

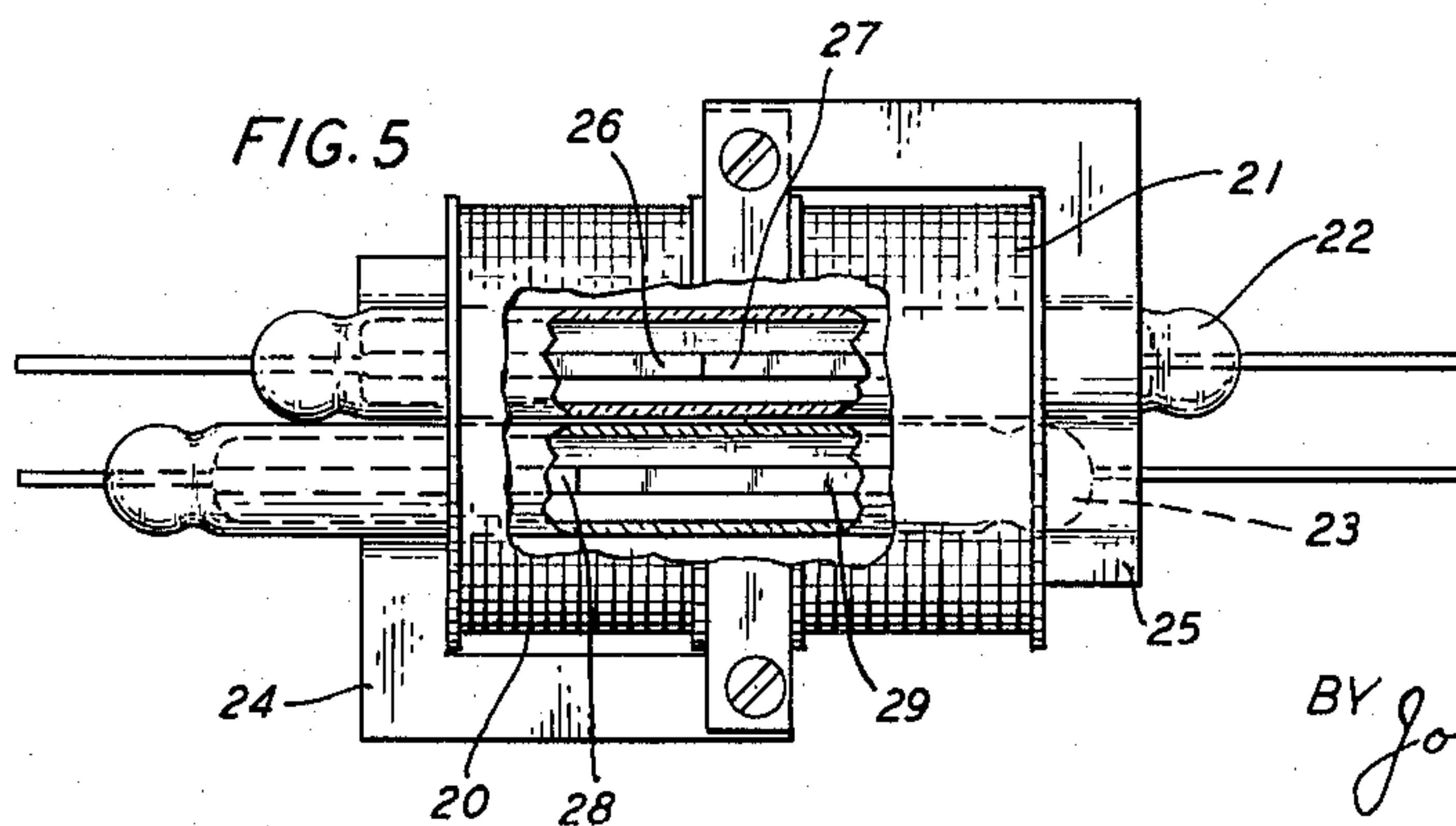
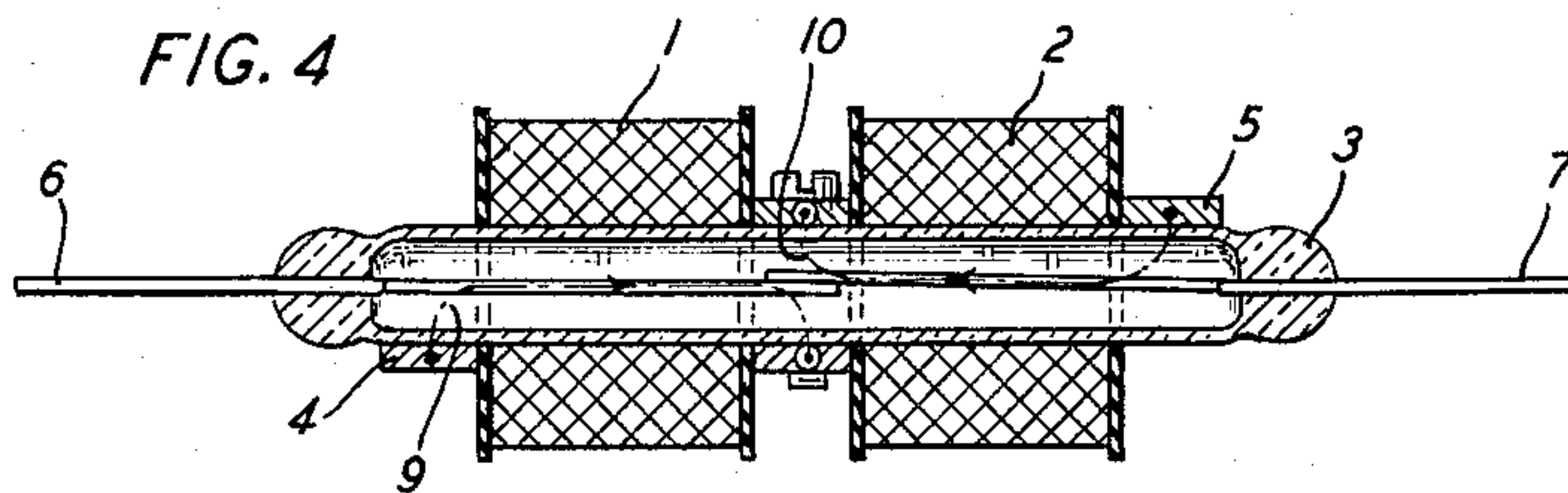
