Oct. 8, 1946. F. R. McBERTY 2,409,054

RELAY CONSTRUCTION

Original Filed July 29, 1940

Fig. 1.

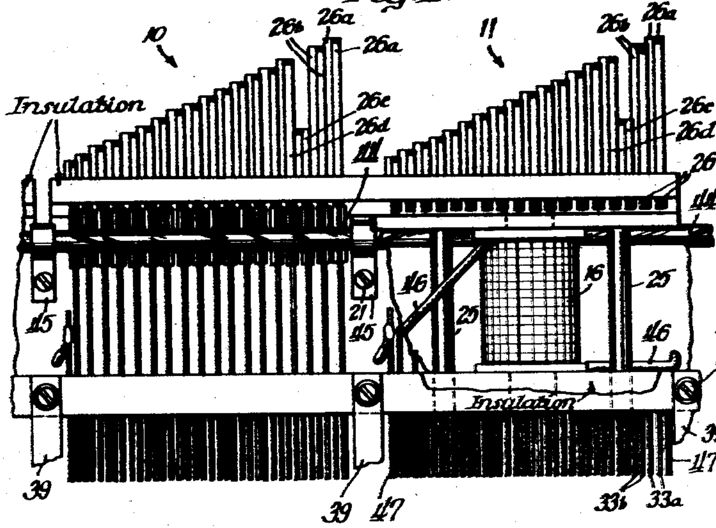


Fig. 2.

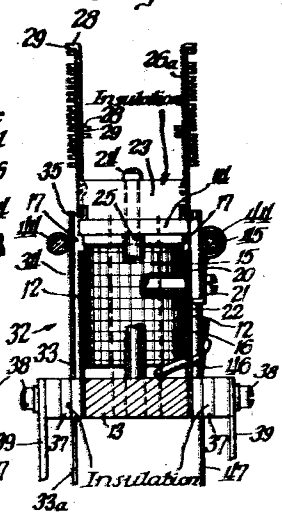


Fig. 3.

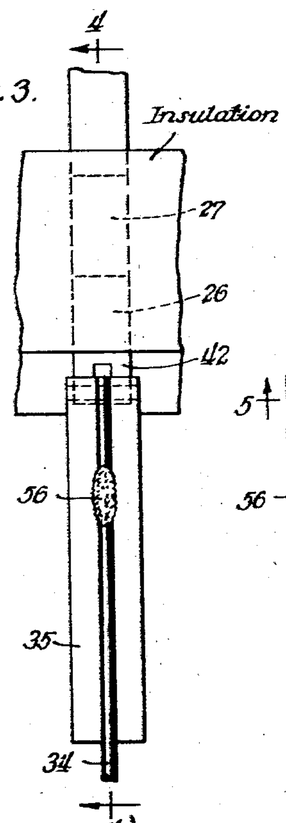


Fig. 4.

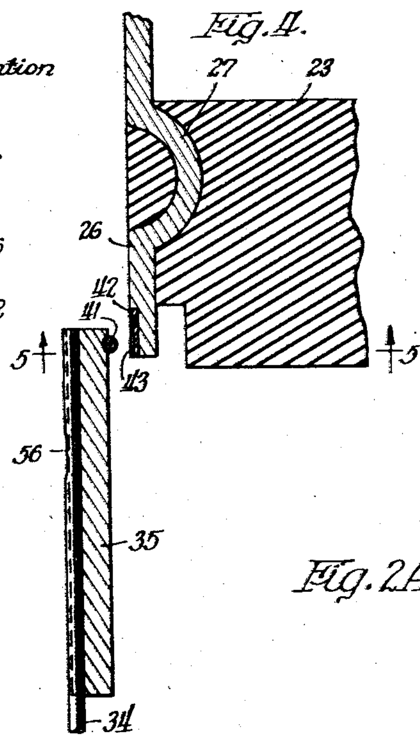


Fig. 5.

