

Oct. 11, 1960

KENJI YATSUSHIRO
MAGNETIC COIL CONSTRUCTION

2,956,210

Filed Feb. 20, 1957

FIG. 1

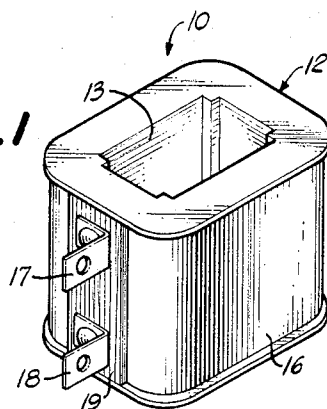


FIG. 1A

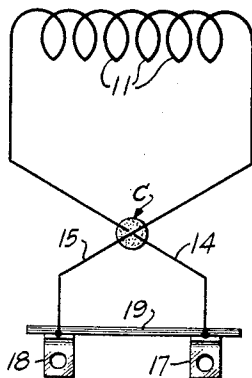
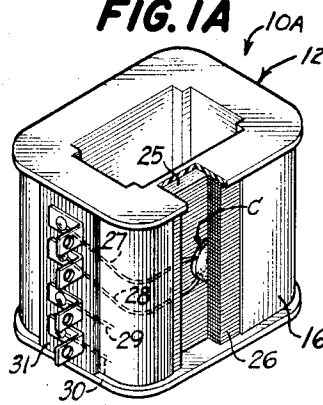


FIG. 2

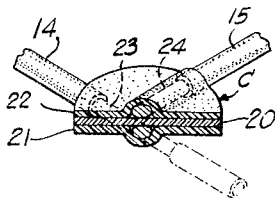


FIG. 4

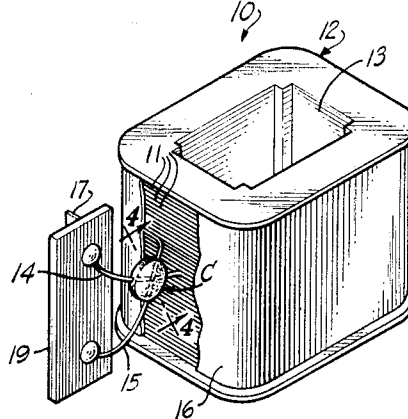


FIG. 3

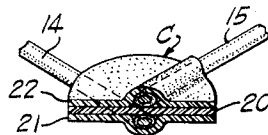


FIG. 5

INVENTOR
KENJI YATSUSHIRO

BY *Margall, Johnston, Cook + Root*

ATTORNEYS

1

2

2,956,210

MAGNETIC COIL CONSTRUCTION

Kenji Yatsushiro, Chicago, Ill., assignor to
Albert F. Dormeyer, Chicago, Ill.

Filed Feb. 20, 1957, Ser. No. 641,360

8 Claims. (Cl. 317—15)

This invention relates to an improved magnetic coil construction, and particularly to the construction of magnetic coils such as employed in solenoids, transformers, relays and other like devices.

Magnetic coils fail either from an overload or a mechanical failure of the magnet wire insulation between the turns or winding. Both conditions cause increased coil temperatures. As the temperature increases, more insulation fails between turns, and this process continues until the copper reaches its melting point at one or more hot spots. Melting of the copper then creates an arc. If the arcing causes the magnet wire ends to weld to adjacent turns, the process continues until subsequent arcing creates an open circuit. A somewhat chain reaction then develops; and when multiple arcing occurs, the overall coil temperature reaches a higher value that eventually exceeds the flash point of the smoke from the decomposing insulation, which results in fire. Since, in most cases, a failing of a magnetic coil may not be readily ascertained or detected, a coil which is burning out creates a fire hazard that may cause extensive fire damage. Further, in a coil which is burning out, the insulation may deteriorate sufficiently to permit the coil wire to move dangerously close to, or in contact with, adjacent metal parts, thereby creating an undesirable shock hazard.

