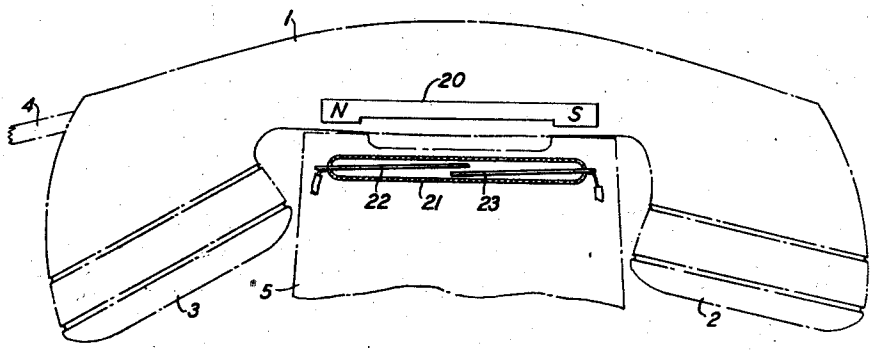


FIG. 4

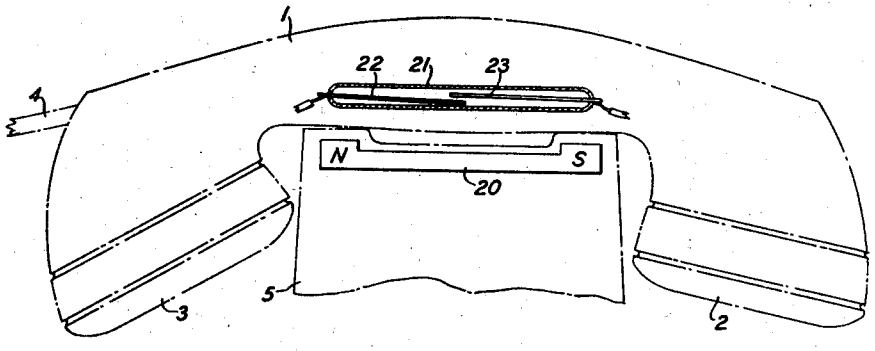


FIG. 7

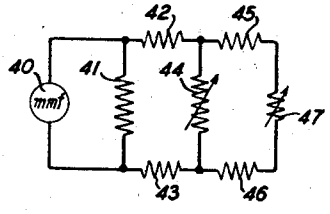
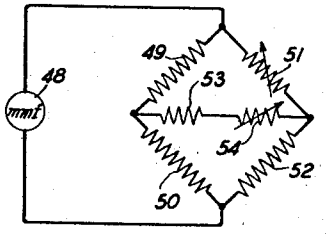


