

Oct. 6, 1936.

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2,056,760

ELECTRIC CIRCUIT CONTROL APPARATUS

Original Filed Aug. 27, 1932

2 Sheets-Sheet 1

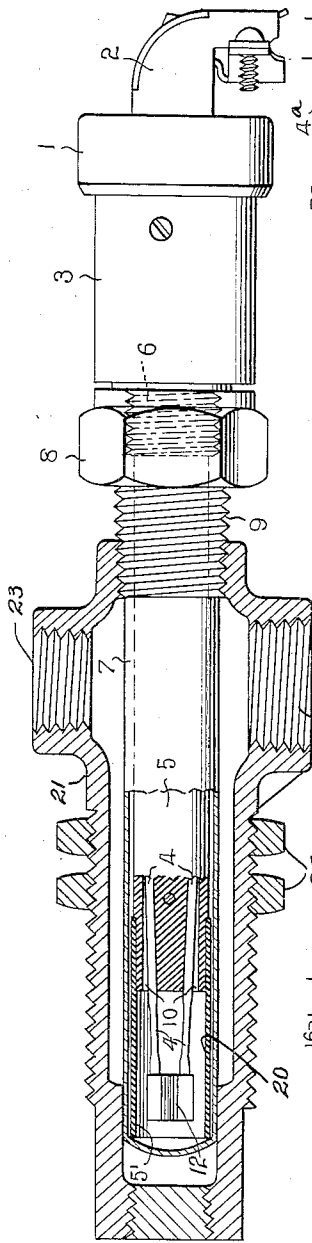


FIG. 1.

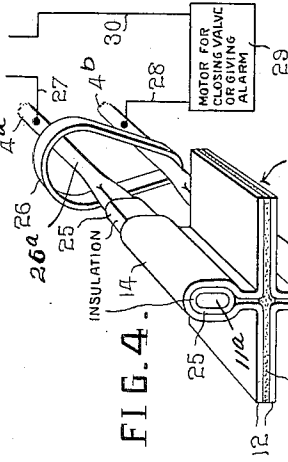


FIG. 2.

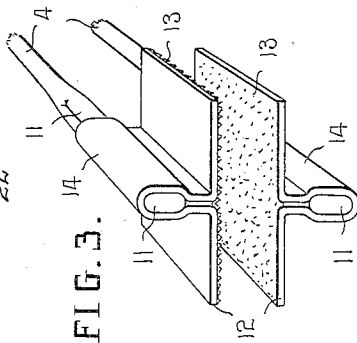


FIG. 3.

FIG. 4.

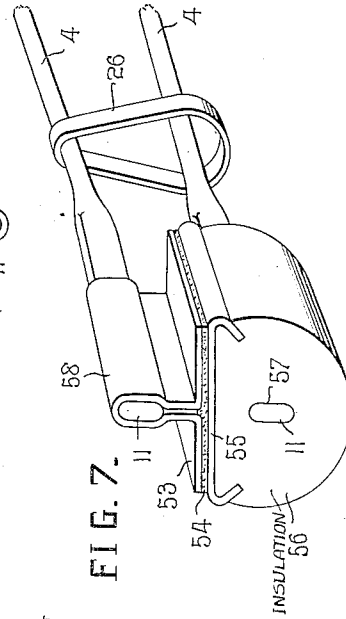


FIG. 7.

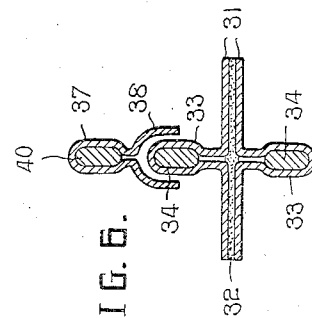


FIG. 6.

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2 Sheets-Sheet 2

FIG. 5.

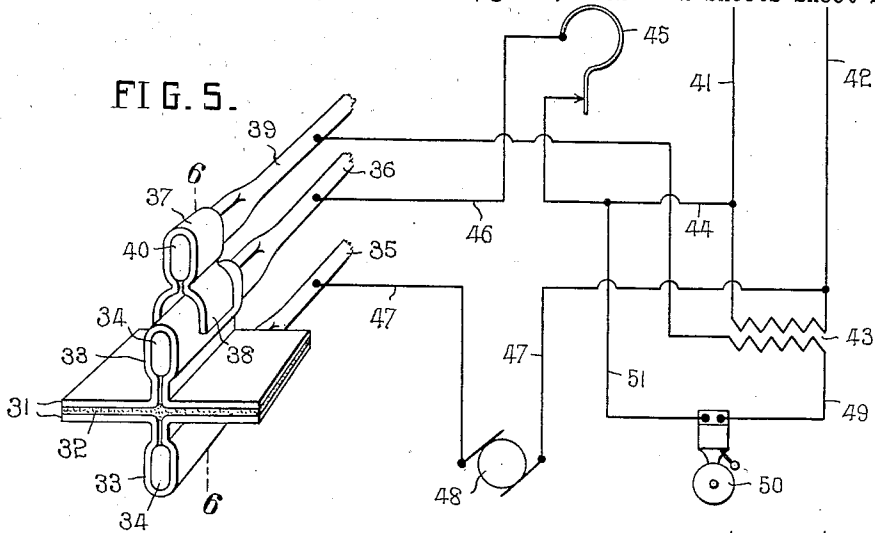


FIG. 8.