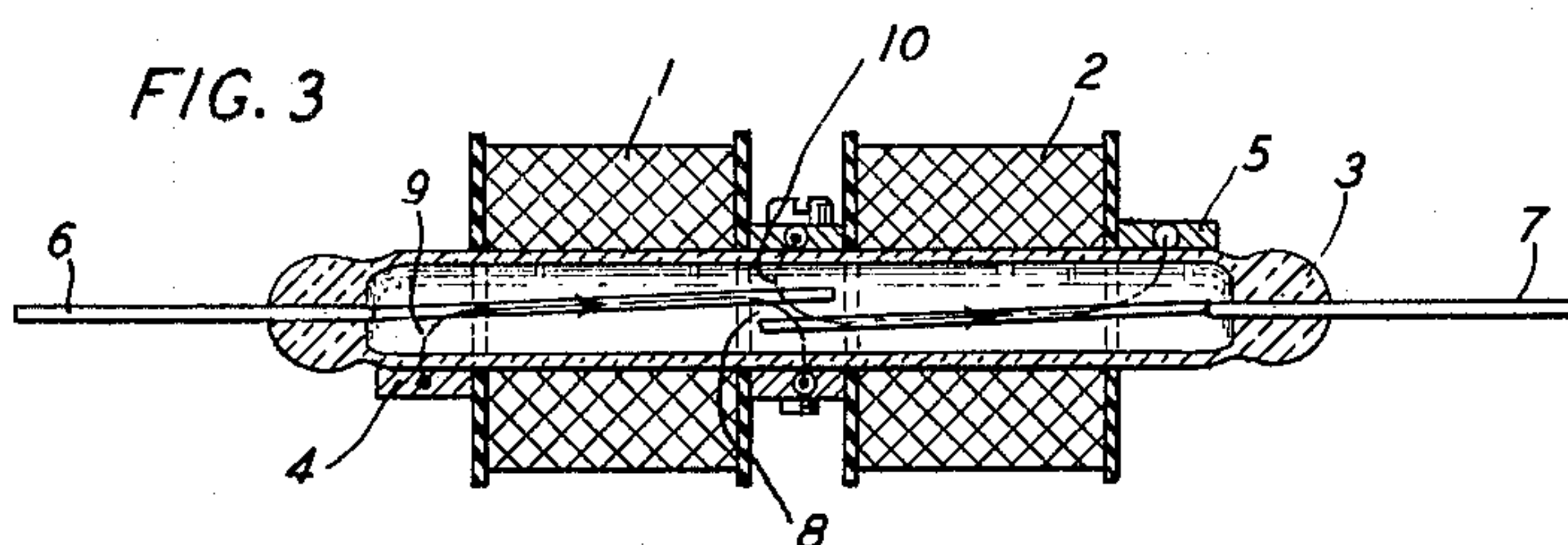
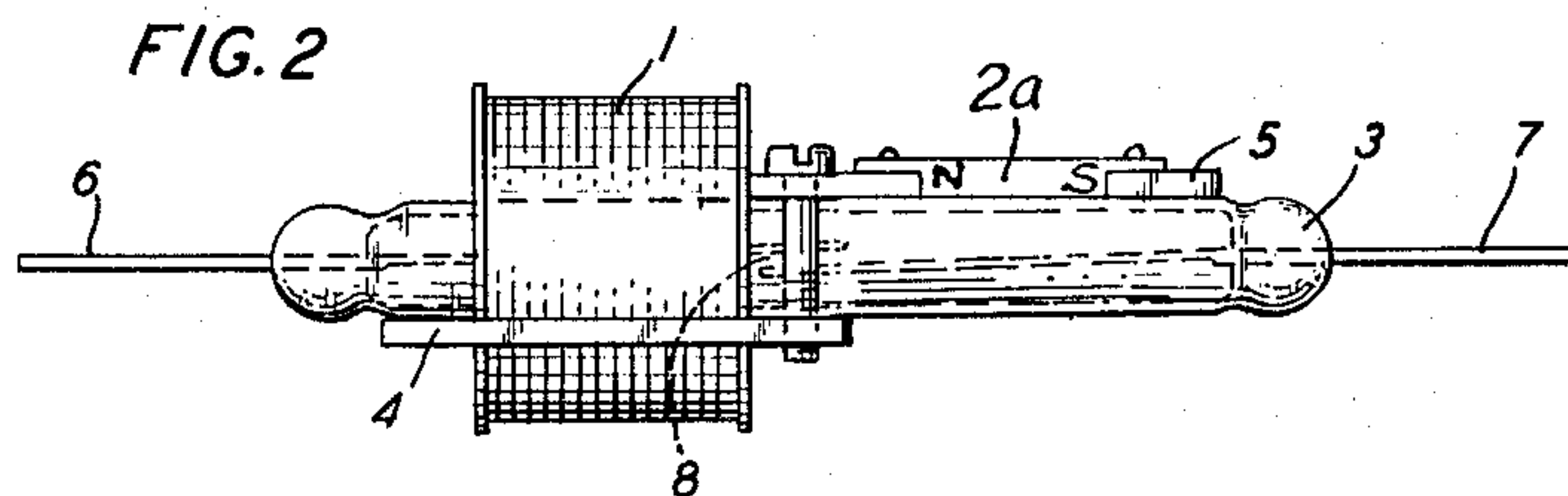
