Aug. 5, 1941. A. B. NEWTON 2,251,494

VOLTAGE CHANGE-OVER RELAY

Filed Dec. 31, 1938 2 Sheets-Sheet 1

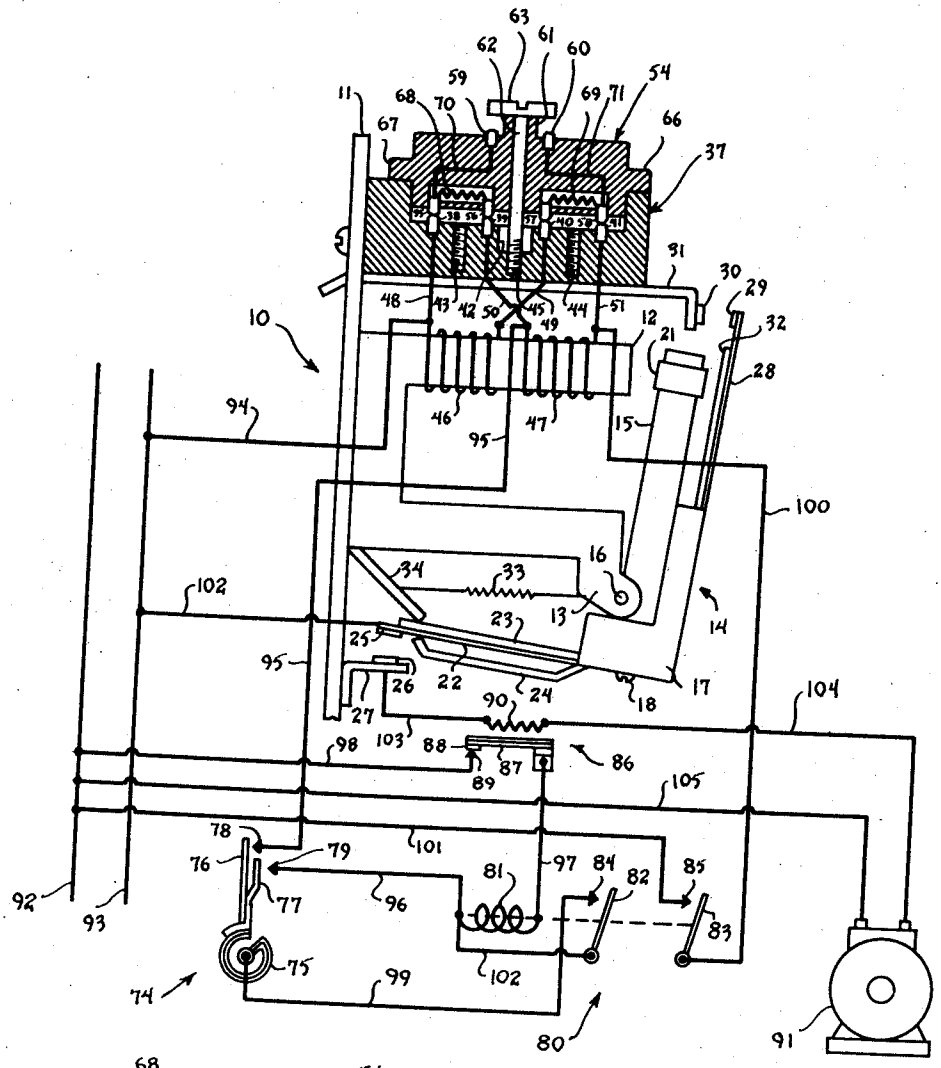


Fig. 1

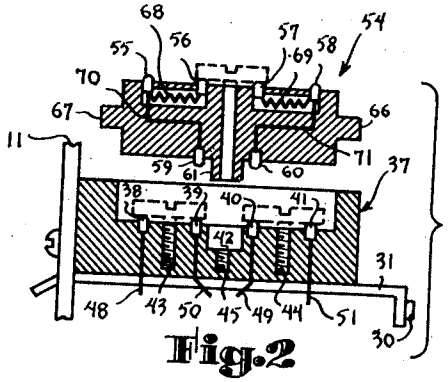


Fig. 2

Inventor
Alwin B. Newton
George H. Fisher
Attorney

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VOLTAGE CHANGE-OVER RELAY

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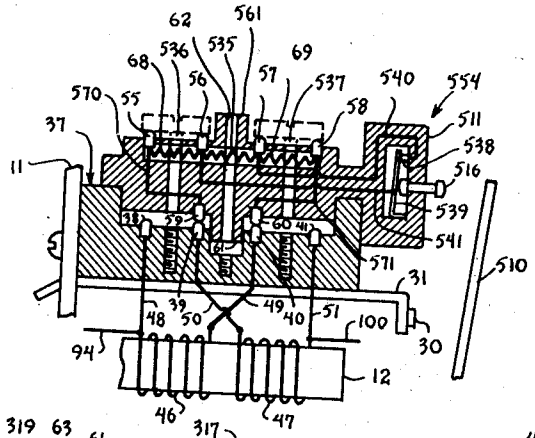


