

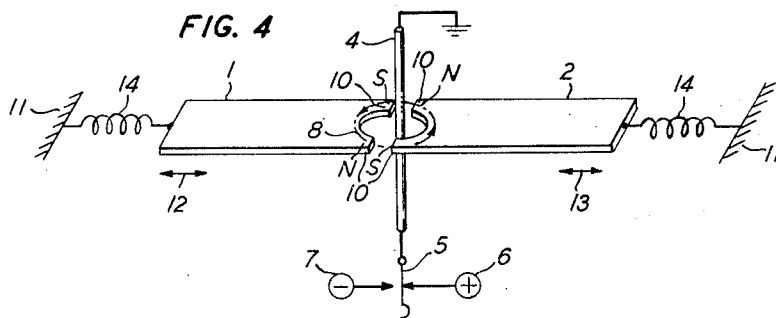
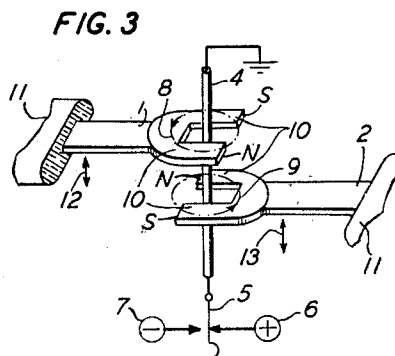
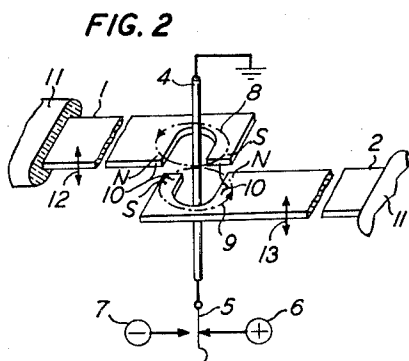
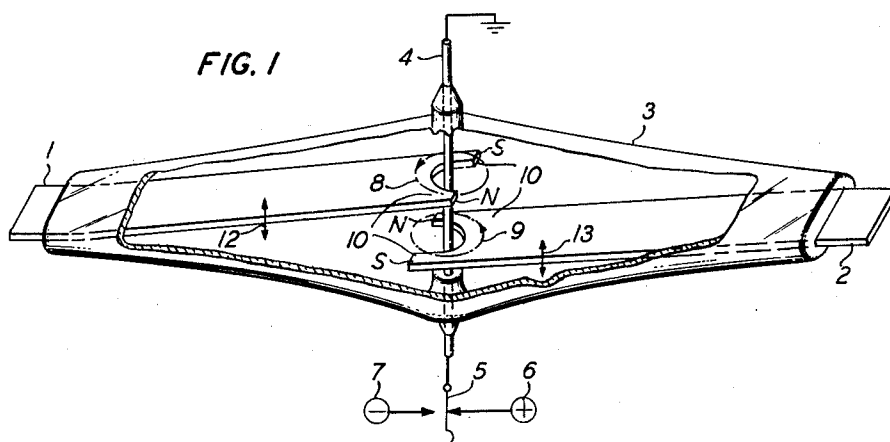
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H. N. WAGAR

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FORKED MAGNETICALLY OPERATED CONTACT ASSEMBLAGE

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INVENTOR
H. N. WAGAR
BY *Turner*
ATTORNEY

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FORKED MAGNETICALLY OPERATED CONTACT ASSEMBLAGE

Harold N. Wagar, Madison, N.J., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

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This invention relates generally to contact devices, particularly to such devices employing magnetic contacts, and more particularly to the contact control mechanisms thereof wherein magnetic flux is utilized to control contact operations.