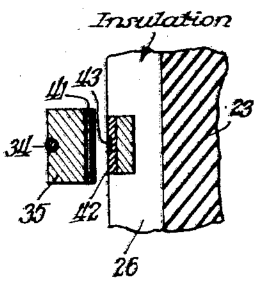
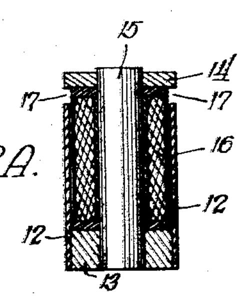


Fig. 2A.



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Attys

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UNITED STATES PATENT OFFICE

2,409,054

RELAY CONSTRUCTION

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8 Claims. (Cl. 200—104)

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My invention relates, generally, to the construction of relays for automatic telephone exchanges and it has particular relation to the construction of the stationary contact members thereof. This application is a division of my copending application Serial No. 348,222, filed July 29, 1940.

The various limitations, costs, defects and failures of automatic exchanges are well known and throughout many years have been the objects of much study, research and invention. They concern the volume and cost of the equipment and its housing, the inadequate speed of operation, electrical interference with or disturbance of the voice currents arising within the switching structure, the power and the destructive effects of its operation, deterioration during the life of many years of uninterrupted operation, changes of structure resulting from abrasion, deformation, stress, corrosion, loss of insulation, changes of speed and timing of movement of parts.

During the life of the equipment, the various factors of change and deterioration require attendance, inspection and test, replacement, repair, adjustment and ultimately total replacement for inoperativeness rather than substitution of radically improved structures. Having in mind these limitations and defects, I have aimed to produce an automatic central-office exchange equipment, compact, unchanging within the limits of necessary operation, durable, simple, utilizing small forces, parts of minimum mass, incapable of adjustment; and have thereby attained speed of action, freedom from internal electrical disturbance and destructive effects, the exclusion of attendance, inspecting, testing adjusting, and repair to a degree not heretofore found in any type of automatic exchange. The compact character permits reduced housing space and cost, combined with reduced hazard of damage; the exclusion of attendance reduces the cost of operation, the hazard of unskilled handling, tampering and sabotage.

To this end, my invention comprises certain new types of electro-magnetic switching devices, certain wiring structures for interconnecting the parts, new forms and compositions of material, and certain methods of utilizing the several materials and producing the desired structures as hereinafter described.

For a more complete understanding of the nature and scope of my invention, reference may be had to the following detailed description taken in connection with the accompanying drawing, in which:

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Figure 1 is a view, in side elevation, certain parts having been broken away to more clearly show the details of construction, illustrating one embodiment of my improved relay construction assembled as a part of a line finder or connector link of an automatic telephone exchange of the relay type;

Figure 2 is an end view of the construction shown in Figure 1, certain parts being shown in section;

Figure 2A is a sectional view, similar to Figure 2, showing in more detail the arrangement of the magnetic circuit;

Figure 3 is a plan view, at an enlarged scale, showing the arrangement of one set of movable and stationary contact members;

Figure 4 is a longitudinal sectional view taken along the line **4—4** of Figure 3; and

Figure 5 is a detail sectional view taken along the line **5—5** of Figure 4.

Referring now particularly to Figures 1 and 2 of the drawing, it will be observed that the reference characters **10** and **11** each designate, generally, a relay construction. Each of these relay constructions may comprise what is known in the telephone art as a tens relay, ten of which are mounted in alignment to provide the tens relay of a line finder or connector link, as is disclosed in more detail in my copending application Serial No. 348,223, filed July 29, 1940. Since the construction of the relays **10** and **11** is identical, only one of them will be described in detail herein.

These relays are designed for use in connection with the type of automatic selective system for automatic telephone exchanges known as the "All-relay" system, of which the selective structure and its mode of operation are described in "Telephone Theory and Practice," by Kempster B. Miller, first edition, 1933, chapter VI.