Accordingly, it is an object of this invention to provide a magnetic coil constructed in such a manner as to eliminate the above problems, and especially to eliminate fire and shock hazards.

The present invention comprises a magnetic coil construction having the start and finish wires crossed and separated by an insulation of a type which will decompose and melt at a predetermined temperature in order to allow the start and finish wires to contact each other and short out the coil. The short circuiting of the coil will be caused to happen at a time during coil failure in order to eliminate fire and shock hazards.

Another object of this invention resides in the provision of a magnetic coil constructed in such a manner that all of the turns or windings will be short circuited should the temperature of the entire coil reach a predetermined value.

Still another object of this invention is in the provision of a magnet coil having its start and finish wires crossed and separated by an insulation which will decompose and melt at a predetermined temperature and allow the wires to contact each other.

A further object of this invention is to provide an economically and easily constructed magnetic coil, wherein fire or shock hazards due to the failure of the coil is eliminated.

Other objects, features, and advantages of the invention will be apparent from the following detailed disclosure, taken in conjunction with the accompanying sheet of drawing, wherein like reference numerals refer to like parts, in which:

Fig. 1 is a perspective view of a magnetic coil embodying the invention;

Fig. 1A is a perspective view of a transformer coil with parts broken away to show underlying parts in accordance with the invention;

Fig. 2 is a generally schematic view of the magnetic coil shown in Fig. 1;

Fig. 3 is a perspective view of the magnetic coil in Fig. 1, with certain parts removed to show underlying parts and other parts arranged to disclose the invention;

Fig. 4 is an enlarged transverse sectional view, taken substantially along line 4, 4 of Fig. 3, and disclosing the preferred embodiment of the invention; and

Fig. 5 is an enlarged transverse sectional view similar to Fig. 4, but illustrating another embodiment of the invention.

The present invention is first illustrated herein as associated with a magnetic coil suitable for use in a solenoid, although it is understood that the invention may be employed with any other type of magnetic coil, such as a transformer, relay, or other like device.

Referring to the drawings, the magnetic coil embodying the invention is generally designated by the numeral 10, and includes a plurality of fine windings or turns 11, Fig. 3, of conductive material, such as fine wire, and which is covered with a suitable insulating material. The turns are wrapped around a substantially square frame or bobbin 12, flanged at its upper and lower ends outwardly to define a continuous channel or trough for receiving the turns 11. However, frames of other shapes, such as a round frame, which may or may not be flanged may also be employed, the shape and configuration not making any difference. Generally, this frame 12 is constructed of an insulating material, and is hollow at 13 to receive the plunger or armature of a solenoid.

All of the turns 11 are connected together and to a common start wire 14 and a common finish wire 15. Although the turns 11, the start wire 14, and the finish wire 15 constitute a single wire, they will be referred to as designated for purposes of describing the invention. Wrapped around the turns is a suitable sheet of insulating material 16, such as an insulating paper. The start and finish wires protrude through the overlapping edge portions of the paper and are connected to terminals 17 and 18, respectively by solder or other suitable means. These terminals are mounted on a relatively stiff strip of insulating material 19 which is suitably secured to the outside of the insulating paper 16, as seen in Fig. 1.

The start and finish wires 14 and 15 are crossed to define a crossover C, as seen in Figs. 2, 3, and 4 and separated by an intermediate sheet of insulating material 20. Outer sheets of like insulating material 21 and 22 are secured over the outer sides of the start and finish wires to further insulate the crossed wires from the turns 11. If desired, the insulated point of crossing may lay over the sheet of insulating paper 16 to further insulate the crossed wires from the turns, but the heat of the coil when failing will be transferred more readily to the crossover when it lays inside the insulating sheet 16. As seen particularly in Fig. 4, and indicated by the numerals 23 and 24, the insulation around the wires at the crossover point has been removed. The insulation separating the crossed wires, particularly the sheet of insulation 20 is of a type which will decompose and melt upon reaching a predetermined temperature thereby allowing the crossed start and finish wires to contact each other and effectively short out the turns 11. An example of the type of insulation which may be used to separate the start and finish wires is "Mylar."