In the prior art, generally, magnetic contact control of contact devices has been accomplished by utilizing a magnetic flux driven longitudinally through contact members and across an air gap at the contacting surfaces thereof. Of course, many different structural arrangements exist which enable the generation of such a longitudinal flux. These structures can be classified into at least two categories: a coil surrounding the contacts, which coil, when energized, generates a flux axial of the coil and in line with or longitudinal of the contacts; and other means, such as a magnetizable core, magnetically coupled to at least one of the contacts, which core, when magnetized, generates a flux which is driven longitudinally through the contacts.

The use of a longitudinal flux, per se, does not present any substantial problem. However, in order to produce this flux, either one or both of the above structures has been employed. These structures have deficiencies which detract from the optimum use of a longitudinal flux to effect magnetic contact control of a contact device. One particularly significant deficiency is that the presence of a coil or magnetic core may hinder any attempt to substantially miniaturize the contact device since the coil or core is limited in the extent to which it, per se, can be miniaturized.

This particular deficiency, as well as others, is difficult to eliminate in the structural arrangements heretofore known. Accordingly, either a new type structure to effect a longitudinal flux or a new way to direct flux is necessary to effectively reduce or eliminate these deficiencies. The first, i.e., the use of different structures has been employed to obtain more or less different desired results. The second alternative, i.e., a new way to direct flux, has also been employed where magnetic contact control is effected by the use of a current driven through the reeds of a sealed reed switch held operated by a bias flux. The current causes circular magnetic flux about the reeds which disturbs and reduces the bias flux and allows the reeds to release. The disadvantage of this way of directing flux is that it can be employed only to cause the release of operated reeds: it seems to lack the utility for causing operation of the reeds.

Although in many cases these above-mentioned structural arrangements effecting a longitudinal directing of flux in line with the contact members and effecting a circular directing of flux about the members are adequate to magnetically control contact operations in required manners, it has been found desirable to employ other ways of directing flux to magnetically control contact operations.

To this latter end the principal object of my invention is to provide a new way of directing flux to effect magnetic control of the contact actions of contact devices.

Another part of the principal object of my invention is to provide a new structural arrangement which will enable the attainment of this new way of directing flux.

A further object of my invention is to take advantage of the new structural arrangement and the new way of di-

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recting flux to effect improvements in the characteristics of such devices. Some examples of such improvements are the simplification of such devices, the enabling of easy miniaturization of such devices, the reduction of the mass of the contact elements of such devices, the increase in speed of contact response of such devices, and the reduction of the cost of producing such devices.

These and other objects of my invention are attained in a specified illustrative embodiment thereof which comprises a pair of bifurcated magnetizable reeds or U-shaped elements supported in operative relationship to each other at their forked ends with the fork cradles of the reeds being diametrically opposite each other, and a conductor disposed within the fork openings of the reeds. Thus, the conductor is magnetically coupled commonly to the forked ends and the fork cradles of both reeds. When the conductor is energized, annular or circular magnetic fluxes are caused about the conductor magnetically coupling the forked ends and fork cradles of the reeds. The forked ends of the reeds provide breaks or changes in the magnetic reluctances of the magnetic circuits traversed by the fluxes. Consequently, magnetic poles are induced at the forked ends of the reeds, the magnetic poles induced at the two ends of one reed being opposite to the magnetic poles induced at the corresponding ends of the other reed. The correspondingly opposite poles cause mutual attraction between cooperating times, thereby to effect closure of the reeds. Release is effected by reducing the strength of the magnetic poles at the ends of the reeds. The restoring forces of the reeds pull apart the reeds.

Therefore, a feature of my invention is a contact device wherein I provide a pair of forked magnetic reeds or elements supported in operative relationship to each other at their forked ends and means for producing annular or circular magnetic flux linking the forked ends in the plane or planes of the forked ends.

A further feature is provision of means to cause an electrical current flow along an axis lying through the respective forked end openings between the times of the forked ends, thereby producing a magnetic flux annularly about that axis so as to link the forked ends of the reeds.

A further feature of my invention is the provision in such a contact device of a conductor disposed within the openings between the times and means for energizing the conductor to cause circular or annular magnetic fluxes about the conductor magnetically coupling the forked ends of the reeds, thereby to effect appropriate magnetization of the times of the forked ends and consequent control of their contact actions.