Fig. 5

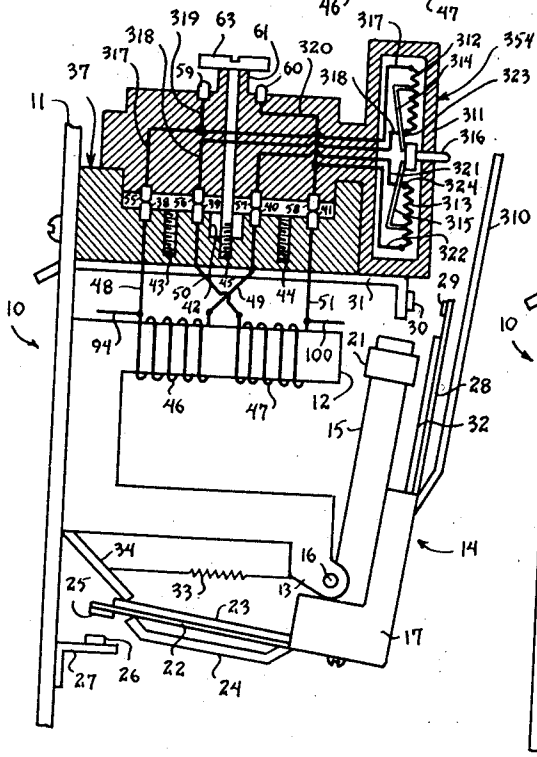


Fig. 3

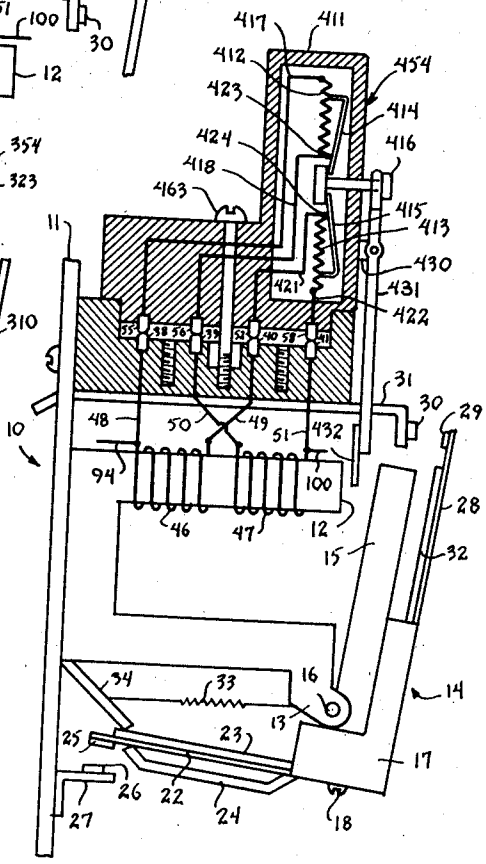


Fig. 4

Inventor

Alwin B. Newton

By George H. Fisher

Attorney

UNITED STATES PATENT OFFICE

2,251,494

VOLTAGE CHANGE-OVER RELAY

Alwin B. Newton, Minneapolis, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

Application December 31, 1938, Serial No. 248,912

19 Claims. (Cl. 175—320)

My invention relates to electrical equipment particularly relays and control systems embodying relays.

Electrical equipment is ordinarily designed and built for use at stated direct current voltages or at stated alternating current voltages and frequencies. In different localities available power sources are often only alternating current or direct current or alternating current of a frequency which may vary from the more commonly found frequency of 60 cycles. Hence ordinarily electrical equipment is far from being universally adaptable to use in all parts of the country and articles of electrical manufacture for national distribution must usually be specially constructed for different localities depending upon the nature of the source of power encountered. Having particular reference to electrical relays, which often form integral parts of such articles of manufacture as control instruments, devices, and systems, in order to supply such articles of manufacture to a national market, development and production costs are relatively heavy due to the necessity of having a number of different items of each type to accommodate the various different power sources to be used.

Broadly, the object of my invention is to render electrical equipment, particularly relays, more universally adaptable to different sources of electric power.

