Oct. 31, 1950 C. A. BIELING 2,528,414

ELECTRICAL WINDING

Filed Feb. 3, 1948

FIG. 1

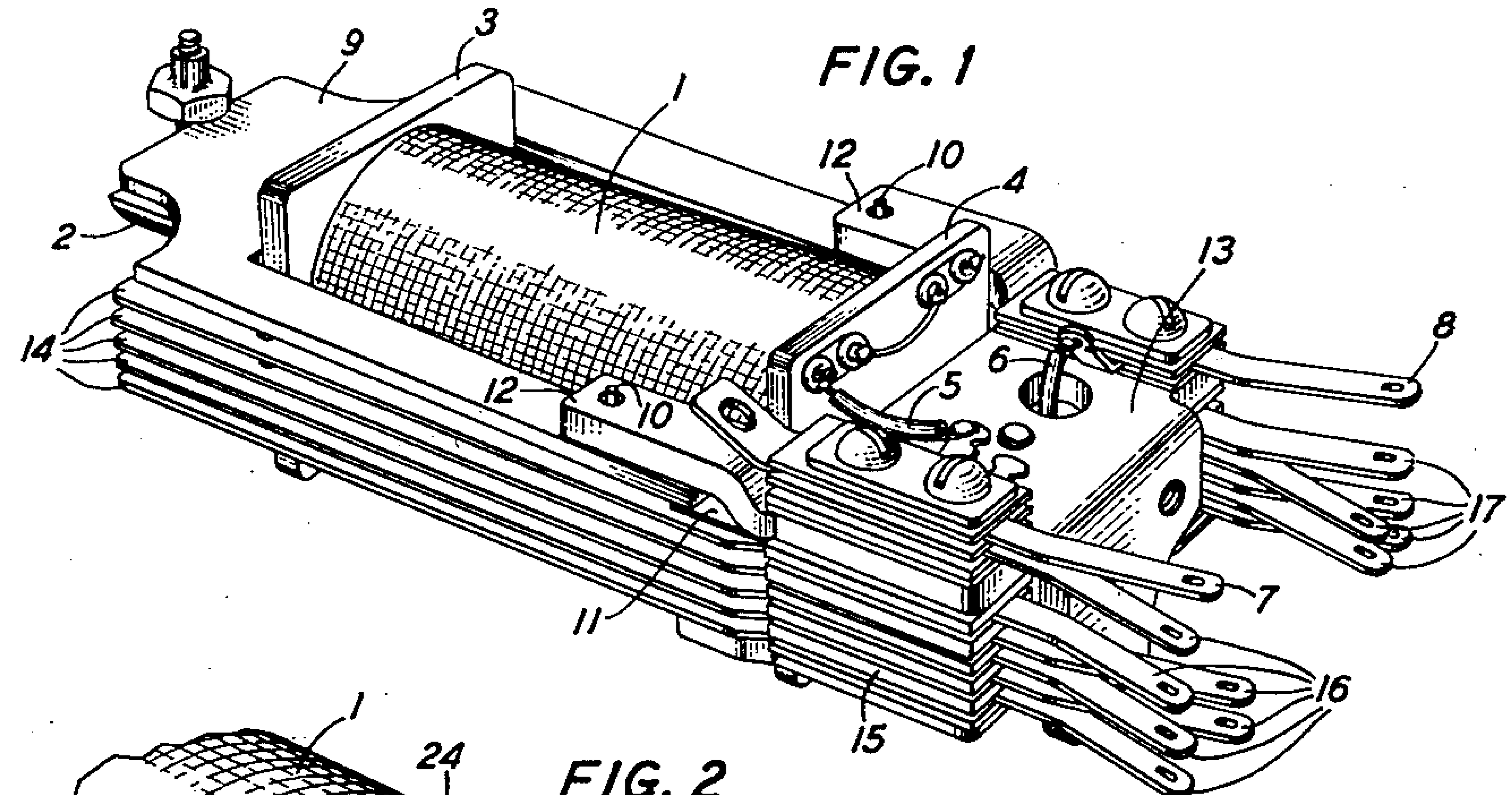


FIG. 2