FIG. 8



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MAGNETIC SWITCHHOOK

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FIG. 5

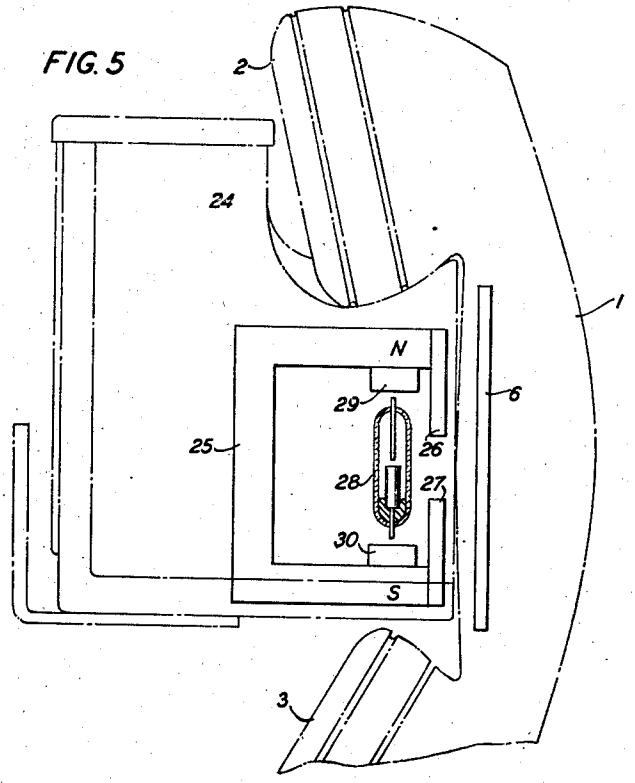
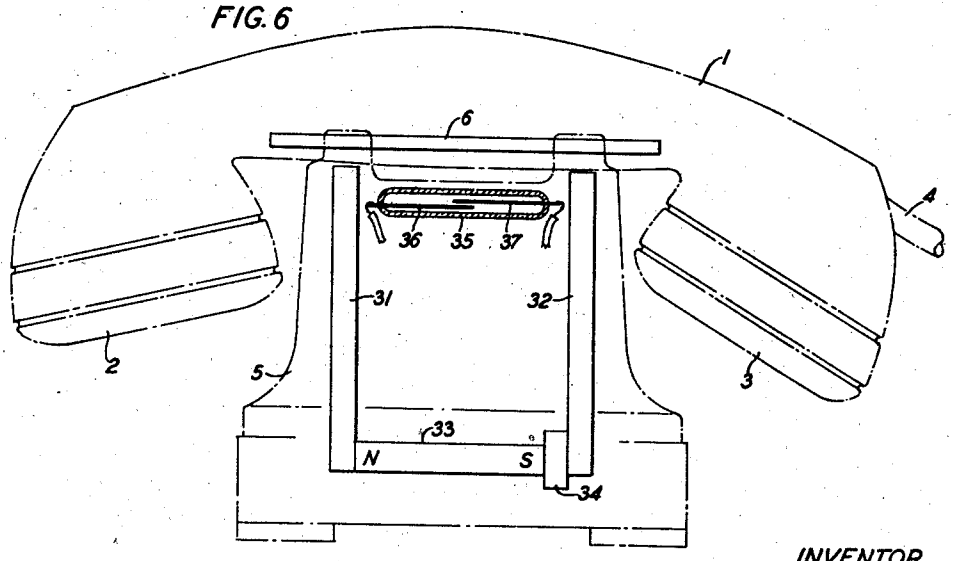


FIG. 6



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Patented June 29, 1943 2,322,851

UNITED STATES PATENT OFFICE

2,322,851

MAGNETIC SWITCH HOOK

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Application January 24, 1941, Serial No. 375,717

9 Claims. (Cl. 179—159)

This invention relates to communication apparatus and particularly to the operation of switching contacts responsive to the taking into use of such apparatus.

When applied to telephone apparatus the invention may be defined as relating to magnetic switchhook operation, the object being to improve the construction arrangement and functioning of subscribers' telephones, by insuring the positive operation of the switching contacts and eliminating moving mechanical parts. Another object is the protection of the contacts against dirt and other foreign matter that would tend to destroy the efficiency of the contact surfaces.

In accordance with the general features of this invention a magnetic circuit including magnetically operated contacts is provided, partly in the apparatus used by the subscriber and partly in the support provided to hold such apparatus when not in use. The movement of the apparatus to and from its support will operate the contacts.

In a specific embodiment of the invention described herein by way of example the magnetic circuit is shown as applied to a telephone handset and its cradle. The handset has incorporated in it a magnetic element which cooperates with other magnetic elements incorporated in the cradle to operate circuit contacts which perform the usual operations of the switchhook contacts.

The magnetic circuit is shown in a variety of forms each having its own peculiar merits. In its simplest form a permanent magnet is embedded or incorporated in the handset so as to operate a set of magnetically operable contacts in the cradle when the handset is placed in its normal position on the cradle.

In another form this order may be reversed, the permanent magnet being placed in the cradle and the contacts in the handset. This latter arrangement is feasible since there are available a variety of sealed magnetic contact devices which will operate satisfactorily when moulded within the plastic handle of the handset.