Another object is to provide means for conveniently changing over a relay so as to adapt it to use with different kinds and sources of power.

Another object is to provide a control system embodying a relay having means adapting it to use at different voltages and frequencies, and a pilot relay cooperating in a manner whereby the voltage impressed on the pilot relay remains the same even though voltage of the power source for the system is changed.

Another object is the provision of a relay having a plurality of coils and means for connecting the coils in different relationships depending upon the nature of the power supply.

Another object is the provision in electrical apparatus of a plurality of coils having taps connected to electrical contacts, in combination with a removable unit having contacts for engaging the aforesaid contacts, the unit having means connecting its contacts so as to connect the coils according to a certain relationship when the unit is in place.

Another object is the provision of a relay having a plurality of coils having taps connected to electrical contacts and a removable invertible unit having contacts on both sides for engaging the aforesaid contacts, the unit having wiring connecting its contacts so as to connect the coils according to a certain relationship when the unit is in place with its contacts on one side engaging the first mentioned contacts and to connect the coils according to another relationship when it is in place in its inverted position.

Another object is the provision of a relay and unit as stated in the previous object wherein the unit embodies resistances which are connected in circuit with the coils according to certain relationships depending on the position of the unit.

Another object is the provision of a relay having a plurality of coils having taps connected to electrical contacts and a removable unit having contacts for engaging the aforesaid contacts, the unit embodying a resistance, movable contacts, means whereby the relay can operate the movable contacts, and wiring such that the coils are connected according to a certain relationship when the unit is in place and whereby operation of the movable contacts by the relay places the resistance in series with one or more coils.

Another object is the provision of a relay and unit as stated in the previous object, the unit being constructed so that it can be placed in an inverted position with the movable contacts being actuable by the relay in the same manner.

A more complete knowledge of my invention enabling those skilled in the art to make, compound, and use the same may be gained from the accompanying drawings and detailed specification.

Figure 1 is a partly diagrammatic view of my improved relay showing the voltage change-over structure in cross section, the relay being shown in combination with an automatic electrical control system including a pilot relay,

Figure 2 is a view of a detail portion of the relay of Figure 1 and another view in inverted position of that portion of the voltage change-over equipment which will be referred to as the adaptor unit,

Figure 3 represents a slightly modified form of the relay shown in combination with another form of adaptor unit,

Figure 4 represents another slightly modified form of the relay shown in combination with another form of adaptor unit, and

Figure 5 is a detail view of a portion of the relay of Figure 3 shown in combination with another form of adaptor unit.

Referring to Figure 1 of the drawings, numeral

10 designates generally one form which my improved relay may take. The relay comprises a base or panel 11 which forms a support for the various elements comprising the relay. Numeral 12 indicates a core member which is of substantially a horizontal U-shape, the joined portions of the legs of the U being attached to the support 11 in any suitable manner. The core 12 is made of magnetic material and may be of laminated or other suitable construction, the lower leg of the core having a portion 13 forming a bracket to which is pivoted or hinged an armature generally designated at 14. The armature comprises a member 15 made of soft iron or other suitable magnetic material through which a pivot pin 16 extends and to which is attached an angular bracket member 17 which is preferably made of Bakelite or other suitable insulative material, the member 17 being attached to member 15 by a screw 18. Encircling the upper end of the member 15 is a brass band 21 which serves as an antistick element to prevent the relay remaining in position when it has been deenergized. The brass band 21 tends to inhibit the passage of magnetic flux between the core 12 and the member 15, this effect of the band 21 being sufficient to prevent any residual magnetism remaining in core 12 after it has been deenergized from causing the armature to remain in its energized position. The brass band 21 is more important when the relay is used with direct current power because with alternating current power the alternating flux may be at or near a zero value at the time the relay is deenergized so that the amount of residual magnetism would be more or less inappreciable. The screw 18 serves to attach a contact strip 22 to the member 17 and also a metal backing strip 23 for the contact strip 22 and a metal member 24 on the opposite side of the contact strip 22. The contact strip 22 carries a contact 25 which is cooperable with a fixed contact 26 supported on a contact bracket 27 attached to the support or panel 11. Contacts 25 and 26 are brought together when the armature is rotated in a counter-clockwise direction and the purpose of the metal member 24 is to positively move the contact strip 22 in a direction to separate contacts 25 and 26 when the armature is rotated in a clockwise direction. It is conceivable that contacts 25 and 26 might become burned and tend to stick and inasmuch as the contact strip 22 is flexible the more rigid member 24 is necessary to positively insure separation of the contacts when the armature is otherwise free to rotate clockwise. The member 17 also carries contact strip 28 having a contact 29 at its extremity cooperable with a fixed contact 30 supported by a bracket 31 attached to the support or panel 11. Adjacent the contact strip 28 is a metal member 32 which serves the same purpose as the previously described member 24. The armature 14 as a whole is biased in a clockwise direction by a coil spring 33 attached between an appropriate point on the armature and a bracket 34 extending angularly from the panel 11.