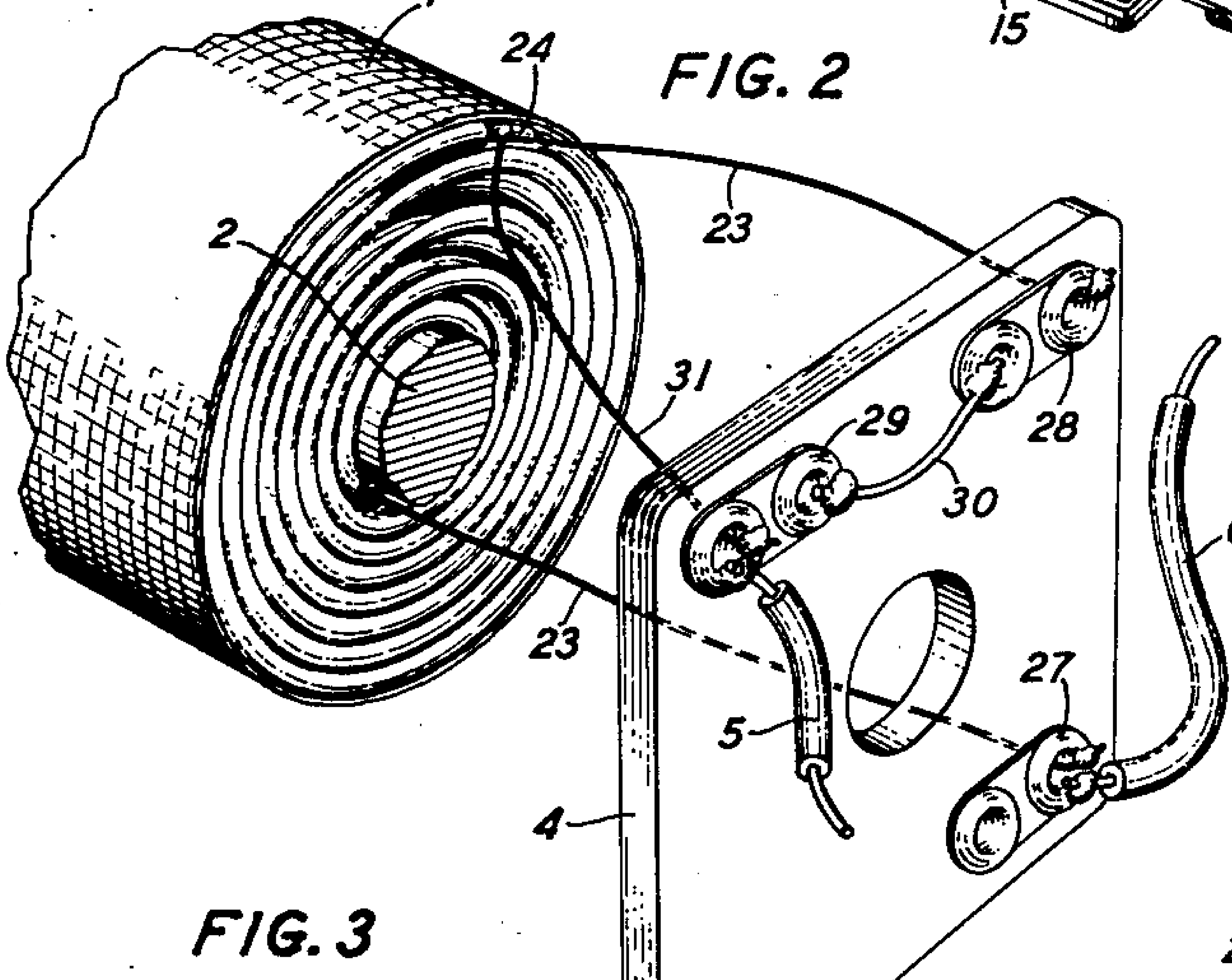


FIG. 4

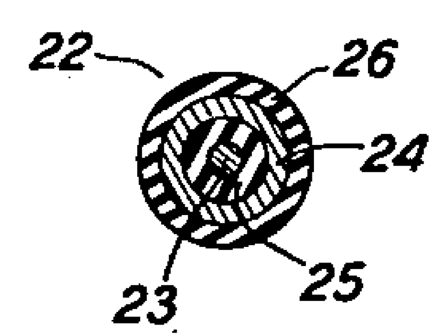


FIG. 6

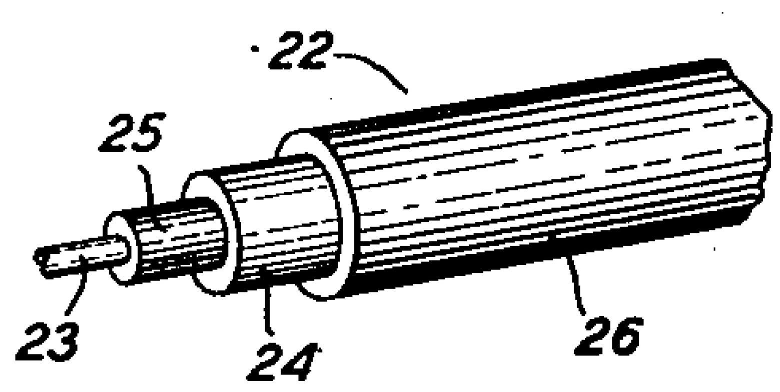


FIG. 3

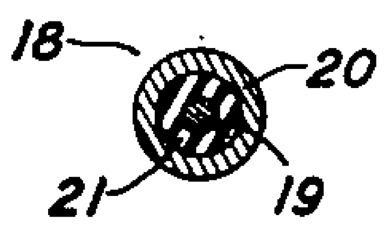