The arrangement illustrated in Fig. 5 is identical in every respect with the arrangement of Fig. 4 except that the insulation on the start and finish wires at their

point of crossover has not been removed. In some cases, this arrangement may prove to be more advantageous. It will be appreciated that the temperature at which the wires will contact each other will be greater due to the fact that the insulation will have to be decomposed around the wires before this can come about.

The temperature at which contact between the start and finish wires is desired to take place may be effected by several methods including picking of the type of insulating material for holding the wires apart, the thickness of the insulating material between the wires, the thickness of the insulating material between the crossed wires and the turns which control the amount of heat transmitted to the sandwiched sheet of insulating material 20, and whether or not the original insulation on the start and finish wires has been removed.

While the crossover has been shown as applied to the start and finish wires, it is to be understood that it could be located at other places, so long as the current generated by contact of the wires in the crossover will either cause the overload device in the circuit to open or the wire of the coil leading from the crossover to burn and open the circuit.

The operation of the preferred embodiment shown in Fig. 4 takes place when the coil is energized and is failing either from an overload or mechanical failure of the wire insulation between turns. These conditions increase the coil temperature which transmits heat to the insulated crossed start and finish wires. When the temperature of the insulating sheet 20 between the crossed wires reaches a predetermined value, it will decompose and melt thereby allowing contact between the uninsulated crossed wires and short out the coil and burn at least one of the wires to open the circuit. Obviously, once the coil is shorted out and the circuit opened, the temperature will gradually drop to ambient temperature. Generally, the coil will be arranged in a circuit which includes an overload device, such as a fuse or circuit breaker, although the coil with its own cross wires arrangement eliminates the need for any fuse or circuit-breaker except for other electrical devices that may also be in the circuit. When the wires in the crossover contact each other thereby shorting the coil out of the circuit, it will cause a high current to flow through the circuit which will, in turn, either cause the overload device to open the circuit or one of the fine wires leading from the board 19 to the crossover to burn and open the circuit. The wires leading from the terminals 17 and 18 will, of course, be much heavier than the fine wires of the coil so that should the circuit be wired with a high amperage overload device, the fine wires of the coil between the crossover and the board 19 will function as a fuse and burn upon being subjected to a predetermined amperage overload. Consequently shorting out of the coil eliminates fire and shock hazards. In any case, it is generally intended that the insulating and/or combination of materials be selected to cause burnout of the coil at a safe temperature.

The operation of the embodiment shown in Fig. 5 is substantially identical except that the burnout will occur at a relatively higher temperature. However, the magnet wire insulation may be employed in this instance to help control the burnout temperature. In this instance, as long as the temperature at which the magnet wire insulation fails mechanically is well below the melting point of the conductor, probably of copper, and the crossed wires are so located that they short out before the general coil temperature exceeds the flash point, no fire will result as long as the arc is properly confined. This is the case where arcing occurs when the copper melts. An additional factor is usually present to promote failure at the crossed coil leads in preference to failure at the adjacent turns, since the full applied voltage is always between the crossed start and finish wires while the highest voltage between turns will usually be a fraction of the total.

When this potential difference is of appreciable magnitude, it will definitely influence the point of failure.

In cases where pure overload might be encountered, such as with transformers, the degree of overload will affect the heating rate. With relatively light overloads, it will be necessary to have the crossed wire insulation fail at a temperature below what might otherwise be permissible to prevent the overall coil temperature from reaching the flash point.