The contacts 25 and 26 are the load contacts of the relay while the contacts 29 and 30 may be used for purposes of establishing a maintaining circuit when the relay is energized as will be referred to later.

The bracket 31 previously described supports a block 37 which has a cross section as shown in Figures 1 and 2 and which may preferably be made of a plastic composition or material. The block 37 is recessed as shown, the bottom of the recess forming a flat surface in which are imbedded four contact strips or bars 38, 39, 40, and 41, the contact surfaces of the contact strips rising out of the adjacent surface of the plastic material. Between the contact strips 39 and 40 is a small recess 42 in the material of the block 37. Midway between the contact strips 38 and 39 is a screw threaded opening 43 adapted to receive a screw and midway between the contact strips 40 and 41 is a corresponding opening 44. Also midway between the contact strips 39 and 40 there is another similar screw threaded opening 45 at the bottom of the recess 42 (see Figure 2).

In my particular relay I employ two coil windings or a coil having two separate parts. On Figure 1 I have shown two coils indicated at 46 and 47 wound on the upper leg of the core 12. The end terminals of these coils are tapped, there being wires 48 and 49 connecting the ends of coil 46 to contact strips 38 and 40, respectively, and wires 50 and 51 connecting the ends of coil 47 to contact strips 39 and 41, respectively. As set forth earlier in my disclosure, my relay is intended to be used with power sources of different voltages and to make the change-over adaptation for use with one voltage or another I use the two coils and the structure being described for connecting them either in series or in parallel. I accomplish making series or parallel connections between the coils 46 and 47 by bridging certain of the contact strips 38 to 41, inclusive. This may be done in various ways all within the scope and purview of my invention. It may be done by inserting screws in the openings 43, 44, or 45 so as to bridge the contact strips adjacent these openings or by means of an adaptor member or unit generally designated at 54.

Referring to Figure 2 this figure shows the block member 37 with the adaptor unit 54 shown spaced therefrom and in an inverted position. Figure 2 also shows in outline the position which the heads of suitable screws would take if screwed into the openings 43 and 44. From Figure 2 it is readily seen that the screw on the left in opening 43 would bridge contact strips 38 and 39 while the other screw would bridge contact strips 40 and 41. With screws in the position shown in outline of Figure 2 coils 46 and 47 would be connected in parallel while if only one screw were inserted in the opening 45 so as to bridge contact strips 39 and 40 the coils 46 and 47 would become connected in series. The series and parallel circuits produced by insertion of the screws in the manner described will be traced in the description of operation following.

The relay 10 and its various elements as so far described is suitably designed and constructed so that it will function properly without excess heating when 220 volts alternating current is impressed thereon with coils 46 and 47 connected in series. If the power to be used is at 110 volts alternating current the coils are then connected in parallel as described and the relay will then also function properly without excess heating.

The alternating current frequency accompanying the 110 volts and 220 volts alternating current power sources referred to above which would be most commonly found would be 60 cycles. My relay is to be universally adaptable to other frequencies such as 25 or 40 cycles and to direct current supplies as well. To adapt the relay to lower frequencies or to direct current it is necessary to connect resistance in series with the coils both when they are in series for 220

volt application and when they are in parallel for 110 volt application. In other words, two coils which are constructed to operate properly in series at 220 volts alternating current would overheat if 220 volts direct current were impressed on them while connected in series. Similarly two coils which function properly in parallel at 110 volts would overheat when 110 volts direct current was impressed on them unless additional resistance were connected in series with each coil. Frequencies lower than 60 cycles would also cause overheating of coils which operate properly at 60 cycles unless resistance is connected in circuit with the coils. To provide for adapting the relay to various frequencies and to direct current power I employ the adaptor unit which I have designated by numeral **54**.