In a preferred embodiment of the invention the magnetic circuit divided between the handset and the cradle is of improved design. Generally stated it comprises permanent magnetic elements, soft iron elements and magnetically operated contacts properly proportioned and arranged with appropriately dimensioned air-gaps so that when the handset is in its normal position on its cradle the field of the permanent magnet will be sufficiently diverted from the contacts to allow them to assume their normal unoperated positions. When, on the other hand, the handset has been removed from its cradle, the effective field of the permanent magnet must pass wholly through the contacts and in sufficient force to operate them. There is, of course, and particularly where as here the air-gaps play an important part in the magnetic circuit, a certain amount of leakage of the field, but still it can be said that the effective field passes through the contacts. A magnetic circuit of this type may take a variety of forms each having its own peculiar merits, but all operating on the same general principle.

The magnetically operated contacts may be of any well-known form, though herein sealed contacts are shown as being preferable to mere magnetically movable open contacts. Since applicant does not claim any particular type of contact device it may be noted that, among many others, the contacts of the following examples of the prior art may be usefully employed: Cox, 2,207,506, July 9, 1940; Leece et al., 2,029,266, January 28, 1936; Ellwood et al., 2,187,115, January 16, 1940; Harrison et al., application S. N. 302,526, filed November 2, 1939.

A feature of the invention is what may be termed magnetic switching, that is the rearrangement of flux paths in a magnetic circuit, accomplished by changing their respective reluctances relative to one another. It is most easily realized by changing an air-gap and hence magnetic switching is accomplished in the present instance by locating part of the magnetic circuit in the handset of the telephone so that the air-gap between that part and the remainder of the magnetic circuit is changed by the movement of the handset from its cradle.

Another feature of the invention is a set of circuit making contacts in the cradle of a telephone responsive, without intermediary mechanical movement, to the movement of a handset onto and from the cradle.

Another feature is the provision of magnetic means in a handset for operating circuit contacts in a cradle upon the lifting of the handset from the cradle.

Another feature is a compound magnetic circuit having one branch through a set of magnetically operated contacts and another and lower reluctance branch thereof in shunt of said first branch completed through a movable magnetic member. In accordance with this last feature the said movable magnetic member may be embedded in or incorporated in a telephone handset while the remainder of the circuit may

be incorporated in the cradle provided therefor.

Another feature is the provision of a soft iron member embedded in a handset for cooperation with a magnetic circuit including a set of magnetically operated circuit closing contacts constructed and arranged in the cradle provided for the support of the handset, whereby the operation of the said contacts will be equally effective in either of two normal positions of the handset. Since the handset may easily be placed on its cradle with the transmitter and cord end to the right as to the left the use of soft iron does not have the disadvantages of a polarized magnetic element.

Other features will appear in the following description.

The drawings consist of three sheets containing six figures showing various forms of the present invention in schematic outline and two magnetic circuit diagrams for explaining the theory of operation thereof.

Fig. 1 shows a preferred embodiment of the invention wherein the permanent magnet and the circuit contacts are embodied in the cradle for the telephone, known as the attenuator type, depending on loss;

Fig. 2 shows an alternative arrangement of the permanent magnets and circuit contacts, known as the bridge type, depending upon conjugacy;

Fig. 3 shows a simple form of the invention wherein a permanent magnet is embodied in the handset and a set of contacts is located in the cradle;

Fig. 4 is a variation of the device shown in Fig. 3 with the permanent magnet located in the cradle and the contacts in the handset;

Fig. 5 shows an arrangement when a different type of cradle is used in which the handset is hung vertically;

Fig. 6 shows a variation of the magnetic circuit shown in Fig. 1;

Fig. 7 is a magnetic circuit diagram of the arrangement shown in Fig. 1;

Fig. 8 is a magnetic circuit diagram of the arrangement shown in Fig. 2.