As shown in Figures 2 and 2A of the drawing, each relay is provided with a magnetic circuit which may be that of an electromagnet having a broad pole piece with a suitable magnetic return. The toward pole piece may take the form of a T and the return pole piece may have the form of an interfitting U member comprising side plates **12** and the back-bar **13**.

The two-sided magnetic structure is designed to receive on each of its sides, groups or armatures whereby the groups of armatures are acted upon by substantially equal portions of the flux generated in the core and thereby respond in substantially equal acts to equal forces.

The T-shaped magnetic member which interfits with the U-shaped magnetic member comprises a pole piece 14 and a core 15. The core 15 comprises the stem of the T and around it is positioned a winding or coil 16 of conventional design. The core 15 may be secured to the back bar 13 and the pole piece 14 by press fits, if it is not desired to provide for ready removal of the coil 16. If it is desired to permit ready removal of the coil 16, then the pole piece 14 should be arranged to be readily detached from the core 15 or the core 15 should be arranged to be readily detached from the back bar 13.

The pole piece 14 is of such material and dimensions with relation to the U-shaped member, the core 15 and the coil 16 that the flux generated by the coil is as nearly as possible equally distributed between the two sides of the pole piece and throughout the length of each side.

It will be observed that air gaps 17 are provided between the ends of the U-shaped magnetic member formed by the side plates 12 and the back bar 13 and the ends of the top of the T-shaped magnetic member formed by the pole piece 14 and the core 15. These air gaps are preferably about $\frac{3}{32}$ inch long. However, these air gaps bear a certain necessary relation to the size and material of the armatures and their proximity to the pole piece, as will be fully described later.

With a view to accurately aligning the side plates 12 of the U-shaped magnetic member with the pole piece 14, clamp plates 20 are provided on opposite sides of the side plates 12 and are secured in position by means of screws 21 which are threaded into the ends of strut members, one of which is shown at 22. It will be observed that the strut members 22 serve not only to provide a clamping action between the upper ends of the clamp plates 20, but also that they serve to space them and the side plates 12 apart.

Positioned on top of the pole piece 14 and common to both of the relays 10 and 11 is an insulating block 23 which is secured in position by screws, one of which is shown at 24, which project through the pole pieces 14 and into the upper threaded end of a strut member 25, the lower end of which is threaded into the back bar 13. The insulating block 23 is preferably formed of mouldable material, such as a thermoplastic. Along the edges of the insulating block 23 are moulded contact members 26 which form the stationary contact members of the relays. As is shown more clearly in Figure 4 of the drawing, each of the contact members 26 is provided with a reentrant portion 27 about which the material forming the insulating block 23 is moulded to securely grip the contact members in position.

Referring again to Figures 1 and 2 of the drawing, it will be observed that the contact members 26 are provided with extensions 26*a*, 26*b*, 26*c*, 26*d*, etc. The extensions 26*a*, 26*b*, 26*d*, etc., are arranged in staggered relation of decreasing lengths and their upper ends are turned outwardly as indicated at 28 and notched as indicated at 29. This staggered arrangement of the extensions is provided in order to facilitate connection thereto of paralleling conductors which can then be positioned in coplanar relation. As is described in detail in my copending application Serial No. 348,223, referred to hereinbefore, corresponding extensions 26*a* of the relays 10 and 11 are connected in parallel circuit relation by a wire which is secured in the notched portions 29 by being spot welded therein.

It will be observed that the upper ends 28 of the extensions 26*c* are turned inwardly rather than outwardly as is the case respecting the other extensions. This construction is employed since these extensions are not paralleled with any other extension of any other relay in the link. In order to permit the conductors connected to extensions, such as the extensions 26*c*, with conductors arranged in coplanar relationship, these extensions on the several relays are staggered by having the upper end portions 28 of different heights.