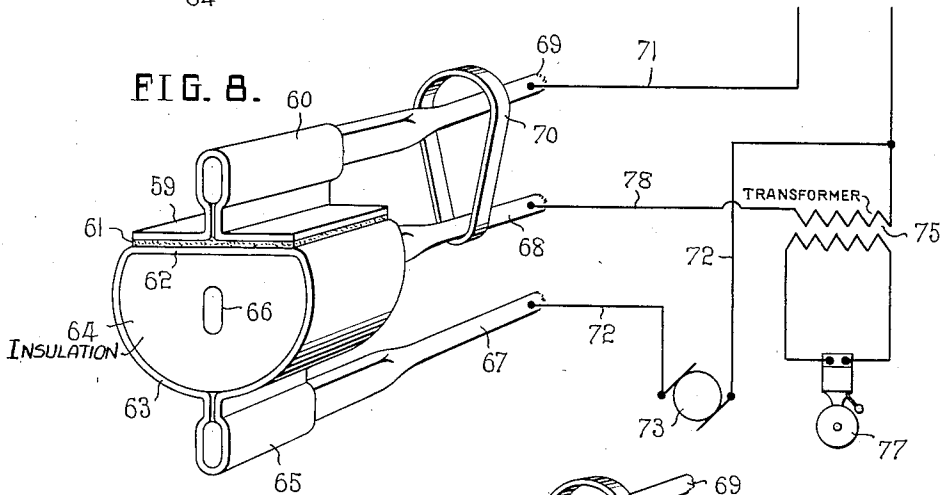
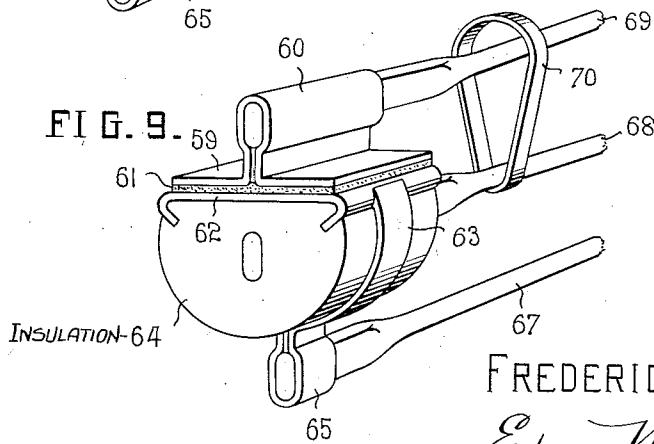


FIG. 9.



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UNITED STATES PATENT OFFICE

2,056,760

ELECTRIC CIRCUIT CONTROL APPARATUS

Frederick D. Austin, Port Chester, N. Y.

Application August 27, 1932, Serial No. 630,742
Renewed August 13, 1935

30 Claims. (Cl. 200—142)

This invention relates to improvements in the art of controlling electrical circuits destined to govern the conditions of heat trans-
ference apparatus, such as domestic boilers,
and other furnace and boiler construction for
insuring safety at all times and preventing
overheating or dangerous water level drop or
other untoward or undesirable conditions.

Among the objects in view is the provision
of a highly sensitive control responsive to fur-
nace or boiler conditions for governing the op-
eration thereof accordingly.

A further object is the effective avoidance of
failure of the safety controlling apparatus to
function as intended.

In greater detail, a further object is to in-
sure the making or breaking of a circuit or
circuits as and when required under conditions
of highly sensitive responsiveness of the circuit
making and breaking means.

With these and further objects in view as
will in part hereinafter become apparent and
in part be stated, the present improved inven-
tion includes a heat-responsive unit for con-
trolling a circuit, and also includes a fusing
alloy which is heat-responsive and proportioned
for a relatively high degree of responsiveness
for fusing at substantially uniform, predeter-
mined temperatures.

The invention further includes heat-respon-
sive control means for a plurality of circuits
for breaking and making circuits under excess
heat conditions.

The invention also includes certain other
novel constructions, combinations, and arrange-
ments of parts as will subsequently become ap-
parent and will thereafter be pointed out in
the appended claims.

In the accompanying drawings,—

Figure 1 is a view partly in side elevation
and partly in longitudinal section of an embod-
iment of the heat-responsive unit and cooper-
ating parts shown detached, parts being broken
away and seen in section for disclosing interior
parts in elevation.

Figure 2 is a fragmentary perspective view of
the immediate heat-responsive unit with a dia-
grammatic showing of its circuit, the fuse be-
ing in its circuit-closing condition.

Figure 3 is a similar view of the same with
the fuse in the circuit-breaking condition, the
circuit being omitted.

Figure 4 is a similar view of a slightly mod-
ified embodiment with the circuit shown dia-
grammatically.

Figure 5 is a view similar to Figure 2 of a
multiple circuit heat-responsive unit with the
circuit shown diagrammatically.