FIG. 5

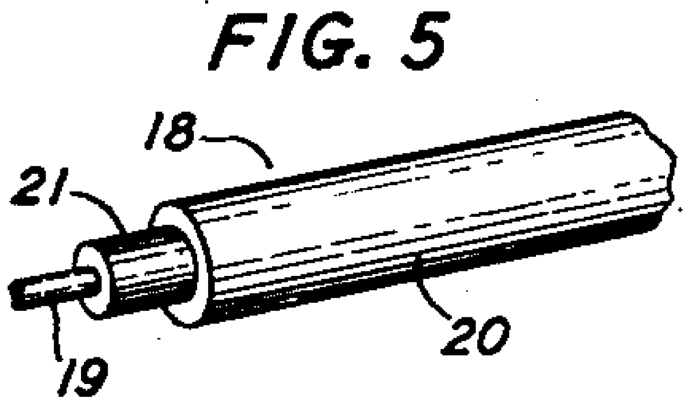


FIG. 7

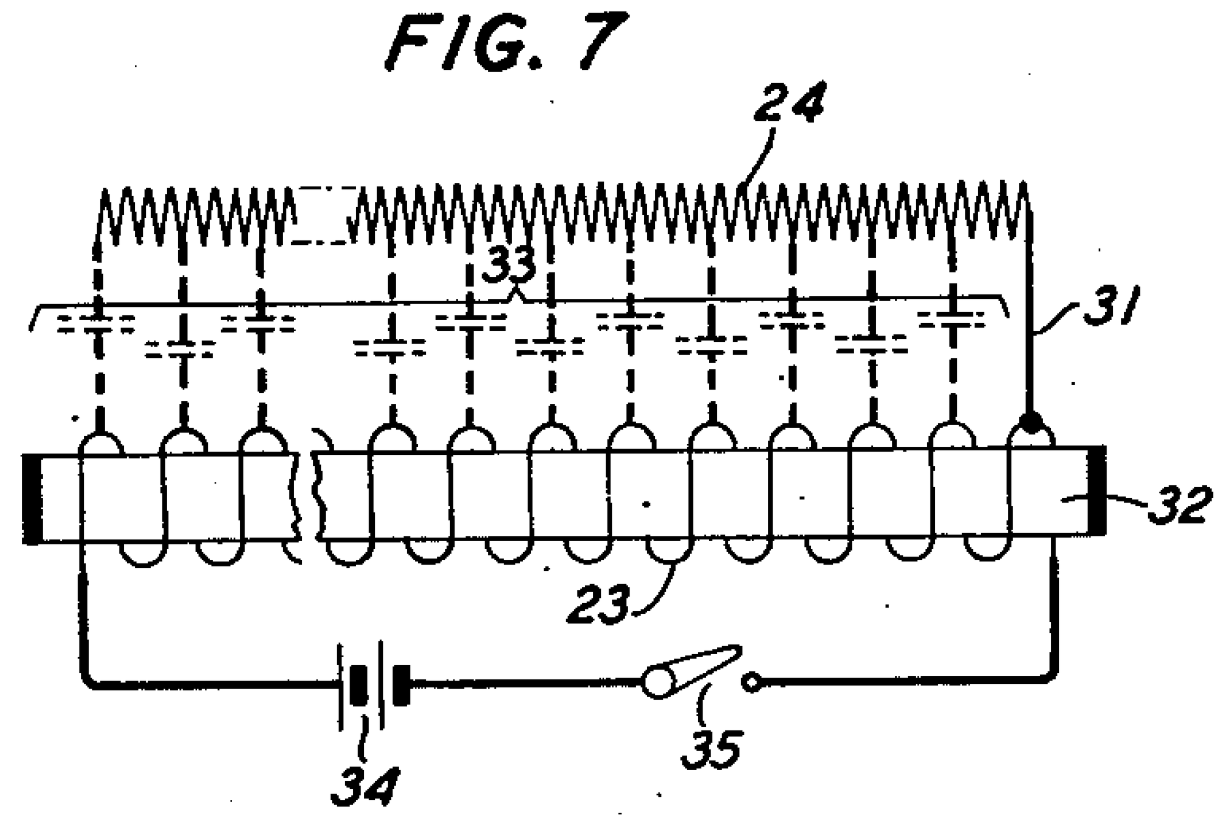
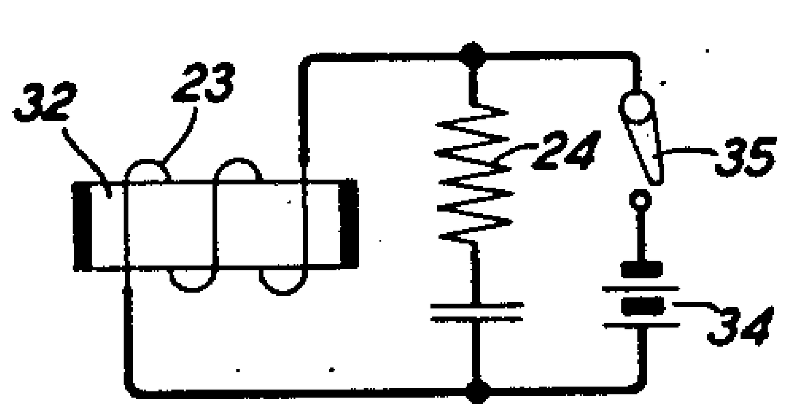