A complete understanding of these and other objects, features, and advantages of my invention may be gained from a consideration of the following detailed description and accompanying drawing, in which:

FIG. 1 depicts one embodiment of my invention employing forked magnetic reeds with overlapping and cooperating ends;

FIG. 2 depicts another embodiment of my invention in which the magnetically affected portions of the reed are located away from the ends thereof;

FIG. 3 depicts still another embodiment of my invention in which only the semicircular ends of reeds of another type are of a remanently magnetic material; and

FIG. 4 depicts a further embodiment of my invention in which the cooperating ends of the forked reeds are positioned in the same plane.

Referring now to the drawing, in FIG. 1, I show a pair of bifurcated reeds 1 and 2 of remanently magnetic material held in overlapping relationship at their forked ends 10 by envelope 3, which can be of any suitable material, preferably of glass. A remanently magnetic material, as is well known in the art, is that type which retains a substantial degree of magnetization after removal of the mag-

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netizing force under specified conditions of use. The envelope 3 seals the reeds in an appropriate atmosphere, such as an inert gas like neon, to protect them from tarnish and other forms of deterioration. The glass is shown cut away to expose the various parts to closer scrutiny. Conductor 4 is disposed between the forked ends or tines 10 of the reeds 1 and 2 and perpendicular, i.e., at right angles, to the planes of the contact surfaces and ends of the reeds. Accordingly, by applying well-known magnetic principles, any magnetic flux generated by conductor 4 will be in the planes of the contacting surfaces of the ends 10. The conductor 4 is sealed in envelope 3, as depicted, and is terminated in ground at one end thereof and in switch 5 at the other end thereof. Through switch 5, either negative polarity battery 7 or positive battery 6 can be connected to the conductor 4. Although it is preferable to use two forked reeds, I can also practice my invention with only one forked reed, the other reed being of the ordinary unforked type.

To operate my embodiment of FIG. 1, I close switch 5 to its right position for a brief interval of time to thereby connect positive polarity battery 6 to conductor 4 in the manner depicted and to cause current to flow upward in conductor 4. Current from battery 6 causes circular magnetic fluxes which are in planes perpendicular to the conductor 4. These fluxes are in the planes of the contacting surfaces of the forked ends 10 of reeds 1 and 2, and are in the directions represented by arrows 8 and 9; the direction of flux flow is assumed as determined by the familiar right-hand rule. These fluxes are coupled respectively to the fork ends 10 and to the end-interconnecting fork cradles of reeds 1 and 2 and cause establishment of the magnetic remanences of the ends and fork cradles to one of their two stable states. Because of the forked or bifurcated nature of the ends of the reeds, the magnetic flux resulting from the remanent states is forced into a path around the conductor 4 including a magnetic air gap. Accordingly, at the contact portion or forked end from which the flux emerges into the air path a north pole is created while a south pole is created at the contact portion or forked end into which the flux returns. While the same poles are created in both reeds, by positioning the reeds so that the openings in the forked ends are opposite each other, the magnetic poles at adjacent ends of the two reeds are opposite.

Thus, the fluxes induce appropriate magnetic poles at the forked ends 10; the magnetic poles at the forked ends 10 of each reed are opposite, and the forked ends 10 of one reed (e.g., 1) have opposite magnetic poles from the corresponding forked ends 10 of the other reed (e.g., 2). Consequently, the ends 10 mutually attract to cause contact closure between reeds 1 and 2. The reeds are movable in the direction indicated by arrows 12 and 13. This operation can advantageously be effected by a relatively short duration pulse from battery 6. The reeds subsequently respond in their natural response time after termination of the pulse or energization. The reeds are held closed after termination of the pulse by the remanent magnetic forces between the contact ends thereof.