In all of the figures the numeral 1 represents the handset carrying a receiver 2 and a transmitter 3. A cord 4 is indicated at the transmitter end of the handset. The handset 1 as well as the cradle on which it rests, here designated by the numeral 5, is shown in dot and dash outline. A rectangle 6 represents a magnetic element in the handset 1. In Fig. 1 the magnetic element 6 is a piece of soft iron which is embedded in the plastic material out of which the handset is moulded. Within the cradle 5 there are two pieces of soft iron 7 and 8, a permanent magnet 9 and a set of contacts 10. With the handset 1 removed from the cradle the field of the permanent magnet 9 will find its way through the soft iron pieces 7 and 8 and the magnetic reeds of the contact 10 and cause these reeds 11 and 12 to make contact with each other. Therefore, when the handset 1 is removed from its cradle 5 the circuit contacts 11 and 12 are closed.

When the handset 1 is placed in the position shown then the soft iron piece 6 will sufficiently divert the field of permanent magnet 9 through the piece 6 and away from the contact reeds 11 and 12 to allow these reeds to return to their release position as shown.

The device of Fig. 1 is known as the attenuator type since the action of the contacts depends on loss of the field when the air-gap between the part 6 and parts 7 and 8 is shortened.

No attempt is made herein to illustrate the true dimensions of these various elements of the magnetic circuit but only to indicate the general plan of operation. There are, for instance, air-gaps between the pieces 7 and 8 and the magnetic element 6 and as well as air-gaps between the ends of the permanent magnet 9 and the magnetic elements 7 and 8. There are necessarily air-gaps between the magnetic element 7 and the magnetic reed 11 as well as between the magnetic element 8 and the reed 12. Again, there is an air-gap between the reeds 11 and 12. These air-gaps as well as the physical dimensions of the various elements are all a matter of practical design and may be varied at will.

Fig. 7 shows the principle of operation of the device of Fig. 1. The permanent magnet 9 is shown as a source of magnetomotive force 40. 41 represents the reluctance of the magnet 9 and 42 and 43 show the reluctances of the air-gaps between the magnet 9 and the pieces 7 and 8, respectively. The variable element 44 represents the reluctance of the combined air-gaps between the pieces 7 and 8 and the magnetic element 6. The diagram elements 45 and 46 represent the reluctances of the air-gaps between the reeds 11 and 12 and the pieces 7 and 8, respectively, and finally the variable element 47 represents the reluctance of the air-gap between the reeds 11 and 12. With the aid of this diagram it will be easy to see that as the reluctance represented by the numeral 44 is increased, by removing the handset from the cradle, a greater magnetomotive force is available to affect the air-gap 47. Conversely, as 44 is made low in value the loss of magnetomotive force becomes so great that the reeds 11 and 12 will part.

The magnetically operated contact device 10 is known generally as an Ellwood relay which is more particularly described in the aforementioned Ellwood patent. Any other type of magnetically operated contact device may be used, however.

In Fig. 2 the same magnetic element 6 is incorporated in the handset but the other elements of the magnetic circuit built into the cradle are somewhat differently arranged. In this case the vertically arranged magnetic elements which are approached by the magnetic element 6 when the handset is placed on its cradle are in the form of two permanent magnets 13 and 14. In this case the magnetically operated contact device 15 is placed substantially midway of the length of these permanent magnets 13 and 14. At the end opposite those ends approached by the magnetic element 6 is a soft iron element 16. With the handset removed from its cradle the field of both the permanent magnets 13 and 14 will thread the magnetic element 16 and the reeds 17 and 18 of the contact device 15 causing the reeds 17 and 18 to make contact with each other. When the handset, however, is placed on its cradle the field of the magnets 13 and 14 is sufficiently diverted from the contact device 15 so that the reeds 17 and 18 separate and open the circuit therethrough.