FIG. 8



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Patented Oct. 31, 1950 2,528,414

UNITED STATES PATENT OFFICE

2,528,414

ELECTRICAL WINDING

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Application February 3, 1948, Serial No. 5,980

4 Claims. (Cl. 175—21)

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This invention relates in general to electrical windings and in particular to windings of electromagnetic relays.

It has been known for some time that when a predominantly inductive circuit such as an inductive winding of an electromagnetic relay is broken while said circuit is conducting electricity substantial sparking occurs at the contacts which open the circuit. Considerable prior art is known as to various means for minimizing this undesirable sparking condition.

In general, it is known that if suitable values of capacity and resistance are arranged electrically in series across the contacts which break the circuits of such windings the sparking thereat is materially reduced. It has been determined that such an arrangement may advantageously be placed in parallel with the winding and not necessarily physically at the contacts themselves.

In order to obviate the use of lumped circuit elements, such as the aforementioned resistance and capacity, the prior art has taught electrical winding construction wherein the capacity may be made inherent in such construction. The well-known use of parallel wound conductors, with distributed capacity therebetween, for the conductors of an electromagnetic relay winding indicates one direction of attack in eliminating at least one of said lumped circuit elements. This general proposition has been improved by utilizing such conductors as afford the best condenser geometry, as disclosed in Patent 2,488,325 to R. L. Peek, Jr. of November 15, 1949. Peek discloses the use of parallel flat conductors wound in such a manner as to inherently provide maximum distributed capacity therebetween by the advantageous use of condenser geometry in the construction of the winding.

In the above prior arrangements for providing the necessary capacity for the protective networks there has been the necessity, nevertheless, for provision of an external lumped resistance since such resistance could not economically and without depleting effect upon the efficiency of the electrical circuit be provided as a part of the conductor assembly itself unless the resistance of the capacitor, condenser or other capacity were sufficient.

It is the main object of the present invention to provide an electrical winding structure having inherent therein the above required capacity and the above required resistance while in the same structure providing the necessary low resistance winding path for the operating currents.

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It is a further object of the invention to attain the main object by utilizing, as the conductor structure, a coaxial conductor.