To effect a released condition of the embodiment of FIG. 1, I close switch 5 to its left position for a brief interval of time to thereby connect negative battery 7 to conductor 4 and to cause current to flow downward in conductor 4. This causes to be generated about the conductor 4 circular or annular magnetic fields which are opposite from those illustrated by arrows 8 and 9. Thus, the forked ends 10 of the reeds 1 and 2 are briefly demagnetized and release is effected by the reeds pulling apart due to their restoring forces. A small amount of residual magnetism may remain after the demagnetizing pulse is terminated. The restoring forces are greater than the residual magnetism forces. The negative current from battery 7 is of less amplitude than that from battery 6, in order to guard against false reclosure which otherwise might be caused by remagnetizing the forked ends 10 in the opposite direction and causing their reattraction by

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the reversed polarity magnetic poles. It is to be understood, that batteries 6 and 7 are employed only for purposes of illustration; other sources of energy known in the art, such as pulse generators, et cetera, can be employed to achieve the same results.

Within the broad aspects of my invention, I can employ other types of reed-forked end arrangements. A few such other types of arrangements are depicted in FIGS. 2, 3 and 4. In these figures, I have used the same numbering scheme as that used in FIG. 1 to label the corresponding parts. In place of the glass envelope 3, which was employed to support the reeds in overlapping position, I depict, for illustrative purposes only, support bases 11, which can be any type known in the art, such as a can enclosure. These alternative embodiments have common characteristics; the parts 10, described as forked ends in the embodiment of FIG. 1, are positioned with respect to each other in the same general operative relationship; there are two parts 10 on each reed interconnected by a magnetizable element (referred to as fork cradles in the embodiment of FIG. 1); the interconnecting portion of one reed is positioned on one side of conductor 4 diametrically opposite the interconnecting portion of the other reed; and, the conductor 4 is disposed perpendicular to the planes of parts 10.

Referring more specifically to each figure, FIG. 2, shows parts 10 at the sides of reeds 1 and 2. This embodiment is operated and released in a manner similar to that described in the embodiment of FIG. 1. The reeds can also be disposed in the same plane with the parts 10 of each reed facing each other. In that case there should be pivot points at the support bases 11 and about which the reeds 1 and 2 can rotate in the operate state to effect electrical contact between the parts 10 of the respective reeds.

FIG. 3 shows forked members similar to that depicted in FIG. 1; however, the members 1 and 2 are narrower, and only the U-shaped parts 10 are of remanently magnetic material. The remaining narrower portions of the members 1 and 2 may be of any suitable spring material. Advantageously, with this embodiment, the masses of the contact arrangements may be small and operation and release can be effected with the use of a minimum amount of power. Operation and release is in the same manner as that described above for the embodiment of FIG. 1.

FIG. 4 shows parts 10 as forked ends of reeds similar to that depicted in FIG. 1; however, the reeds 1 and 2, and the parts 10 thereof are disposed in the same plane, with conductor 4 positioned between the forked ends. Interconnected between bases 11 and reeds 1 and 2, respectively, are representative springs 14. The particular positioning and attachments of the spring 14 are given in this depiction for illustrative purposes only, it being apparent that the supporting and terminal fittings for the reeds 1 and 2 can be arranged in any manner known to one skilled in the art. Operation of this embodiment is in the same manner as that described for the embodiment of FIG. 1, except that the circular magnetic field causing circular magnetic fluxes (represented by arrow 8) is common to the parts 10 of both reeds 1 and 2. This does not change in any substantial manner the mode of operation above described for the embodiment of FIG. 1. The released condition is, however, effected in a different manner. When parts 10 are demagnetized briefly, the springs 14 exert forces which pull apart the reeds 1 and 2.

It will be clear to one skilled in the art that the spring forces, in all of the depicted embodiments, must be of sufficient strength to cause the reeds to be pulled apart by overcoming any residual magnetism and yet enable the remanent magnetic forces of the magnetic poles to pull them together during operation.