Where it is said above that the magnetically operated contact device 15 is placed substantially midway of the length of the permanent magnets it should be understood that considerable variation in this placing is possible, as indicated in Fig. 8. Here the magnetomotive force of the magnets 13 and 14 is represented by the diagram

element 48. The reluctance of the path through the magnets 13 and 14 from the position at which the contact device 15 is placed to the ends of the magnets 13 and 14 nearest the soft iron piece 6 is represented by the diagram element 49. Likewise the reluctance of the path through the magnets 13 and 14 from the position at which the contact device 15 is placed to the ends of the magnets 13 and 14 nearest the soft iron element 16 is represented by the diagram element 50. 51 represents the reluctance of the combined air-gaps between the soft iron piece 6 and the magnets 13 and 14 and is shown as variable since this air-gap is the main variable element in the magnetic circuit.

The reluctance of the air-gap between the soft iron piece 16 and the magnets 13 and 14 is represented by the diagram element 52. Likewise 53 represents the reluctance of the air-gaps between the reeds 17 and 18 and the magnets 13 and 14 and 54 represents the variable air-gap between the reeds 17 and 18. Thus it will be seen that if the contact device 15 is placed exactly midway of the length of the magnets 13 and 14, the value of 49 would equal the value of 50 and hence conjugacy would be achieved by having the air-gap 51 equal the air-gap 52 when the handset is on its cradle. It will likewise be seen that these values may be changed in accordance with the well-known principles of the bridge type of circuit.

In both the diagrams of Figs. 7 and 8 the reluctances of the soft iron elements of the magnetic circuit are ignored as being negligible in comparison to the reluctances of the air-gaps.

It should be noted in connection with Figs. 1 and 2 that the contact device 10 in Fig. 1 and the contact device 15 in Fig. 2 both represent either one or a plurality of such devices. In some telephone circuits it may be found sufficient to close only one contact while in others a plurality of contacts must be closed when the handset is taken into use. The usual sequential operation of a plurality of contacts may be secured by using contact devices such as 10 and 15 of different sensitivities or by physically placing them in slightly different locations, and it will readily be seen by the aid of the diagrams Fig. 2 and Fig. 8 that either of these methods or arrangements would produce the desired sequential operation.

Fig. 3 represents a simple form of the invention in which the handset 1 rests on a cradle 5. A permanent magnet 20 is incorporated in the handset and when placed on the cradle as shown, causes the operation of the contact device 21.

In this case the piece 22 becomes an armature which lifts away from a non-magnetic back contact 23 due to influence of the permanent magnet 20. When the handset is removed from the cradle 5 then the armature 22, not being energized any more by the magnet 20, will drop back and make contact with the element 23.

It should be noted that this contact device 21 may be constructed in the form of an ordinary armature and back contact but the sealed type is preferred. As shown this may be a pair of sealed contacts such as shown in the aforementioned Cox or Leece patents or it may be of that type developed by Ellwood with a back contact instead of the usual front contact.

Fig. 4 shows a variation of the arrangement shown in Fig. 3 with the contact device 21 incorporated in the handset and the permanent magnet 20 located in the cradle 5.

In Fig. 5 is shown an alternative arrangement in which the handset 1 is hung in a vertical position on a support 24. A soft iron piece 6 is incorporated in this handset and cooperates with a magnetic circuit placed in the support 24. This consists of a permanent magnet 25 with auxiliary soft iron pole-pieces 26 and 27 and a magnetically operated set of contacts 28. There may be also used further soft iron auxiliary pole-pieces 29 and 30 properly located in relation to the magnetic contact device 28. This contact device may be of any well-known mercury type, for instance, such as shown in the before-mentioned Harrison et al. patent. When the handset 1 is hung in the position shown the field of the magnet 25 is sufficiently diverted through the soft iron pole-pieces 26 and 27 and magnetic element 6 in the handset to allow the contacts of the device 28 to open as shown. When the handset 1 is, however, moved away from this position, the field of the permanent magnet 25 becomes effective to operate the contacts of the device 28 and close the circuit. Again, the device 28 is representative of one or a plurality of such contacts depending upon the circuit arrangement which is to be used.