It is a still further object of the present invention to provide an electrical winding constructed of a coaxial conductor structure, one of whose conductors is of relatively large resistance and the other of whose conductors is of relatively small resistance.

It is another object of the invention to improve the construction of electrical windings in general and more particularly of electromagnetic relay windings.

The foregoing objects and others will be apparent from the following description of an exemplary embodiment of the present invention. Reference will be made, from time to time, to the drawings supplementing such description, which drawings may be described generally as follows:

Fig. 1 shows a perspective view of an electromagnetic relay of generally well-known construction, to the construction of which relay has been applied the invention;

Fig. 2 shows an enlarged and exploded perspective of part of the relay of Fig. 1 hereinafter referred to for description of certain details of construction;

Figs. 3 and 4 illustrate the cross-sections of two suitable conductor configurations which may be used in accordance with the present invention to construct the winding of the relay of Fig. 1;

Figs. 5 and 6 illustrate, respectively, perspective views in cut-away fashion of the conductors of Figs. 3 and 4;

Fig. 7 represents, as nearly as can be shown diagrammatically, the true schematic representation of the winding circuit of a relay such as shown in Fig. 1, when constructed in accordance with the present invention and when provided with an external energizing circuit; and

Fig. 8 shows a lumped circuit element schematic of a well-known arrangement which electrically embodies protective features well known in the art and briefly mentioned above.

According to the present invention an electromagnetic relay winding is constructed of a coaxial conductor. The inner conductor is insulated from the outer conductor. One of the conductors is of low resistance compared to the other conductor. The resistance of the inner conductor, for instance, may be in the order of electrical resistance required as a usual expedient in the efficient design of operating windings of electromagnetic relays. The outer conductor, in this case, is to be constructed so as to possess a relatively high resistance, as will be explained. The practice of the invention, of course, does not preclude that the above conditions may be reversed as to the relative orders of magnitude of resistance since it is not material to the invention which conductor is employed as a high resistance and which as a low resistance. The latter will be readily understood from the subsequent discussion.

In a conductor configuration of the above nature it is known that a substantial distributed capacity exists between outer and inner conductor. This capacity is utilized in the present invention as part of the protective network for the winding. The outer conductor, in the exemplary situation chosen for description, may be constructed so as to exhibit a desired resistance determined by such factors as the material used and the thickness of the layer of such material. According to the invention this resistance is chosen and produced to be as nearly as practicable to that value best suited to the protection purpose to be performed when combined with the cumulative effect of the above-mentioned distributed capacity. The inner conductor is unaffected in that it may be designed to exhibit the usual relay winding resistance range. If the outer conductor is connected directly to the inner conductor at only one end of the winding then a winding structure is realized which possesses inherently a desired low resistance energizing winding and a series circuit of controllable resistance and controllable capacity in parallel therewith for protection of the contacts controlling energization and deenergization of said winding.

In Fig. 1 is shown an electromagnetic relay of generally well-known construction. A winding **1** is supported on a core **2** between the usual spoolheads **3** and **4**. The electrical leads **5** and **6**, connected to the energizing circuit of winding **1**, are brought out to terminals **7** and **8** in any suitable manner. An armature **9** is pivotally mounted in cooperative relationship with core **2**, by means of pins **10** and leaf springs, such as **11**, to extensions **12** of a combination core heel piece and mounting bracket **13**. Contact springs **14** are assembled in pile-up section **15** and are terminated in terminals **16**. Another similar set of such springs may be likewise assembled on the opposite side of winding **1** terminating in terminals **17**. The operation of armature **9**, as is well known, effects the desired electrical switching functions represented by the various contact spring combinations.

In Figs. 5 and 6 are shown two representative types of conductors which may be used satisfactorily in the practice of the present invention. In Fig. 5 a coaxial conductor, generally referred to by reference numeral **18**, comprises an inner conductor core **19** and an outer conductor sheath **20** separated in the usual manner by insulation **21** or other dielectric. Furthermore such insulation or dielectric may be of an imperfect type exhibiting a finite leakage resistance. The use of the word "insulation," or its equivalent, in the specification or claims is not to be limited to perfect insulators or perfect dielectrics and is to be considered as comprising any insulation or other dielectric. In this disclosure the core conductor is chosen for the energizing path of the winding under consideration although it should be remembered that the functions of the two conductors may be alternated, provided, of course, in the case where the sheath is used as the energizing path, that said sheath be insulated from succeeding and preceding turns of the winding.