Figure 6 is a transverse section therethrough
taken on the plane indicated by line 6—6 of
Figure 5.

Figure 7 is a view similar to Figure 4 of a
slightly modified form of circuit closer, the cir-
cuit being omitted.

Figure 8 is a view similar to Figure 7 of a
modified embodiment thereof to provide for
multiple circuits, the circuits being seen dia-
grammatically.

Figure 9 is a view similar to Figure 8 of a
further slight modification, the circuits being
omitted.

Referring to the drawings by numerals, 1 in-
dicates a standard electric fitting consisting of
a pronged insulating carrier having a right-
angle armor shield 2 to receive any of the well
known armored electric cables with multiple
wires. The prongs of the fitting 1 are remov-
ably inserted in an insulating handle 3, which
is provided with the customary sockets for re-
ceiving the prongs from the part 1 and direct-
ing them into contact with the outer terminals
of electrical conductors 4, 4. The conductors
4 extend throughout the length of an insulat-
ing bar or rod 5 which extends from the end
of and is preferably formed integral with the
handle 3, the outer end of the rod adjacent
the handle being provided with threads 6 for
being detachably threaded into a metallic shell
or casing 7. The shell 7 at its outer end is
preferably provided with a nut-like or polysided
handle 8 adapted to receive a wrench or other
tool for rotating the shell into operative posi-
tion. The shell is provided with threads 9 ad-
jacent the handle 8, which threads are prefer-
ably of the pipe thread type so as to be
properly received in any appropriate pipe cou-
pling or fitting. The shell 7 is preferably, as
seen in Figure 1, imperforate and closed at its
inner end so as to prevent moisture from reach-
ing the contained parts when the shell 7 is
surrounded by moisture. The outer end por-
tion of the shell is internally threaded to re-
ceive the thread 6 of the bar 5. The conductors
4 are preferably in the form of rods of resilient
material so as to be capable of being sprung
toward each other as seen in Figure 1. The
bar 5 is provided with enlargements 10, 10 of
the passageways through which the rods 4 ex-
tend at least for a short length of the inner

portion of the bar 5 so as to enable ample spring action of the rods 4 when required.

The free terminals of the rods 4 are preferably flattened or otherwise rendered polysided, as plainly seen at 11, 11, in Figure 2, and the rods are held in electrical conductive contact or engagement with each other under a state of tension by a heat-responsive fuse unit supported by the rods and made up of plates 12, 12, and an interposed film 13 of fusing material, as will hereinafter be described. The plates 12, 12 comprise the contact members of rods 4, 4 and are held in conducting relation by the material 13. Each of the plates 12 is provided with a sleeve 14 to receive the respective terminals of rods 4 and the sleeves are shaped to snugly receive the flattened terminals 11 and thus prevent the plates 12 from rocking or pivoting on the rods 4 when the fuse 13 gives way and allows the parts to move apart under the expanding tension of the rods 4 to the position seen in Figure 3.

The plates 12 are preferably made of relatively thin sheet metal, such as copper, and the fusing material 13 is preferably as thin as is practicable for resisting fusing under heat up to the degree previously determined, and, to that end, the film of fusing material 13 is preferably in the nature of solder applied as a thin solder coat between the two sheets 12.

While the heat-responsive unit or fuse, as seen in Figures 1 and 2, is capable of a wide range of use, one effective use is indicated by the diagrammatically shown hookup as seen in Figure 2, wherein one of the conductors or rods 4 is connected by a line 15 directly to one side 16 of the source of current, and the other rod 4 is connected by a line 17 through the instrumentality to be actuated 18 with the other side of the source of current indicated at 19. The instrumentality to be actuated may, for purposes of illustration, comprise the operating motor of an oil burner, or any other motor controlling the supply of fuel to the furnace or other heat transference apparatus which is being safeguarded by the heat-responsive unit.

It will be observed that as long as conditions remain normal and satisfactory, and the boiler or other heat transference apparatus is operating under safe conditions, the current will flow through the fuse 13 uninterruptedly. However, if from a drop in the water level below the safety level or from any other cause the fusing material 13 becomes overheated, the melting of that material will release the plates 12 from their connection with each other and the parts will move quickly apart under the spring action of the rods 4 to the position indicated in Figure 3. Assuming the line 16 to be the hot side and line 19 to be grounded, the current can not pass from 16 to line 19, and, therefore, the motor 18 will cease operating and prevent maintenance or increase in the dangerous condition. An insulating sleeve 20 preferably surrounds the heat-responsive unit so that, when the rods 4 move apart incident to the fusing of the fuse material 13, no part of the plates can reach contact with the shell 7. The sleeve 20 is preferably detachably slid over the inner end portion of the rod 5, but may be otherwise arranged within the inner portion of shell 7 so long as the heat-responsive unit is properly safeguarded. It will also be observed that when the plates 12 have moved apart incident to the release of the fuse 13, they can not rock or tilt or otherwise pivot, and, therefore, can not by assuming a diagonal

position accidentally come in contact with each other.