In Fig. 6 an arrangement, alternative to the arrangement shown in Figs. 1 and 2, is disclosed. In this case the usual soft iron element of the magnetic circuit is incorporated in the handset 1. A pair of soft iron magnetic elements 31 and 32 are placed in the cradle 5 and a permanent magnet 33 is located on the lower extremities of these elements. The rectangle 34 represents a piece of brass or other non-magnetic material and here represents the means whereby the elements may be mechanically secured together while still providing the necessary air-gap. In this case also the Ellwood type unit is illustrated as a magnetically operated contact device 35 having two reeds 36 and 37. When the handset 1 is removed from the position shown and taken into use the field of the permanent magnet 33 finds its way through the elements 36 and 37 of the contact device 35 and causes them to close together thereby closing the electrical circuit therethrough. When the handset 1 is placed in the position shown then the soft iron piece 6 sufficiently diverts the field of the magnet 33 from the elements 36 and 37 to cause them to assume the open position here shown.

It should be noted that in Figs. 1 and 2 the transmitter and cord end of the handset are placed in one position while in Fig. 6 they are placed in another position. This illustrates the fact that with the soft iron piece incorporated in the handset a non-polarized device is provided.

It should be understood that where a permanent magnet is shown herein an electromagnet may be as easily substituted. It is only necessary to have a source of magnetomotive force and hence all references to a permanent magnet should be understood to broadly cover the use of a magnetic structure acting as such a source of magnetomotive force.

What is claimed is:

1. In communication apparatus, a supporting structure, sound translating apparatus removably supported thereon, a pair of magnetic elements in said support each terminating in one end thereof substantially at the surface of said support on which said sound translating apparatus normally rests, a set of magnetically operated circuit contacts extending between the other ends of said magnetic elements, a permanent magnet extending substantially from one of said elements to

the other of said elements at a point substantially midway of their length and a magnetic element incorporated in said sound translating apparatus and disposed to extend substantially between the first ends of said magnetic elements, whereby when said sound translating apparatus is resting in its normal position on said support the field of said permanent magnet is substantially diverted from a path through said contacts to a path through said magnetic element in said sound translating apparatus and whereby as a result thereof said contacts assume their normal unoperated positions.

2. In communication apparatus, a supporting structure, sound translating apparatus removably supported thereon, a pair of permanent magnets in said support each terminating in one end thereof substantially at the surface of said support on which said sound translating apparatus normally rests, a low reluctance magnetic path between the other said ends of said permanent magnets, a set of magnetically operated circuit contacts extending substantially from one of said permanent magnets to the other at a point substantially midway of this length and a magnetic element incorporated in said sound translating apparatus and disposed to extend substantially between the said first ends of said permanent magnets, whereby when said sound translating apparatus is resting in its normal position on said support the field of said permanent magnets is substantially diverted from a path through said contacts to a path through said magnetic element in said sound translating apparatus and whereby as a result thereof said contacts assume their normal unoperated positions.

3. In communication apparatus, a supporting structure, sound translating apparatus removably supported thereon, a pair of magnetic elements in said support each terminating in one end thereof substantially at the surface of said support on which said sound translating apparatus normally rests, a set of magnetically operated circuit contacts extending between the other ends of said magnetic elements, a permanent magnet extending substantially from one of said elements to the other of said elements at a point substantially midway of their length and a magnetic element incorporated in said sound translating apparatus and disposed to extend substantially between the said first ends of said magnetic elements, said various magnetic elements being constructed and arranged to form a magnetic circuit including a plurality of air gaps and so proportioned that when said sound translating apparatus is resting in its normal position on said support the field of said permanent magnet will be sufficiently diverted from a path through said contacts to a path through said magnetic element in said sound translating apparatus to allow said contacts to assume their normal unoperated positions.