In Fig. 6 a coaxial conductor, generally referred to by reference numeral **22**, comprises an inner conductor core **23** and an outer conductor sheath **24** separated by insulation **25**, the sheath **24**, in this case, being enclosed by insulation **26**. Figs. 3 and 4, respectively, show cross-sections of conductors **18** and **22** of Figs. 5 and 6.

According to the present invention and according to the exemplary disclosure thereof as set forth herein, the core, such as **19** or **23**, consists of the usual low resistance conductor employed for the usual relay winding energizing paths. It may consist of solid or stranded wire or other suitable conductor means in accordance with well-known principles. The sheath, such as **20** or **24**, on the other hand is made purposefully of a high resistance relative to the resistance of core **19** or **23**. The resistance of such a sheath may be controlled by choice of material and thickness thereof as assembled. Such sheaths may be produced by painting, dipping, spraying, electrodeposition, etc., or any other means known in such art. The manufacture of conductive coatings upon insulating surfaces is sufficiently well known that it is unnecessary here to more than mention such processes as useful in producing the type of conductor structure useful in the practice of the present invention.

It is common knowledge that a coaxial conductor structure, such as **18** or **22** or the like, embodies inherent capacity between core and sheath. This capacity is distributed in nature along the length of the composite conductor and the value of such capacity may be controlled by selection of insulation or dielectric material **21** or **25**, size of core **19** or **23**, size of sheath **20** or **24**, separation distance between the outer surface of core **19** or **23** and inner surface of sheath **20** or **24**, and other factors known to those skilled in such matters.

Therefore, by means of present knowledge of wire and conductor manufacture, it is possible to produce a coaxial conductor structure, such as **18** or **22**, wherein the core **19** or **23** possesses the necessary low resistance and current carrying capacity usually required in the energizing paths of electromagnetic relays; wherein the sheath **20** or **24** has a controllable resistance of a value high relative to that of the core **19** or **23** and which is assumed to be of the correct value for use in a resistance-capacity protective network as previously mentioned; and wherein is provided the necessary value of capacity between core and sheath for use in such protective networks. It is significant that the impedance and resistance relations usually found in coaxial structures have been purposefully departed from with the intent motivated by the conception of this invention. It is necessary only to satisfy the above resistance and capacitance requirements in accordance with good relay or other electrical winding design.

A coaxial conductor, such as **22** of Fig. 6, is preferred over conductor **18** of Fig. 5 for quick acting relays, as will be explained. Consequently, as shown in Fig. 2, such a conductor has been used for descriptive purposes of certain details of construction of the relay assembly. Both ends of the winding **1** are shown as terminating at the terminal end of the relay assembly as is usual practice. At one end of said winding **1** the core **23** is shown electrically connected directly to eyelet **27** secured to spoolhead **4**. Electrical lead **6** is connected electrically to eyelet **27** and, as previously explained in relation to Fig. 1, to terminal 8 of the relay. No other electrical connections are made to this one end of the winding 1. At the other end of winding 1 core 23 is electrically connected to eyelet 28 secured to spoolhead 4. The sheath 24 is electrically connected, by means of a lead 31, directly to eyelet 29 secured to spoolhead 4. Eyelets 28 and 29 are electrically interconnected by a strap or lead 30 and lead 5 is connected from eyelet 29 to terminal 7, as previously explained in regard to Fig. 1. Of course eyelets 28 and 29 may be combined into one eyelet and core 23 and sheath 24 may be connected together at the winding end. There are numerous such rearrangements, the one shown being chosen merely to clearly indicate the various electrical connections involved. The important provision on any such arrangement is that the core 23 and sheath 24 should be electrically connected to each other at only one end of the winding so that an appreciable capacity may be realized between these two conductors throughout the remainder of their parallel lengths.

Conductor structure 18 of Fig. 5 could be used as the winding 1 just as well as conductor 22 of Fig. 6 but certain functional aspects of the operation of a relay with such a winding may be undesirable if fast operation is desired. If conductor structure 18 were used the outer sheath 20 would effect a short circuited turn about each layer of the energization path. This situation would be desirable for rapid conduction of heat away from the center of the winding but, as is well known, would have a retarding effect upon the speed of operation and release of such a relay. When such a structure as 22 of Fig. 6 is employed, the beneficial heat conducting properly of the other type of winding is lost but, on the other hand, the speed of operation of the relay is not retarded. A choice can be made depending upon the purpose of the relay and the present invention contemplates both such arrangements and others which may be suggested by this disclosure.