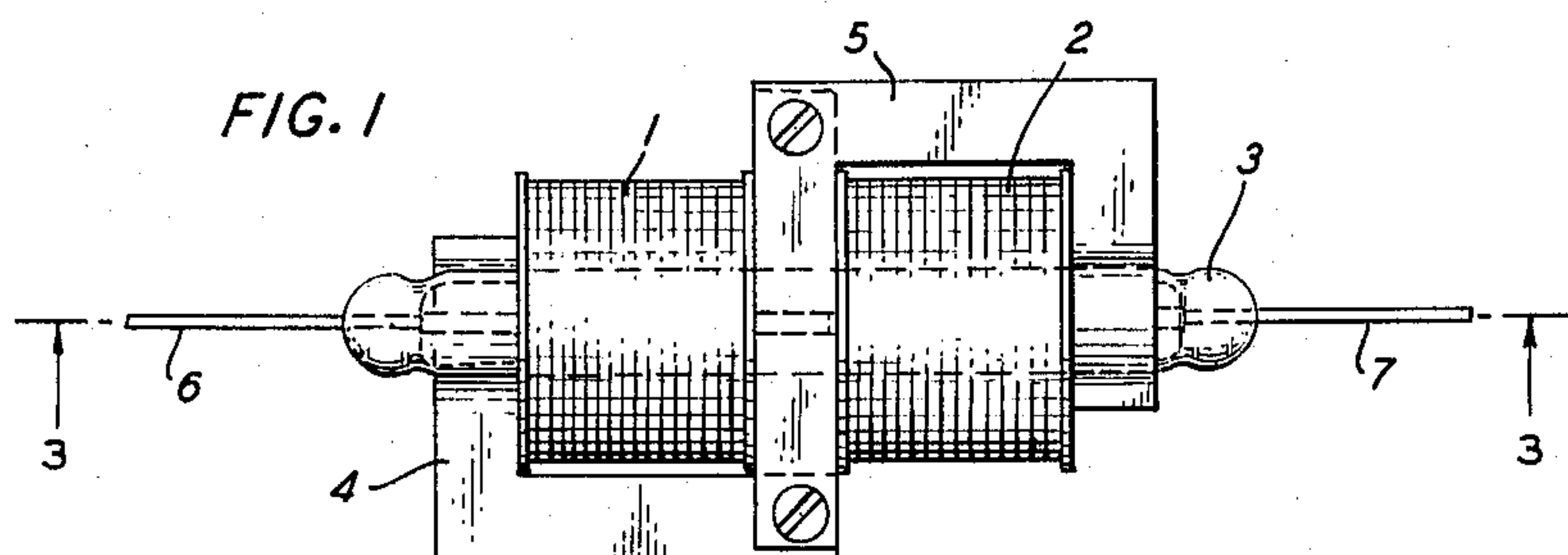
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H. N. WAGAR