It will also be observed that the extensions 26*a*, 26*b*, etc., on one side of the insulating block 23 are offset with respect to the corresponding extensions on the other side. The purpose of this offset relationship will be presently apparent.

The contact members 26 and their extensions are formed of good conducting nontarnishing material such as German silver. In the embodiment of the invention shown in the drawing they are 0.080 inch wide and $\frac{1}{32}$ inch thick. The lengths of course vary depending upon the length of the extension individual thereto.

Individual to each of the anvil contact members 26, there is provided a contact finger which is designated generally at 32. Each contact finger 32 comprises a metallic reed 33 in the form of round wire which has good electrical conducting quality and is highly resilient and corrosion resisting. I have found that stainless steel wire, known as 18–8, and having a diameter of 0.016 inch, is highly satisfactory for my purposes.

Mounted on the upper end 34 of each of the metallic reeds 33 is an armature 35 which serves not only to flex the metallic reed 33 on energization of the winding 16 but also it serves to conduct current between the reed 33 and the associated anvil contact member 26. It is noted that the armatures 35 bridge the associated air gaps 17. The armatures 35 are so mounted with respect to the adjacent edges of the pole pieces 14 that an air gap of 0.032 inch is provided therebetween. It is possible to increase this air gap to 0.053 inch but the smaller air gap is preferable. When the armature 35 has been moved into its alternate position on energization of the coil 16, there is provided a residual air gap between the armature 35 and the adjacent edge of the pole piece 14 of from 0.010 to 0.012 inch. It will then be apparent that the movement of the armature 35 from one position to another is about 0.020 inch.

The armatures 35 are formed of material which not only has good electrical conducting properties but also material which is magnetic. I have found that material known as Alleghany metal No. 4750 is entirely satisfactory for this purpose. Each of the armatures 35 is preferably about 0.478 inch long, about 0.080 inch wide and about 0.0429 inch thick.

The lower ends 33*a* of the metallic reeds 33 project beyond insulating support members 37. The insulating support members 37 are formed of the same material as the insulating block 23 and, as will hereinafter appear, the metallic reeds 33 are especially prepared so as to make certain that they will be securely held in the insulating support members 37 on completion of the moulding operation.

Referring to Figure 1 of the drawing, it will be observed that the projecting lower ends 33*a*, 33*b*, etc., of the metallic reeds 33 extend downwardly through the same distances. It will also be observed that the lower ends 33*a*, 33*b*, etc., on one side of the relay construction are offset with respect to the corresponding lower ends 33*a*, 33*b*, etc., on the other side. This arrangement is provided in order to permit the coplanar arrangement of cross connecting conductors between corresponding tens relays of adjacent links as is described more fully in my copending application, referred to hereinbefore. The cross connecting conductors are secured by suitable means, such as welding, to the lowermost portions of the projecting lower portions **33a**, **33b**, etc. Since these projecting portions are staggered, the cross connecting conductors can obviously be arranged in a single plane, as described. Since the contact members **26** are arranged in alignment with their respective contact fingers **23**, the reason for the offset positions of the contact members **26** on the opposite sides of the insulating block **23** will now be apparent.

The insulating support members **37** in which are moulded the metallic reeds **33** may be secured in position on the back bar **13** by means of screws **38**. These screws also serve to carry support members **39** which are arranged to support conductor brackets carrying conductors extending underneath the relays **10** and **11**. As is set forth in detail in my copending application Serial No. 348,223, referred to hereinbefore, certain of the downwardly extending ends **33a**, **33b**, etc., of the metallic reeds **33**, are arranged to be connected in parallel in their respective links, while the remaining downwardly projecting end portions are arranged to be cross connected as described.

As shown more clearly in Figures 3, 4 and 5 of the drawing, each of the armatures **35** is provided with an erosion resisting contact member **41** in the form of a short length of round wire. The contact member **41** is preferably formed of good conducting material which will resist erosion due to abrasion and arcing. I have found that round wire formed of palladium is satisfactory for this purpose. A wire having a diameter of 0.020 inch and a length of about 0.070 inch of this material is welded, as shown, across one face of the armature **35** to provide the contact engaging surface thereof.