There has been no attempt to disclose all possible conductor configurations which could be employed in accordance with the invention. The core could be flat, oval, rectangular, triangular, etc., depending upon the other factors of the particular designs. Likewise, plural core coaxial conductors could be used. Furthermore, the whole structure, including outer insulation, if any, could be flat, oval, rectangular, triangular, etc., depending upon the intended physical makeup of windings constructed with such conductors.

Fig. 7, at this point, speaks for itself: 32 represents the relay such as shown in Fig. 1; 23 is the core conductor shown as the energizing path in series with battery 34 and contacts 35; 24 represents the resistance of the sheath conductor which is connected to the energizing winding, core 23, by lead 31 and which has between it and core conductor 23 a capacity represented by 33 as distributed along the length of core conductor 23.

Fig. 8 is the simplified schematic of a well-known protective circuit and, with the foregoing description in mind, may be described as a relay 32 having an energizing winding 23 (core conductor) in series with a battery 34 and contacts 35 and provided with a resistance-capacity protective network comprising resistance 24 (sheath

conductor) and capacity 33 (distributed between core conductor and sheath).

The manner in which the protective network protects contacts 35 from the ill effects of sparking thereat due to inductive surges to and from winding 23 is too well known to require exposition.

There are many modifications of the invention which will be suggested by this disclosure and it is not intended that the scope of the present invention shall be limited to the particular configuration of conductor shown, to the specific manner of electrical connections shown or to the application of the invention to any particular relay or circuit. Furthermore, the invention is applicable to windings other than electromagnetic relay windings and restriction of the invention to the latter is not intended. The appended claims alone define the scope of this invention.

What is claimed is:

1. In an electrical apparatus, an electrical winding comprising a single coaxial conductor having a solid inner conductor, a tubular outer conductor having a homogeneous cross-section of non-porous conductive material, insulation between said conductors, and insulation surrounding said outer conductor, one of said conductors from end to end being of relatively low resistance and the other of said conductors from end to end being of relatively high resistance, said inner and outer conductors being connected directly to each other at one end only of each of said conductors.

2. In an electromagnetic relay, an electrical winding comprising a single coaxial conductor having a solid inner conductor of relatively low resistance from end to end, a tubular outer conductor having a homogeneous cross-section of non-porous resistance material and of relatively high resistance from end to end, insulation between said conductors, and insulation surrounding said outer conductor, said inner and said outer conductors being connected directly to each other at one end only of each of said conductors, the resistance of said inner conductor from end to end being of the order of magnitude usually employed for the energizing path of an electromagnetic relay winding, the resistance of said outer conductor from end to end and the capacity between said conductors being of the orders of magnitude usually employed in series circuit of resistance and capacity paralleled with said energizing path as a means for dissipating electrical energy stored in said energizing path.

3. In an electromagnetic relay, an electrical winding comprising a single coaxial conductor having an inner metallic conductor of relatively low resistance from end to end and an outer tubular conductor having a homogeneous cross-section of non-porous resistance material and of relatively high resistance from end to end, insulation between said conductors, and insulation surrounding said outer conductor, said inner and said outer conductors being connected directly to each other at one end only of each of said conductors whereby in such a winding said inner conductor from end to end comprises the energizing path for said relay winding, said outer conductor from end to end comprises a resistance, said separating insulation effects a capacity between said conductors, and said direct connection at one end only of each of said conductors effectively produces a series circuit of capacity and resistance in parallel with said energizing path.

4. An electromagnetic relay winding compris-

ing a single coaxial conductor having an inner metallic conductor of a relatively low resistance from end to end, an outer tubular conductor having a homogeneous cross-section of non-porous resistance material and of a relatively high resistance from end to end, insulation between said conductors, and insulation surrounding said outer conductor, said inner and said outer conductors being connected directly to each other at one end only of each of said conductors, said inner conductor from end to end comprising an inductive energizing path for said relay, said outer conductor from end to end comprising a resistance, and said separating insulation effecting a capacity between said conductors, whereby said interconnection of said conductors at one end only of each of said conductors effectively produces a series circuit of capacity and resistance in parallel with said energizing path for the purpose of dissipating electrical energy stored in said inductive energizing path.

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