The material used in the forked ends or parts 10 of any of the embodiments of FIGS. 1-4, can be either remanent material or soft magnetic material, e.g., iron-nickel. An especially suitable remanent magnetic ma-

terial is one having a substantially rectangular hysteresis loop with a coercive force in the neighborhood of 25 oersteds, and magnetic reduction of about 18,000 gauss. If the parts 10 are of remanent material, the actuation current applied to conductor 4 need be only of short duration; if the parts 10 are of soft magnetic material other than the remanent type, the actuation current must be applied continuously. In the latter instance, when the actuation current is removed, the magnetism of the reeds will also be removed and the reeds will release.

Although the conductor 4, in these figures, is depicted as being perpendicular to the planes of the contact surfaces of the end parts 10, I can also practice my invention by setting the conductor at other angular positions with respect to the planes of the end parts 10.

Furthermore, I can also use a plurality of separate conductors instead of one conductor within the fork openings to accomplish various circuit control features, such as coincident current operation, et cetera.

It would be apparent to one skilled in the art that the fork cradles of the reeds can be disposed at any suitable position with respect to each other and with respect to the conductor; they need not be on diametrically opposite sides of the reeds as depicted in FIGS. 1, 2, 3 and 4.

The discontinuities in reluctances between the forked ends of the reeds and the air gaps can also be attained by the presence of a nonmagnetic material adjacent the forked ends in the place of air. In either event, the substantial differences in the reluctances of the magnetic material of the forked ends and of the nonmagnetic material will enable the induction of magnetic poles at the forked ends in the manner above described.

It is to be understood that the above-described embodiments of my invention are given to illustrate the principles of my invention. Numerous other devices and arrangements may be devised by those skilled in the art without departing from the spirit and scope of my invention.

What is claimed is:

1. A contact device comprising a pair of magnetizable contact elements contiguously disposed, at least one of said elements comprising two contact portions and an interconnecting portion to form an opening between said contact portions, said contact portions of said one element being operative with the other element; and conductor means commonly magnetically coupled to the contact and interconnecting portions of said one element and disposed within said opening, said conductor means selectively energizable to cause circular magnetic flux thereabout coupling said contact portions thereby to effect magnetizations of said contact portions.

2. The invention defined in claim 1 wherein said other element comprises two contact portions and an interconnecting portion joining said contact portions to form an opening between said contact portions, said conductor means commonly magnetically coupled to the contact and interconnecting portions of said other element, and said element being disposed such that the openings thereof will be aligned and such that the contact portions of each element will be correspondingly opposite each other whereby selective energization of said conductor means causes selective magnetizations of aligned contact portions of both said elements thereby to effect control of the actions thereof.

3. The invention defined in claim 2 wherein said conductor means is at least one conductor positioned through the aligned openings of both said elements.

4. A contact device comprising a pair of magnetizable contact elements contiguously disposed, at least one of said elements comprising two contact portions and an interconnecting portion arranged to form an opening between said contact portions, said contact portions being operative with the other element across an air gap defined therebetween; and conductor means commonly magnetically coupled to the contact and interconnecting por-

tions of said one element and disposed within said opening, said conductor means energizable to cause circular magnetic flux thereabout coupling said contact portions thereby to effect opposite magnetizations of said contact portions, said magnetizations effecting consequent attraction of the contact portions of said one element to said other element thereby to effect closure with each other.

5. The invention defined in claim 4 wherein said other element comprises two contact portions and an interconnecting portion joining said contact portions to form an opening between said contact portions, said conductor means commonly magnetically coupled to the contact and interconnecting portions of said other element, and said elements being disposed such that the openings thereof will be aligned and such that said contact portions of each element will be correspondingly opposite each other whereby energization of said conductor means causes correspondingly opposite magnetizations of aligned contact portions of both said elements thereby to effect mutual attraction and consequent closure thereof.

6. The invention defined in claim 5 wherein said conductor means is at least one conductor positioned through the aligned openings of both said elements.