The shell 7 and its contained parts are, of course, well adapted for use anywhere where the rise of temperature beyond a predetermined point indicates a dangerous condition and may be depended upon to effect release of the fuse. One important location is that of having the shell 7 extending into the water of a boiler so that, when the liquid level drops too low, the shell is exposed directly to the heat action, and, therefore, to such a temperature as will break the circuit of the fuel supply apparatus, and thus prevent continuation of the overheating or the dangerous condition incident to a too low water level. It should be understood, of course, that the lines 15 and 17 extend through the standard connection 2 and thus are detachably maintained in electrical contact respectively with the conductors or rods 4.

As a special application, the shell 7 may be threaded into the outer threaded end of an adapter 21 having a lower connection 22 with the boiler below the liquid level thereof and an upper connection 23 with the boiler above the normal liquid level, the adapter 21 being located at approximately the lowest safe liquid level. It is also feasible to arrange the adapter 21 to extend into the flue or other heat travel area of the furnace or other heat transference apparatus, and, to that end, clamping nuts 24, 24, may be threaded onto the extended portion of the adapter 21 for clamping the parts in the desired location. Details of the preferable arrangement and connection of the adapter 21 are seen in my co-pending patent application filed even date herewith.

It is well understood, of course, that with various heat transference apparatus and various types of fuel and forms of fuel feeding and controlling devices, different circuit hook-ups are required, according to the nature of the action necessary. For instance, while the foregoing has been applied directly to a motor circuit wherein the action of the motor is depended upon for supplying fuel, it is entirely practicable to apply the present invention to motor circuits where the motor is depended upon to cut off the supply of fuel, as, for instance, where a motor is employed to close a gas valve. Or, under some circumstances, it may become desirable to have an alarm set off with the arising of a dangerous condition.

In Figure 4 is illustrated an embodiment in which the circuit is controlled by being turned on or made instead of being broken or turned off when the fuse is melted. In this form, the electric conductor members or rods 4^a and 4^b are supported or mounted in longitudinal bores through an insulating member or rod in the same manner as are the rods 4 of Fig. 1. However, the rods 4^a and 4^b in addition to serving as current carrying members also comprise supporting or carrier elements or members. The free end portions 11^a, 11^b respectively of rods 4^a, 4^b function solely as supporting means and are not in circuit. The portion 11^a is provided with an insulator or dielectric covering 25 preferably in the form of a sleeve or tube of insulating material which snugly fits and conforms to the portion 11^a. The fuse 25^a is of similar construction to that of Figs. 1, 2, and 3 and its parts are therefore designated by like reference characters, although as will be noted, the plates 12, 12 do not here comprise contact

members. The rods 4^a and 4^b are held in fixed relation to each other by the fuse 25^a, one fuse sleeve 14 receiving the supporting rod portion 11^b and the other fuse sleeve 14 receiving the insulated supporting rod portion 11^a. The insulation 25 may be of any preferred kind, such as a layer of fiber, or the rod 4^a may be shortened and supplied with an extending end portion of insulating material adapted to enter the sleeve 14. The other rod 4^b opposite that provided with the insulation 25 carries a contact member which may be in the form of a metal ring 26 which is fixed to and in electrical contact with the respective rod 4^b and which is in surrounding spaced relation to the rod 4^a which has the insulating material 25. The rods 4^a and 4^b are sprung or stressed toward each other when the heat-responsive unit or fuse 25^a is slid into place on the rods, so that the heat-responsive unit retains the rods under tension, with the contact member 26 in spaced relation to its cooperable and engageable contact portion 26^a on rod 4^a which defines the other contact member. Thus, when the heat reaches the predetermined high degree, the fusible material 13 will disrupt and allow the plates 12 to spring apart as above described under the inherent resilient force of rods 4^a and 4^b. With that movement the ring 26 and the contact portion 26^a of insulator carrying rod 4^a will be brought into contact. As seen in Figure 4, one hookup with the construction just described may well consist of a line 27 leading from a source of current to the conductor 4^a carrying the insulation 25. A line 28 leads to the motor 29 for actuating the fuel valve or for operating an alarm, or other purpose as required, and a line 30 leads from the motor 29 back to the source of current. Thus, so long as the ring 26 is out of contact with portion 26^a of the insulator carrying rod 4^a, the motor 29 will remain stationary, but when the temperature rises to the danger point and the fuse 25^a gives way, the operation of the rods 4^a and 4^b closing the circuit through the engaged contact members 26 and 26^a will energize the motor 29 and accomplish the desired end.

While the heat-responsive or fuse members thus far described are designed for use in two-wire circuits, the invention is well adapted for multiple circuit use, as seen in Figures 5 and 6, wherein the heat-responsive or fuse member consists of plates 31, 31, similar in all respects to the plates 12 and connected together by the fusing material 32. Plates 31 are provided with anchoring sleeves 33 adapted to receive the flattened terminal portions 34, 34, of conductor rods 35 and 36 corresponding to rods 4. But in this construction a third sleeve is provided, as indicated at 37, and carrying and forming part of a plate or wings 38 spaced above and in line with one of the plates 31. The sleeve 37 and plates 31 are thus normally out of electrical contact. A third conductor rod 39 having a flattened portion 40 extends into and is in electrical contact with the sleeve 37 and holds the sleeve and plate 38 from tilting or otherwise moving under normal conditions so as to be sure not to contact with fuse plate 31. While the parts of Figure 5, so far as the circuit is concerned, are shown diagrammatically, it will be readily understood that the rod 39 in the actual physical embodiment will be embedded in the insulating rod or bar corresponding to bar 5 and held rigidly thereby, and the line from the conductor