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STRONG MAKE OR BREAK REED SWITCH

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INVENTOR
H. N. WAGAR
BY *John C. Morris*

ATTORNEY

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STRONG MAKE OR BREAK REED SWITCH

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 to electromagnetic switching devices and particularly pertains to devices of the type commonly known as reed switches. Such switches are typically illustrated in United States Patent No. 2,187,115, issued to W. B. Ellwood et al. on January 16, 1940, and United States Patent No. 2,929,895, issued to M. S. Shebanow on March 22, 1960.

Reed switches were developed as a result of a need for reliable switches having a positive switching action when operated at low power levels. In order to meet this need, it was found that efficient utilization of magnetic flux was required. Conventionally, this requirement is met by winding the operating coil centrally about the switch housing. With this arrangement, the overlapping reeds are enclosed in the central portion of the coil. As a result, a maximum magnetic flux is concentrated in the air gap separating the reeds. However, as the magnetic flux serially traverses each reed in the conventional arrangement, the magnitude of flux in the air gap is limited by the amount of flux either reed can accommodate. Therefore, the magnetic saturation level of either reed limits the amount of force which can be generated.

It has been discovered, however, that by separating the operating coil into two parts and associating each with its own reed and a single flux conducting member, more efficient utilization of magnetic flux is obtained. With this arrangement, the saturation flux from each reed can be combined in the air gap. As a result, the operative flux in the air gap is double that found in the conventional arrangement. As force is proportional to the square of flux, doubling the flux in the air gap will quadruple the force. Accordingly, application of this discovery produces switches exhibiting positive switching action at power levels below that required for the same degree of switching action in conventional arrangements.

It is, therefore, an object of this invention to provide a new operating arrangement that can be applied to reed switches singly or in groups in order to obtain positive contact operation with low power requirements.

It is another object of this invention to improve the switching characteristics and increase the efficiency of electromagnetic switching devices.

A feature of this invention is the arrangement of two magnetic circuits in an electromagnetic switching device wherein each circuit is essentially restricted to its own armature.

Another feature of this invention is an arrangement whereby two independent magnetic circuits in an electromagnetic switching device crisscross in aiding relationship through an air gap separating two armatures.

Still another feature of this invention is a pair of magnetic guide members mounted with respect to one another on opposite sides and on opposite ends of the electromagnetic switching device whereby each is utilized to effectively confine flux within a single magnetic circuit.