7. A contact device comprising a first pair of magnetically interconnected contacts disposed in a first plane; a second pair of magnetically interconnected contacts disposed in a second plane; means for supporting said first pair in operative relationship to said second pair with the interconnected portions thereof being opposite each other; conductor means disposed between and magnetically coupled to the contacts of both said pairs and substantially perpendicular to the planes thereof; and means for energizing said conductor means in a particular manner to cause circular magnetic fluxes in said planes to induce particular magnetic poles at the contacts of said first pair and opposite magnetic poles at the corresponding operative contacts of said second pair thereby causing mutual attraction of said first and second pairs.

8. The invention defined in claim 7 wherein said contacts are of remanently magnetic material and wherein said magnetic fluxes cause change of the remanent magnetization of said contacts to induce appropriate magnetic poles thereat.

9. The invention defined in claim 8 further comprising means for energizing said conductor means in another manner to cause circular magnetic fluxes in said planes to reduce the strength of said induced poles at the contacts of said pairs thereby to cause mutual repulsion thereof.

10. The invention defined in claim 9 wherein the contacts of each pair are the forked ends of a bifurcated reed and wherein the reeds are supported by said supporting means in overlapping relationship at the forked ends thereof and wherein said conductor means is disposed through the fork openings of each of said reeds.

11. The invention defined in claim 9 wherein the contacts and interconnected portions of each pair are arranged in the same plane and wherein said conductor means is positioned between the contacts of each pair.

12. The invention defined in claim 9 wherein the contacts of each pair are disposed on a reed at a particular location away from the reed end and wherein said conductor means is commonly positioned between the contacts of each reed.

13. The invention defined in claim 9 wherein only the forked ends of said reeds are of remanently magnetic material, the remainder of said reeds being of a suitable spring material.

14. A contact device comprising a pair of reeds each having a forked end comprising a plurality of magnetic tines interconnected by fork cradles defining fork openings between adjacent tines; means supporting said reeds so that each tine of one reed is adjacent a corresponding tine of the other reed to define magnetic air gaps between corresponding tines, so that corresponding fork cradles

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of said two reeds are situated at different angular positions about an axis common to respective corresponding fork openings of said two reeds, and so that the next adjacent tines of each reed are situated at different angular positions about said axis; and means for producing annular magnetic fluxes about said axis and encompassing the tines and fork cradles of said two reeds.

15. The invention defined in claim 14 wherein said supporting means holds said corresponding fork cradles of said two reeds situated at diametrically opposite positions about said axis and holds said next adjacent tines of each reed situated at diametrically opposite positions about said axis.

16. The invention defined in claim 15 wherein said flux producing means is a conductor situated coaxially with said axis and common to respective corresponding fork openings of said two reeds.

17. The invention defined in claim 16 wherein said supporting means holds said tines and said corresponding fork cradles of said two reeds situated in planes orthogonal to said conductor.

18. An electrical contact device comprising a pair of magnetic members each having a forked end and defining contact portions at said ends, contact portions of each member being positioned adjacent contact portions of the other member, and means for creating opposite magnetic poles at said adjacent contact portions of said pair of members, said means including a conductor positioned substantially perpendicular to said ends and within the openings of said forked ends of said members.

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19. An electrical contact device comprising a pair of magnetic members each having a forked end and defining contact portions at said ends and means for controlling the contacting of said contact portions, said means comprising a conductor disposed within the forked ends of said magnetic members and magnetically coupled thereto and means supporting said members such that the open sections of said forked ends are disposed on opposite sides of said conductor.

20. An electrical device in accordance with claim 19 wherein said forked ends are of a remanently magnetic material having stable states of magnetic remanence and wherein said controlling means includes first means for applying current through said conductor for remanently magnetizing said forked ends in a stable magnetic remanent state and second means for applying current through said conductor to demagnetize said forked ends without remanently magnetizing said ends in a different stable remanent magnetic state.

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