rod 39 will comprise a third wire of a three-wire circuit hook-up through the connection 2. While the three-wire circuit is capable of quite a wide range of variable hook-ups, one acceptable form is illustrated in Figure 5 in which 41 and 42 are the main line or supply wires, and it may be assumed that 41 is the hot wire while 42 is the grounded wire. A bell-ringing or other transformer 43 is preferably hooked directly across the leads 41 and 42. A line 44 extends from lead 41 to the usual thermostat 45, and a line 46 extends from the thermostat to the rod 36. A line 47 leads from the rod 35 through the instrument to be energized, such as the oil burner motor 48, back to the lead 42. The second winding of the transformer 42 has one side connected by line 49 to any appropriate signal or alarm 50, and a line 51 leads from the other side of the signal 50 to the line 44. A line 52 leads from the rod 39 to the side of the winding of the transformer opposite that connected to line 49.

With this particular multiple circuit hook-up, the operation will be apparent from the diagram seen in Figure 5, and consists of the continuous operation of the motor 48 when the thermostat 45 is in the closed position and other conditions are normal. Current from lead 41 flows along line 44, through the thermostat and line 46, through rod 36, plates 31 and the fuse 32, rod 35, line 47, and thus back to the lead 42 through the motor 48. Should the heat for any reason reach the danger point and the fuse 32 be thereby fused, the rods 35 and 36 will spring apart and thus break the circuit to the motor 48. The upper plate 31 and sleeve 33 will spring upward when thus released, since rod 35 is under spring tension. Sleeve 33 will be thus moved into contact with the wings of plate 38, and the circuit of signal 50 thus closed. The current from transformer 43 will then flow through the circuit 49, 51, 44 to thermostat 45, 46 through rod 36, upper plate 31, plate 38, and sleeve 37, rod 39, and line 52 back to the transformer. The signal or alarm will be thus given, and the hook-up is such that it will be given only when the motor is stopped by the dangerous condition producing response in the heat-responsive unit causing fusing of fuse 32.

In Figure 7 is seen a further embodiment substantially identical in form and operativeness to that seen in Figure 4, and differing essentially in details of construction. In the embodiment of Figure 7, the conductor rods 4, 4, are arranged exactly as seen in Figure 4 with the ring 26 carried by one of the rods 4 and surrounding but spaced from the other so long as the rods are held sprung toward each other by their engagement with the heat-responsive fusing unit consisting of the plate 53 soldered at 54 with the fusing solder to plate 55. Plate 55 is anchored to an insulating block 56, as by a dovetail joint connection, the plate 54 being formed with in-turned flanges to provide the necessary undercut groove for receiving the overhang piece of the block 56, so that the block can be readily slid into locking engagement with the plate. The block 56 is preferably formed with a flattened or polysided opening 57 for receiving the similarly shaped terminal portion of the respective rod 4, and the plate 35 is provided with the usual integral sleeve 58 to receive the polysided terminal portion of the other rod 4. The heat-responsive unit, as seen in Figure 7, is thus functionally identical with that seen in Figure

4, and its operation therefore does not require description.

In Figure 8 is seen a heat-responsive fusing unit similar generally in construction to that seen in Figure 7, but having the third connection corresponding to the embodiment seen in Figure 5, and, in fact, the fusing unit of Figure 8 and that of Figure 5 are obviously interchangeable. However, the hook-up shown in Figure 8 is somewhat different, and it must be understood that the present invention does not relate particularly to the hook-up but more directly to the means which makes the hook-up possible, and includes the fusing unit and its cooperating parts.

In Figure 8 is seen the plate 59 having the usual conductor receiving sleeve 60 and secured by the fusing material 61 to the plate 62. A loop or band 63 extends laterally from the plate 62 and preferably surrounds an insulating block 64, the band terminating in a conductor-receiving, elongated sleeve 65. The insulating block 64 is provided with a conductor-receiving passageway or opening 66, which is preferably elongated or otherwise polysided in cross section and is adapted to receive the flattened end of a conductor rod. Conductor rods 67, 68, and 69 extend into the sleeve 65, the opening 66, and sleeve 60 respectively. A metal ring or other appropriate contact piece 70 is in electrical contact with and fixed to the rod 68 and surrounds but is normally out of contact with rod 69. In this connection, it should be borne in mind that the ring 70 and the ring 26 while effective for the purposes indicated may perform their work also effectively even if they are not made in the form of a complete ring, but only so much is provided as will form a hook or part overhanging the non-conducting rod so as to come in contact when the rods move apart.