Many of the foregoing objects and features are illustrated in an embodiment of this invention wherein two magnetic circuits are arranged to crisscross in aiding relation through an air gap which appears between reeds in a reed switch of the normally open or "make," as distinguished from "break," type. Each magnetic circuit includes a flux source, a reed member, the tip of the remaining reed member, and a single guide member for confining flux within a single effective magnetic circuit.

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This arrangement, coupled with the proper flux polarity, produces a force of attraction between overlapping reeds larger than the force obtainable in a switch having a centrally wound coil.

According to another embodiment of this invention, two effective magnetic circuits, each having its own reed, are allowed by magnetic flux guide members to interact with each other only at that portion of each circuit which appears in the tip of its own reed. With this arrangement, the force of attraction exerted by each magnetic circuit on its own reed member is reinforced by a force of separation exerted by the other magnetic circuit.

Other objects, advantages, and novel aspects of this invention will become apparent upon consideration of the following detailed description in conjunction with the accompanying drawing wherein:

FIG. 1 is a plan view of a switch assembly constructed in accordance with the present invention;

FIG. 2 is a front elevational view of the switch assembly shown in FIG. 1 wherein a permanent magnet has been substituted for the coil;

FIG. 3 is a front elevational view taken in section of the switch assembly shown in FIG. 1 to illustrate one arrangement of interacting magnetic circuits;

FIG. 4 is a front elevational view taken in section of the switch assembly shown in FIG. 1 wherein another arrangement of interacting magnetic circuits is illustrated; and

FIG. 5 is a plan view with portions broken away of another form of switch assembly constructed in accordance with the present invention.

Referring to the drawing in FIG. 1, there is shown one illustrative embodiment of this invention comprising a coil 1 and a coil 2 each wrapped around an opposite end portion of a vessel or glass tube 3. Clipped around coils 1 and 2 are flat U-shaped magnetic flux conducting brackets or guide members 4 and 5, respectively. The guide members 4 and 5 can be conveniently made from soft magnetic material. Sealed in the vessel or glass tube 3 are the contacts or reeds 6 and 7. It will be seen from FIG. 2 that the contacts or reeds 6 and 7 overlap one another to form an air gap 8.

The operation of the illustrated embodiment can best be seen by reference to FIG. 3. A magnetic flux 9, shown representatively as a line in the drawing, is generated by the coil or magnetic flux source 1. The flux 9 is confined by the guide member 4 to a single effective magnetic circuit comprising a substantial portion of the reed or armature 6, the tip of the reed or armature 7, the air gap 8, and the guide member 4. A magnetic flux 10, shown representatively as a line in the drawing, is generated by the coil or magnetic flux source 2. The flux 10 is also restricted to a single effective magnetic path by the guide member 5. This path comprises a substantial portion of the reed or armature 7, the tip of the reed or armature 6, the air gap 8, and the guide member 5.

When arranged as shown in FIG. 3, the magnetic fields or fluxes 9 and 10 crisscross in aiding relationship through the air gap 8. Moreover, reeds 6 and 7 contribute flux to the air gap 8 independently of each other. Therefore, a high level of flux density is produced in the air gap. Reeds 6 and 7 are able to contribute flux independently to the air gap 8 as a result of orienting the guide members 4 and 5 on opposite ends and on opposite sides of the vessel or glass tube 3. With this arrangement, flux from one reed passes through the air gap, into and through the tip of the other reed member, and into its respective guide member. For example, the flux 9 passes from the reed 6 through the air gap 8, into and out of the tip of reed 7 and into the guide member 4. As a result, the flux 9 is collected and guided through a mag-

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netic circuit completed by the guide member 4 instead of being compelled to complete its magnetic circuit through the reed 7, which is already saturated by the flux 10. Furthermore, the guide member 5 permits the flux 10 to be concentrated in the air gap 8 in a similar manner. Therefore, as two operative fluxes, 9 and 10, have been combined in the air gap 8, FIG. 3 illustrates a switch having an especially strong make characteristic.