Each of the contact members **26** is likewise provided with erosion resisting material. As shown, this comprises an insert **42** in the lower end of each of the contact members **26**. The inserts **42** may be formed of palladium and are inlaid by conventional means in a strip of German silver from which the contact members and their integral extensions are cut. The insert **42** is preferably about $\frac{1}{32}$ inch wide and about 0.010 inch thick. As indicated at **43**, each of the inserts **42** is grooved intermediate its ends so as to provide two distinct points of contact engagement with the generally cylindrical contact member **41** carried by the armature **35**. In the event that the alignment between the armature **35** and the contact member **26** is not such as to initially cause both contact engagements to take place, it will be obvious that the armature **35** will be turned slightly due to the pull of the flux generated by the coil **16** so as to cause the two point contact engagement as described.

The lower end of the stationary contact conductor **26** is free of the backing of the insulating support **23**, as will be seen in Figures 2, 3 and 4. This avoids the danger of clogging the contact portions with insulation, and it leaves the free portion of the stationary contact conductor **26** of such short length that its natural period of vibration is extremely high.

It is highly desirable that the armatures **35** associated with each side of each of the relays **10** and **11** be accurately aligned so that uniform air gaps are provided between them and the adjacent edges of the pole pieces **14**. For this purpose, as shown in Figure 2 of the drawings, the metallic reeds **33** are so arranged that they tend to bias the armatures **35** outwardly to a position beyond the normal open circuit position.

The stop member **44** of suitable, hard, rigid and non-hygroscopic material such as Pyrex glass, is positioned along the armature **35**, and is so located that the inherent resilience of the metallic reeds **33** urge the armature into engagement therewith. The glass rods **44** are held in position by means of suitable non-magnetic clamp members **45** which are held in place by the screws **21**. It is the common experience in apparatus of the types herein under consideration that the resting anvils upon which spring points, levers and armatures normally rest under more or less pressure are subject to various changes which alter the positions of the resting parts and delay or stop their operation. The metals and some insulating material used yield under the hammering of the return strokes of the parts and alter the position of rest and consequently the operating adjustment. Moisture is deposited upon the surfaces which affects the material chemically, or in the case of sudden lowering of temperature, may actually freeze the parts in their resting position; oxides and impalpable metallic powders form; dust accumulates; the moisture when present consolidates these extraneous materials into adherent scales or adhesive cements, the deleterious action of which is increased as the contacting surfaces are hammered down into close fitting surfaces. These effects disturbing to the operation, vary with temperature, moisture and frequency of operation and require a large factor of safety in the forces required to move the movable part from its resting anvil. In the course of a relatively short period, such parts require cleaning and in the meantime, increasingly frequent and irregular failures of operation may take place. The moving parts—armatures and reeds—in the invention here described, bear upon their resting anvils with slight force, merely enough to fix accurately the position of rest, and are intended to be operated upon by minimum attractive forces, since by these means the energy consumed by the device and the detrimental and destructive effects of the motion are reduced to a minimum and the speed of operation is increased.

The stop-rod **44** of Pyrex or equivalent glass, is straight, inflexible, unchanging under normal temperatures; it is not deformed by the impact of the parts resting upon it; it suffers no chemical change, accumulates no moisture or dust, it changes temperature slowly and does not freeze the armatures; and in no way injuriously affects the metal parts resting upon it. In fact, the operation of the armatures hundreds of millions of times, equivalent to thousands of years of commercial operation, exhibits practically no alteration in the characteristics of operation. It must be assumed that the impact of the returning armature upon the glass rod must expend in heat its energy of motion and must create some vibration; but it is found that the period of vibration is of such high frequency and so brief as to be hardly detectable in a cathode ray oscillograph.