While the hook-up of the structure seen in Figure 8 may be identically the same as that seen in Figure 5, or may be any other known multiple circuit hook-up, an acceptable arrangement is shown diagrammatically in Figure 8 to consist of a line 71 leading from the source of supply to the conductor 69, thence through plate 59, fusing material 61, plate 62, and sleeve 65 to conductor 67. A line 72 leads from conductor 67 back to the other side of the source of current through the motor or other electrically actuated part 73. Hence, so long as the fuse 61 remains intact, the motor 73 will function properly. When, however, the fuse 61 gives way and the plates 59 and 62 move apart, the rod 69 will come in contact with the contact making member 70 and thus the circuit will be changed, cutting out the motor 73 and establishing a circuit from the source of supply through line 71, conductor 69, ring 70, conductor 68, and line 72 to transformer 75, and thence by line 76 back to the source of current. The transformer may be connected to any part to be energized, such as the alarm 77.

In Figure 9 is seen a very slight modification of the construction shown in Figure 8 in which the essential difference is the employment of a narrower band about the insulating block, so that the dovetail connection, as seen in Figure 7, may be effectively employed, and as the description of Figure 8 with the exception mentioned equally applies to Figure 9, the same reference numerals have been employed and repetition of the description is unnecessary.

As will be apparent from the foregoing and

from the drawings, each of the heat-responsive units is made up in a manner to enable it to be slid onto and off of or have slip engagement with the respective flattened or polysided end portions of the conductor rods. Thus, after a fuse has "blown" the operator withdraws the coupling 1 and unscrews the rod 5 and withdraws it from the shell 7. It will be noted that the shell 7 remains in place so that there is no leakage of water from the adapter 21. If the sleeve 20 is mounted on the rod 5, it is withdrawn and then the respective disconnected parts of the fuse unit are slid off of the conductor rods and a new fuse unit slid onto the rods. Naturally, the rods are relatively sprung toward each other to enable the new fuse unit to be slid into place so that the required tension will be provided to cause separation of the parts of the unit when fusing occurs. When the hook-up includes the rod 39 or the rod 67 or the third rod in any instance, it is not necessary to put the third rod under tension, but only to provide relative tension between the two other rods.

While the present invention is shown in the drawings and above described as especially well adapted for use in connection with boilers and like heat-transference apparatus, it should be understood that the control or heat-responsive unit is just as effectively designed and adapted for many other uses. In Figure 1 of the drawings, the parts are shown on a scale which for boiler application is approximately normal and standard, and, of course, the other figures show the parts on exaggerated scales for average uses; but the invention is in no sense limited to size or proportions of parts so long as the operative combinations are maintained, and the parts may be made larger or smaller than shown according to the use or application desired.

For instance, among many other valuable uses additional to those above set forth, the parts may be proportioned (usually reduced in size) to adapt the heat-responsive unit and one or more of its circuits to be successfully employed in conjunction with bearings or other mechanical parts where friction endangers disastrous heating in the absence of adequate lubricant. The bearings for rotating, oscillating and reciprocating shafts and other moving parts are universally lubricated to reduce friction, and the lubricant in reducing the friction avoids development of heat; but it not infrequently happens that through clogging of oil ducts or otherwise a dearth of lubricant occurs and the bearing is burned out or other parts injured. The present invention is particularly well adapted and especially designed to prevent such injury. The friction-produced heat causes the fuse to respond and cut out or otherwise govern the current on which the machinery depends for its operation. and, therefore, before the friction has done any damage, the movement of the insufficiently lubricated part is stopped, and the bearing is saved. To apply the invention to a bearing, the parts are, of course, made of a size to cooperate with the particular bearing, and an opening or pocket is formed in the bearing part or a cooperating or adjacent part, and the wall of such opening is tapped so that the thread 6 can be caused to thread into the opening until the fuse 13 is in sufficient proximity to the bearing or part that will be likely to be heated by friction to insure fusing of the fuse before any injury has been

done. Of course, the shell 7 will not be used in such an arrangement, but an electrical insulator, such as sleeve 5', will be used, or any appropriate insulating cover for the conductor parts will be provided to prevent short-circuiting. The sleeve 5' or other insulator cover will, of course, be located as near to the part to be protected as possible short of frictional contact so as to insure the highest possible degree of sensitivity and responsiveness of the fuse to the heat as it begins to be generated by friction. Actual tests and continued use of the invention for safeguarding bearings has abundantly proved its success and efficiency. The burning out of a bearing, whether of the ponderous size of bearing for ships' drive shafts or the smaller sizes, such as the connecting rod bearings of internal combustion engines, will be effectively avoided by the use of the present invention.

Obviously, numerous other uses are available for the invention, and it is valuable for safety and protection wherever any excessive or unintended heating occurs or other heat-transference happens resulting from an unintended, harmful or dangerous condition, and it is not a departure to apply the invention wherever usable.

It should also be understood that the heat-responsive control of the present invention will function effectively regardless of the source of the heat, whether generated, released, or accumulated, and the sensitiveness and durability of the fusing solder are of particular importance. By "sensitiveness" is meant capacity to respond or fuse at substantially the exact temperature required. It is customary for me to calculate on a variation of from three degrees above to three degrees below the exact temperature point at which fusion is intended to occur, and this I consider a reasonable margin of safety, but from almost innumerable tests and actual commercial use I have successfully demonstrated that the variation will be much slighter under all ordinary conditions than this margin of safety.