FIG. 4 illustrates another advantage that is obtained by using single guide members mounted with respect to one another on opposite ends and on opposite sides of the vessel or glass tube. It will be seen that the only substantial difference between FIGS. 3 and 4 is in the polarity of the flux 10 and the manner in which the tips of the reeds 6 and 7 overlap. While in FIG. 3 the reed 6 is above the reed 7, in FIG. 4 the order is reversed and the reed 7 is above the reed 6. Stated another way, the reed overlap relationship can be conveniently understood by considering the tube 3 and its contents, as shown in FIG. 3, merely to have been rotated 180° about its long axis. By virtue of this new arrangement the tip of the armature 7 has been removed from the magnetic circuit traversed by the flux 9; and the tip of the armature 6 has been removed from the magnetic circuit traversed by the flux 10. As shown, the switch in FIG. 4 is of the type which contains normally closed contacts. When such a switch is subjected to the flux from magnetic circuits arranged as illustrated, it will exhibit a strong break characteristic.

The strong break occurs for the following reasons. Similar to the arrangement of FIG. 3, flux from each armature or reed member establishes a force of attraction between itself and its collecting guide member. As distinguished from FIG. 3, however, substantially no flux appears between the tips of the reeds 6 and 7 after the reeds have been separated. However, with the coils 1 and 2 poled to produce "like-poles" on the reed tips, at the instant the coils are energized what little flux that does appear between the reeds produces an initial "kick" or force therebetween to positively break apart the reeds and start them moving towards their respective guide members.

It will be readily understood that either coil 1 or coil 2 in the preceding descriptions may be replaced with a permanent magnet or any other convenient source of magnetic flux. In illustration thereof, the coil 2 in FIG. 1 is shown replaced in FIG. 2 with a permanent magnet 2a mounted in the guide member 5. Moreover, latching or biasing of the reeds 6 and 7 with respect to each other may be obtained by the use of permanent magnets, holding coils, or by making one or more of the reed members from a remanent material.

The concepts illustrated by the foregoing embodiments are readily adaptable for use in various switch arrangements whereby new switching devices may be obtained. An example of such a device is shown in FIG. 5. The illustrated device comprises a first coil 20, a second coil 21, a pair of reed switches 22 and 23 having overlapping reeds 26 and 27 and overlapping reeds 28 and 29 respectively sealed therein, and two guide members 24 and 25. While an air gap (not shown) exists between the contacts or reeds 28 and 29, there is no air gap between contacts or reeds 26 and 27. As a consequence, the reed switch 22 is of the normally closed type while the reed switch 23 is of the normally open type. The reed switch 22 is arranged so that overlap between the tips of reeds 26 and 27 is located between coextensive portions of the guide members 24 and 25. Moreover, the reeds 26 and 27 are associated with the guide members 24 and 25 in the same manner as the reeds 6 and 7 are associated with the guide members 4 and 5 in FIG. 4. The reed switch 23, however, is arranged so that the air gap existing between the overlapping tips of reeds 28 and 29 is located centrally with respect to the guide member 24. Since the guide member 24 is associated with the coil 20, flux developed

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by the coil 20 will be restricted by the guide member 24 to a single effective magnetic circuit which passes in parallel through the reed 26 and the series combination of reeds 28 and 29. In a similar manner, the guide member 25 associated with the coil 21 will confine flux developed by the coil 21 to a single effective magnetic circuit which includes the reed 27. So arranged, the foregoing components exhibit a transfer switching action when the coils 20 and 21 are energized with the proper polarity. Energization of the coils will cause the reed switch 22 to open and the reed switch 23 to close. In addition, as coils 20 and 21 must be operated simultaneously to obtain simultaneous operation of the switches, the aforesaid proper polarity can be acquired by connecting the coils electrically in series or in parallel and operating them from a common source. By this means the device becomes a neutral transfer switch and will operate without regard to the polarity of the potential applied to its common terminals.

While only one normally open switch is shown in FIG. 5, another switch can easily be associated with the guide member 25 in the same manner that the reed switch 22 is associated with the guide member 24. Moreover, while each switch is shown equipped with only two reeds, one or more reeds could be added to each switch and associated with each magnetic circuit as desired. In a similar manner many other combinations and arrangements singly or in arrays can be assembled. For example, a relay can be assembled by combining the device shown in FIG. 5 with a plurality of others of the same type. Switching versatility can be obtained by biasing one or more of the switches contained therein with a holding coil or permanent magnet or by making one or more of the reed members from a remanent material.