Not only do the glass rods or stop members **44** align the armatures **35** so that uniform air gaps are provided, but also they serve to prevent oscillation of the armatures **35** on the deenergization of the coil **16**. As soon as the armatures **35** engage the stop members or glass rods **44** they are immediately brought to rest without vibration or shattering.

It will be noted that leads **46** from the coil **16** are brought out and are connected to metallic reeds **47**, which also extend through the insulating support members **37**.

Since certain further changes may be made in the foregoing described constructions and different embodiments of the invention can be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. A stationary contact assembly comprising a series of closely spaced flat metallic strips having body portions disposed edge to edge substantially in the same plane, said strips having their lower ends disposed on substantially the same level, and their upper ends disposed at different levels and extending laterally out of said plane, erosion resisting contacts mounted on the strips at their lower ends, said strips having looped portions in alignment adjacent said lower ends and a supporting block of insulation having a face thereof disposed substantially in the plane of said strips and having integral portions moulded around and extending over said loops for holding the strips in fixed position.

2. A stationary contact assembly comprising a series of closely spaced thin flat metallic strips having their lower ends aligned edge to edge on the same level, contact points on said aligned lower ends, a supporting block of insulation having a face lying substantially flush with the front faces of the lower ends of said strips, said strips having offset portions above the contact points disposed within and moulded in the body of insulation to hold the strips in fixed position, and having upwardly extending portions providing terminals.

3. A stationary contact assembly comprising a series of thin flat metallic strips having their lower ends disposed in parallelism edge to edge, contacts of erosion resisting metal mounted on said lower ends, a flat block of insulation forming a support for said strips, said block having an edge face substantially flush with the outer surfaces of said lower ends of the metallic strips, each of said strips having a part of its length offset into and embraced by and moulded in the material of the block of insulation and having an upwardly extending terminal portion.

4. A contact member for a multiple relay comprising a flat sided strip of tarnish resisting metal having a plate of precious metal upon the flat face at its lower end, said plate of precious metal being inset to be substantially flush with the face of the strip and having a groove extending longitudinally of the strip, the strip having a lateral loop adjacent its lower end forming an anchorage by which the member is adapted to be supported and having a laterally offset terminal portion at its upper end, said terminal portion having a notch for locating a connecting wire.

5. The contact of claim 4 wherein the strip is formed of German silver and the contact plate of palladium.

6. Multiple contact arrangement comprising a stationary contact element, a flat narrow metallic strip fixedly supported in insulated relation, a contact plate of erosion resisting metal clad upon the face of the lower end thereof, a groove formed in said contact plate to provide ridges on opposite sides of the groove, a cooperating movable contact element cooperating with said stationary contact element, said movable contact element comprising a narrow rigid metallic armature aligned longitudinally with said strip and having its inner end overlapping said contact plate, a slender spring wire reed upon the outer end of which said armature is rigidly attached in longitudinal alignment, and a short piece of fine contact wire of an erosion resisting metal welded upon and across the upper overlapping end of the armature and lying transverse to the aforesaid ridges on the stationary contact, said wire reed being adapted to be flexed longitudinally to bring said contact wire into engagement with said contact plate and adapted to be twisted if necessary to secure engagement of said contact wire with both ridges when the movable contact element is urged toward the stationary contact element.

7. Contact means comprising a series of coplanar edge to edge metallic strips of graduated length, said strips having their lower contact ends disposed in alignment and having looped portions extending out of the plane of the bodies of the strips, a bar of insulation moulded about said loops and substantially flush with the outer faces of the strips and leaving the lower contact ends and the upper ends of said strips free.

8. The contact assembly of claim 2, wherein the upwardly extending portions have laterally extending terminal portions of substantially equal length lying at spaced levels above said block, and said laterally extending terminal portions have their ends grooved to provide seats for receiving bare wire conductors.

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