The fusing material employed to provide the fuses 13, 32, 54, and 61 may for the technical interpretation and application of those parts of the invention not specifically relating to the fuse material itself be considered as any known fusing substance responding at the required temperatures. However, the fact is that the known fusing materials have not been satisfactory for regular use because submergence for any continued periods with known fusing material tends to vary the condition of the fusing material such that it can not be depended upon to fuse at any fixed temperature or within available variations therefrom, and among other objects of that part of the present invention which relates specifically to the fusing material itself is the production of a fusing material capable of withstanding the action incident to submergence for long periods so as to constantly remain responsive to and fusible at a substantially fixed temperature or within available variation therefrom, say not more than three degrees above or three degrees below the established or fixed point of temperature. I find by many tests that the present improved fusing material will usually respond at practically identically the temperature required. This new fusing material which I have invented is comprised of an alloy of bismuth, lead, and tin proportioned to produce a solder adapted for soldering the plates together with a very thin film of the fusing solder. The proportions of bismuth, lead, and tin relative to each

other is, of course, varied according to the fusing point required. If the fusing point in hot water is to be 212° F., the fusing alloy is produced by first making an initial alloy of fifty-eight parts bismuth to forty-two parts lead by weight, and then to this initial alloy are added five and two-tenths parts of tin by weight. For an alloy which fuses at 222° F. after standing in hot water under pressure or vapor the initial alloy of fifty-eight parts bismuth to forty-two parts lead by weight has added three and twenty-five hundredths parts tin by weight. For an alloy which fuses at 240° F. after standing in hot water, as, for instance, water under pressure of nine and one-half pounds steam, the initial alloy of fifty-eight parts bismuth and forty-two parts lead by weight has added one and two-tenths parts tin by weight. For an alloy which fuses at 266° F. after standing in hot water, as, for instance, water under pressure of twenty-five pounds steam, an initial alloy is prepared of sixty-three parts tin to thirty-seven parts lead by weight, and to this initial alloy is added nine and two-tenths parts bismuth by weight. For an alloy which fuses at 298° F. after standing in hot water, as, for instance, water under pressure of fifty pounds steam, to the initial alloy of sixty-three parts tin and thirty-seven parts lead by weight are added five parts bismuth by weight. For an alloy which fuses at 322° F. after standing in hot water, as, for instance, water under pressure of seventy-five pounds steam, to the initial alloy of sixty-three parts tin and thirty-seven parts lead by weight are added three and two-tenths parts bismuth by weight. For an alloy which fuses at 338° F. after standing in hot water, as, for instance, water under pressure of one hundred pounds steam, to the initial alloy of sixty-three parts tin and thirty-seven parts lead by weight are added two parts bismuth by weight.

While I have referred to the fact that the fusing alloy thus produced is highly responsive at the predetermined or substantially predetermined temperature even though standing in water or other moisture, it should be understood that acting as a fuse this alloy in its various proportions named is effective also when subjected to various gases or left in the open air, so that it is highly dependable for fusing purposes at required, established temperatures.

This improved material is made the subject of my co-pending divisional application, filed April 19, 1933, Serial No. 666,931, since continued in part by my substitute co-pending application filed May 4, 1934, Serial No. 723,997, correcting certain errors in the said divisional application; and the pipe fitting or tubular structure into which the thread 9 is shown as threaded in Figure 1, and also the combination thereof with the shell 7 and its contained parts are made the subject matter of claim in my co-pending application filed August 27, 1932, Serial No. 630,743.

What is claimed is:

1. In circuit control apparatus, a fuse device cooperable with and operable to hold electric contact members in relatively fixed relation and comprising plates, means preventing tilting of the plates relative to each other when the plates are disconnected, and fusible material connecting the plates in facewise engagement.

2. In circuit control apparatus, conductor rods, a fuse device cooperable with said rods and comprising plates, said rods and said plates having cooperable means to hold said plates against tilting relative to each other when said plates

are disconnected and for assuring non-turning of said plates relative to said rods, and fusible material connecting said plates in facewise engagement.

5 3. In circuit control apparatus, conductor rods, one of said rods being under tension tend-
ing to move said rods relative to each other, a
10 fuse device cooperable with and holding said rods in fixed relation to each other and comprising plates, said rods and said plates having
cooperable means to hold said plates against
tilting relative to each other when said plates
are disconnected and for assuring non-turning
of said plates relative to said rods, and fusible
15 material connecting said plates in facewise engagement.

4. A fuse device comprising plates and fusible material connecting the plates, each of said plates being provided with a sleeve for detachably engaging a supporting member for the device.

5. A fuse device comprising plates and fusible material connecting the plates, the plates being provided with polysided sleeves adapted to
25 have sliding, non-rocking engagement with supporting members.

6. A fuse device as claimed in claim 1 wherein the plates are flat.

7. A fuse device comprising plates and fusible material connecting the plates, the plates being formed into laterally outstanding supporting member receiving sleeves.

8. In circuit control apparatus, the combination of fuse-connected plates having means of
35 detachable engagement with supporting rods, and means for insulating the engagement of one of the rods with one of the plates.

9. The combination as claimed in claim 8 wherein the means of engagement comprises sleeves, and the insulating means an insulating lining for one of the sleeves.