From the foregoing it will be readily apparent that various arrangements of coils, permanent magnets, and switches biased and unbiased by permanent magnets, coils, or remanent members can be advantageously used to exploit this invention. Therefore, while certain specific embodiments have been selected for detailed disclosure, the invention is not limited in its application to the embodiments disclosed. As a result, the embodiments which have been described should be taken as illustrative of the invention and its application rather than as restrictive thereof.

What is claimed is:

1. In a switching device the combination comprising two overlapping reeds, each sealed in an opposite end of a glass tube and movable in response to magnetic flux; a source of magnetic flux adjacent to each end of said glass tube, and a plurality of not more than two effective magnetic flux conducting guide members arranged with respect to one another on opposite ends and on opposite sides of said glass tube, each of said guide members having one end adjacent to the overlapping portion of said reeds and being situated in a magnetic circuit including one flux source and one reed member.

2. The combination in accordance with claim 1 wherein each guide member comprises a flat U-shaped bracket made of a soft magnetic material.

3. The combination in accordance with claim 1 wherein at least one magnetic flux source is a permanent magnet.

4. In a switching device having only two effective magnetic circuits the combination comprising a first armature having a tip, a second armature having a tip, said first armature and said second armature movable in response to magnetic flux, and in contacting relationship with each other; a first of said two effective magnetic circuits comprising a first source of magnetic flux, said first armature and a single guide member for confining magnetic flux from said first source within said first magnetic circuit, said single guide member having one end adjacent to the tips of said first and second armatures, and a second of said two effective magnetic circuits

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comprising a second source of magnetic flux, said second armature and a single guide member for confining magnetic flux from said second source within said second magnetic circuit, said single guide member having one end adjacent to the tips of said first and second armatures.

5. The combination in accordance with claim 4 wherein the first of said two effective magnetic circuits includes the tip of said second armature and the second of said two effective magnetic circuits includes the tip of said first armature.

6. The combination in accordance with claim 4 wherein said first armature and said second armature comprise reed members sealed in opposite ends of a glass tube.

7. A switching device comprising at least one pair of vessels each having at least two magnetic reeds sealed in contacting relationship therein, said pair of vessels located within only two effective magnetic circuits, the first of said two effective magnetic circuits having a source of magnetic flux, at least one of the reeds sealed in a first vessel and at least one of the reed members sealed in a second vessel of said pair of vessels, and a single guide member located on one end and one side of said pair of vessels and having one end adjacent to the contacting portions of the reed members located within said vessels, said single guide member for concentrating magnetic flux from said first source within said first magnetic circuit, and the second of said two effective magnetic circuits comprising a second source of magnetic flux, the remaining reeds sealed in said first vessel and a single guide member for concentrating magnetic flux from said second source within said second magnetic circuit, said single guide member being disposed with one end adjacent to the contacting portions of the reed members located within said vessels and positioned with respect to the guide member in the first of said two magnetic circuits at the opposite end and on the opposite side of said pair of vessels.

8. A switching device in accordance with claim 7 wherein each guide member comprises a flat U-shaped piece of soft magnetic material clipped around a source of magnetic flux.

9. A switching device in accordance with claim 7 wherein the first of said two effective magnetic circuits includes all of the reeds sealed in said second vessel.

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10. A switching device in accordance with claim 7 wherein the first of said two effective magnetic circuits includes the tip of one reed sealed in said first vessel and the second of said two effective magnetic circuits includes the tip of another reed sealed in said first vessel.

11. A switching device in accordance with claim 7 wherein the reeds sealed in said first vessel are magnetically in series with each other but magnetically in parallel with at least one reed sealed in said second vessel.

12. In a switching device the combination comprising:
a vessel;
a first contact sealed in one end of said vessel;
a second contact sealed in the other end of said vessel and having a portion overlapping a portion of said first contact;
a first source of magnetic flux disposed at said one end of said vessel;
a first guide member disposed on one side of said vessel with one end adjacent to the overlapping portions of said first and second contacts;
a second source of magnetic flux disposed at said other end of said vessel; and
a second guide member disposed on the other side of said vessel with one end adjacent to the overlapping portions of said first and second contacts, said second guide member arranged to concentrate magnetic flux from said second source in said second contact and said first guide member arranged to concentrate magnetic flux from said first source in said first contact whereby said first and second contacts each conducts a separate magnetic flux.

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BERNARD A. GILHEANY, *Primary Examiner*.

B. DOBECK, *Assistant Examiner*.