Further, it may be necessary to pressurize the crossover to prevent the wires therein from buckling apart, although the usual construction of a coil will force the crossed wires together once the separating insulation melts and decomposes. In such cases, the crossover will be arranged in the coil to have pressure exerted against both sides thereof. An example of this type of arrangement is shown in Fig. 1A where a transformer coil 10A is shown having primary and secondary windings 25 and 26. The primary winding is first arranged over the bobbin 12. The start and finish wires 27 and 28 of the primary winding are crossed to form the crossover C. The secondary coil having start and finish wires 29 and 30 is then arranged over the primary coil and the crossover C to firmly imbed the crossover under pressure between the primary and secondary windings. All of the start and finish wires are mounted on a single terminal board 31.

From the foregoing, it will be seen that the present invention provides an economical magnetic coil construction which eliminates fire and shock hazard.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention, but it is understood that this application is to be limited only by the scope of the appended claims.

The invention is hereby claimed as follows.

1. In a magnetic coil, a plurality of windings having common start and finish wires, said start and finish wires being arranged to cross each other, and means between said wires at the point of cross over thereof permitting direct contact therebetween when said coil reaches an overheated condition, said means including a mass of insulation, capable of decomposing and melting when it reaches a predetermined temperature thereby permitting contact between the start and finish wires.

2. A magnetic coil comprising a plurality of insulated windings, start and finish wires common to said windings, said start and finish wires crossing each other and being free from insulation in the areas of crossing, means insulating said start and finish wires at the point of cross over thereof from each other and from the windings, whereby said means permits the start and finish wires to contact each other causing at least one of the wires to burn and open when the coil reaches an overheated condition.

3. A magnetic coil comprising a plurality of insulated windings, start and finish wires common to said windings, said start and finish wires crossing each other and being free from insulation in the areas of crossing, means insulating said start and finish wires at the point of cross over thereof from each other and from the windings, whereby said means permits the start and finish wires to contact each other causing at least one of the wires to burn and open when the coil reaches an overheated condition, said means including layers of insulation between and on opposite sides of said start and finish wires.

4. A magnetic coil comprising a plurality of insulated windings, start and finish wires common to said windings, said start and finish wires crossing each other and being insulated like said windings, means between said wires at the point of cross over thereof to hold same apart, said means including a mass of insulation which will decompose and melt at a predetermined temperature when the coil reaches an overheated condition and permit the start and finish wires to contact each other thereby causing at least one of the wires to burn and open thereby eliminating a fire hazard.

5

5. In a magnetic coil having start and finish wires crossing each other, a layer of solid insulating material separating said start and finish wires at the point of cross over thereof, said insulating material being of a type which will decompose and melt at a predetermined temperature when the coil reaches an overheated condition and permit the start and finish wires to contact each other and cause at least one of the wires to burn and open thereby eliminating a fire hazard.

6. In a magnetic coil having start and finish wires crossing each other, a layer of solid insulating material separating said start and finish wires at the point of cross over thereof, layers of solid insulating material covering the opposite sides of said wires, said insulating material being of a type which will decompose and melt at a predetermined temperature when the coil reaches an overheated condition and permit the start and finish wires to contact each other and cause at least one of the wires to burn and open thereby eliminating a fire hazard.

7. In a transformer coil having primary and secondary windings with start and finish wires crossing each other, and means normally preventing contact between the point

6

of cross over of the start and finish wires of the primary winding which permits direct contacts between the wires when the coil becomes overloaded and overheated thereby burning at least one of the wires and opening the primary winding and rendering the coil inoperative.

8. A transformer coil comprising a bobbin, a primary winding arranged on the bobbin, a secondary winding arranged over said primary winding, a crossover sandwiched between said windings, said crossover including the start and finish wires of the primary winding arranged to cross each other, and insulating means between said start and finish wires at the crossover which allows the wires to contact each other when the coil reaches an overheated condition.

References Cited in the file of this patent

UNITED STATES PATENTS

1,718,980	Ringwald	July 2, 1929
2,779,842	Walker	Jan. 29, 1957

FOREIGN PATENTS

360,992	Germany	Oct. 9, 1922
---------	---------	--------------