10. In circuit control apparatus, the combination, with an insulating bar, of conductor rods carried thereby, one of said rods being resilient and movable relative to the other, and the rods
45 extending beyond the insulating bar, and metal plates slidably engaging said rods, and fusible means connecting said plates.

11. In circuit control apparatus, the combination, with conductor rods, one of which is tensioned to spring relative to the other, of a fuse unit engaging the rods and retaining the tensioned rod under tension, means insulating one of the rods from the fuse unit, and circuit-making means carried by one rod and extending
55 past the other and shaped to overhang the latter rod for effecting circuit-closing contact when the rods move relatively apart on being released by the fusion of the fuse unit.

12. In circuit control apparatus, a fuse device comprising fuse-connected plates, each having means of engagement with a conductor rod, and a second means of engagement with a conductor rod electrically connected with one of the
65 plates.

13. A fuse device as claimed in claim 12 and insulating means for one of the conductor engaging means.

14. A fuse device as claimed in claim 12 in combination with conductor rods and circuit-closing means carried by one of the rods and located to contact with another rod upon the fusing of the fuse means.

15. In circuit-control apparatus as claimed in claim 8 in combination with supporting rods

engaging the same and a circuit closer carried by the non-insulated rod in position to contact with the insulated rod upon fusing of the fuse means.

16. The combination as claimed in claim 11 wherein the circuit-making means is a ring fixed to one rod and surrounding the other and spaced therefrom while the rods are held by the fusing unit.

17. A fuse device as claimed in claim 12 wherein the means of engagement with the conductor rod in each instance is a receiving sleeve.

18. In circuit control apparatus, a fuse device comprising a plate adapted to detachably engage a conductor, fusible material on one face of the plate for affording electrical connection of the plate with another conductor, and a sleeve-like part carrying the plate and adapted for engaging a sufficient polysided portion of the first-mentioned conductor to prevent tilting of the plate relative to said first-mentioned conductor.

19. In circuit control apparatus, a fuse device comprising a plate adapted to detachably engage a conductor, fusible material on one face of the plate for affording electrical connection of the plate with another conductor, and a polysided portion adapted for cooperating with said first-mentioned conductor to prevent tilting movement of the plate relative to said first-mentioned conductor.

20. In circuit control apparatus, a fuse device comprising plates in facewise relation to each other, fusible material interposed between and connecting the plates, and means carried by one of the plates for engaging a polysided portion of a supporting member to connect the plate thereto and retain the plate against tilting movement relative to the supporting member.

21. In circuit control apparatus, a fuse device comprising a plate having a polysided receiving portion, a supporting member shaped correspondingly to said portion and removably receiving said device, said member having a current conducting portion, a current conducting member cooperable with said conducting portion to control an electric circuit, and fusible material anchoring said plate in position to retain said conducting portion in fixed relation to said conducting member.

22. In circuit control apparatus, a fuse device comprising a plate having a polysided receiving portion, a supporting member shaped correspondingly to said portion and removably receiving said device, said member having a current conducting portion, a current conducting member cooperable with said conducting portion to control an electric circuit, and fusible material anchoring said plate in position to retain said conducting portion in fixed relation to said conducting member, said supporting member being resilient and being held in said fixed relation under stress such that said conducting portion is movable relative to said conducting member upon fusing of said fusible material.

23. In circuit control apparatus, the combination, with electrical conductors adapted to be held in circuit closing relation relative to each other and one movable with respect to the other, of a plate detachably and slidably engaging one of the conductors, and fusing material connecting the plate for retaining the movable conductor against movement to a circuit breaking relation with respect to the other conductor.

24. The combination as claimed in claim 23 wherein the plate is provided with means retaining the same in non-rotative engagement with the movable conductor.

5 25. In circuit control apparatus, a supporting member, a pair of relatively movable cooperable contact arms carried by said supporting member, each of said arms being under stress for movement relative to said supporting member and to each other, and one of said arms 10 having a portion extending beyond the place of contact, a fusible member carried by said extending portion and serving to hold said arms against relative movement, and means electrically insulating said fusible member from said 15 extending portion.

26. The combination as claimed in claim 25 wherein the fusible member is removably mounted on said extending portion.

20 27. The combination as claimed in claim 25 wherein the fusible member is slidingly and removably mounted on one of said contact arms.

28. In circuit control apparatus, a hollow supporting member having a tubular end portion 25 of insulating material, cooperable contact arms

fixed in said hollow member and extending in laterally spaced relation into said tubular portion for cooperable electrical engagement, one of said arms being under stress for movement relative to the other of said arms, a fusible member carried by said one arm and retaining the same against movement relative to the other of said arms, and means electrically insulating said fusible member from said one arm. 5

29. The combination as claimed in claim 28 wherein the arms are each under stress for relative movement with respect to each other and with respect to said supporting member and are held against movement under such stress by said fusible member. 10 15

30. In circuit control apparatus, a pair of plates, fusible means interposed between and holding said plates in facewise engagement, supporting members tensioned for movement relative to each other, means on said plates detachably securing said plates to said members thereby to hold said members in relatively fixed relation, and means electrically insulating one of said plates from its supporting member. 20 25

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