4. In communication apparatus, a supporting structure, sound translating apparatus removably supported thereon, a pair of permanent magnets in said support each terminating in one end thereof substantially at the surface of said support on which said sound translating apparatus normally rests, a low reluctance magnetic path between the other ends of said permanent magnets, a set of magnetically operated circuit contacts extending substantially from one of said permanent magnets to the other at a point substantially midway of their length and a magnetic element incorporated in said sound translating apparatus and disposed to extend substantially between the said first ends of said permanent magnets, said various magnetic elements being constructed and arranged to form a magnetic circuit including a plurality of air gaps and so proportioned that when said sound translating apparatus is resting in its normal position on said support the field of said permanent magnets will be sufficiently diverted from a path through said contacts to a path through said magnetic element in said sound translating apparatus to allow said contacts to assume their normal unoperated positions.

5. In communication apparatus, a supporting structure, a hand telephone comprising a receiver and a transmitter moulded into either end of a handle of insulating material removably supported on said supporting structure, a bridge type magnetic circuit having a permanent magnet acting as a source of magnetomotive force effective at two corners thereof and magnetically operated circuit contacts effective at the remaining two corners of said circuit, one arm of said magnetic circuit including a magnetic element moulded into said handle, magnetic elements mounted in said supporting structure and the air gaps therebetween, whereby the force from said permanent magnet effective to operate said contacts may be controlled by varying the said air gaps in said one arm of said bridge circuit.

6. In communication apparatus, a supporting structure, a hand telephone comprising a receiver and a transmitter moulded into either end of a handle of insulating material removably supported on said supporting structure, a complex magnetic circuit comprising a plurality of elements in a plurality of branches and including a permanent magnet and a pair of magnetically operated contacts in one of said branches mounted in said supporting structure, extensions of said magnetic circuit comprising another branch thereof being positioned to be contiguous to said hand telephone when said hand telephone is positioned on said support and a magnetic element moulded in said hand telephone to control said other branch of said magnetic circuit by attenuation when said hand telephone is so positioned.

7. In communication apparatus, a supporting structure, a hand telephone comprising a receiver and a transmitter moulded into either end of a handle of insulating material removably supported on said supporting structure, a complex magnetic circuit comprising a plurality of elements in a plurality of branches and including a permanent magnet and a pair of magnetically operated contacts in one of said branches mounted in said supporting structure, said contacts being mounted within said structure near the surface approached by said hand telephone when positioned on said support and a magnetic element moulded in said hand telephone for completing another branch of said magnetic circuit in parallel with said contacts when said hand telephone is so positioned.

8. In communication apparatus, a supporting structure, sound translating apparatus removably supported thereon, a pair of magnetic elements in said support each terminating in one end thereof substantially at the surface of said support on which said sound translating apparatus normally rests, a third magnetic element extending between the other ends of said first and second magnetic elements, a fourth magnetic element extending substantially from said

first element to said second element at a point substantially midway of the length of said first and second elements and a fifth magnetic element incorporated in said sound translating apparatus and disposed to extend substantially between the first ends of said first and second magnetic elements, one of said elements comprising a pair of cooperating magnetic contacts and at least one other of said elements comprising a permanent magnet operating as a source of magnetomotive force for said magnetic circuit, said various magnetic elements being constructed and arranged to form a magnetic circuit including a plurality of air gaps and so proportioned that when said sound translating apparatus is resting in its normal position on said support the field of said permanent magnet will be sufficiently diverted from a path through said contacts to a path through said fifth magnetic element to allow said contacts to assume their normal unoperated positions.

9. In communication apparatus, a supporting structure, a hand telephone comprising a receiver and a transmitter moulded into either end of a handle of insulating material removably supported on said supporting structure, a complex magnetic circuit comprising a plurality of elements in a plurality of branches including a permanent magnet and magnetically operated circuit contacts, one element of said magnetic circuit being moulded into said handle and the remaining elements of said magnetic circuit being mounted in said supporting structure, the position of said one element in said handle being such that an air gap is included in said magnetic circuit when said handle is in its normal position on said support, and a compensating air gap in said magnetic circuit in said supporting structure whereby the field of said permanent magnet is sufficiently diverted from said contacts in said normal position of said apparatus to release said contacts.

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