Referring to Figure 1 this unit takes the form of a block which is preferably made of a plastic composition or material molded so as to take the general shape shown in cross section in Figure 1. The unit **54** is shaped so that it will fit into the recess in the block **37** there being four contact strips **55**, **56**, **57**, and **58** imbedded or mounted in the material of the unit **54** which are similar to the contact strips **38** to **41** already described and which are so arranged that they mate with and engage the latter contact strips when the unit **54** is in the position shown in Figure 1. The opposite side of the unit **54**, that is, the upper side as seen in Figure 1, is similarly shaped so that it will fit into the recess in block **37** in the same manner, there being two contact strips **59** and **60** correspondingly imbedded in this side of the unit **54**. Between the contact strips **59** and **60** is a projection **61** and an opening **62** extends through the projection **61** and the entire unit **54** so that a screw **63** may pass through the opening for retaining the unit **54** in position as shown in Figure 1, the screw **51** being screwed into the opening **45** in the block **47**. The purpose of the projection **61** is to prevent the head of the screw **63** from bridging the contact strips **59** and **60** when the unit **54** is in the position shown in Figure 1. Figure 2 shows the unit **54** in inverted position and spaced from the block **37**. From Figures 1 and 2 it can be seen that the unit **54** is substantially symmetrical on opposite sides of a central horizontal plane. When unit **54** is placed in the recess in block **37** with the unit inverted as seen in Figure 2 the projection **61** extends into the small recess **42** in the block **37**. The unit **54** may have laterally extending ear portions **66** and **67** and within the unit are embodied two electrical resistances **68** and **69**. The resistances **68** and **69** may be disposed within suitable openings in the material of unit **54** or the material of the unit **54** may be directly moulded around these resistances. The ends of resistance **68** are connected to contact strips **55** and **56**, respectively, and the ends of resistance **69** are connected to contact strips **57** and **58**, respectively. Contact strip **55** is connected to contact strip **59** by a suitable connection **70** while contact strip **58** is connected to contact strip **60** by a suitable connection **71**. The connections **70** and **71** may be wires or metal connections formed within the material of the unit **54** or externally thereof.

With the adaptor unit **54** in the position shown in Figure 1 the coils **46** and **47** are connected in parallel with one of the resistances **68** and **69** in series with each coil. These circuits will be traced in the description of operation following. If the unit **54** is inserted into block **37** in inverted position as seen in Figure 2 a single screw as shown in outline in the upper part of Figure 2 is used to retain the adaptor unit in position. The head of this screw then bridges contact strips **59** and **60** and connects the two coils **46** and **47** in series with each other and with the two resistances **68** and **69**. This circuit will be traced later in the description.

The automatic control system of Figure 1 in which I have shown my improved relay embodied comprises a thermostat **74** of conventional type having a bimetal element **75** and two flexible contact blades **76** and **77** movable thereby. The blades **76** and **77** in this type of thermostat are arranged to sequentially engage with respective fixed electrical contacts **78** and **79**. The blades **76** and **77** engage and disengage from their respective contacts at temperatures between which there is a differential of 2° for example. Numeral **80** designates generally a pilot relay comprising a coil **81** arranged to move a pair of switch blades **82** and **83** to the left when the coil is energized, the blades **82** and **83** cooperating with fixed electrical contacts **84** and **85**, respectively. Numeral **86** designates an overload cut-out which may be of conventional type including a bimetal switch element **87** carrying a contact **88** cooperating with fixed contact **89**. Adjacent the element **87** is an electrical heating resistance **90** in the load circuit which extends through the contacts **25** and **26**. By way of example I have shown a motor **91** as the electrical load to be controlled it being apparent of course that any other type of electrical loads could be substituted. Numerals **92** and **93** designate line conductors which may be connected to the source of external power which may be of various natures as will now be dealt with.

While I have disclosed herein a temperature control system it will be understood that my relay may be embodied in various types of equipment such as control instruments or devices or the like and that such instruments or devices may be distributed for commercial or domestic use in localities where the available electric power may be alternating current or direct current and may be at various voltages and frequencies. Let it be assumed that the line conductors **92** and **93** are connected to a source of 110 volt alternating current power of 60 cycle frequency. Under these conditions the adaptor unit **54** will not be in use but two screws will be in the block **37** in the manner shown in outline in Figure 2. The thermostat **74** may be set so that blade **76** engages contact **78** at 72° and blade **77** engages contact **79** at 70° and when the temperature falls to or below 70° both blades will be in engagement with their respective contacts. When this occurs a circuit will be completed for energizing the pilot relay **80** as follows: from line conductor **93** to wire **94**, wire **48**, contact strip **38**, the head of the screw bridging contact strips **38** and **39**, contact strip **39**, wire **50**, coil **46**, wire **95** (which is connected to the left end of coil **47**), fixed contact **78**, thermostat blade **76**, thermostat blade **77**, contact **79**, wire **96**, coil **81**, wire **97**, overload cut-out **86**, wire **98** back to line conductor **92**. Upon completion of this circuit and consequent energization of coil **81** switch blades **82** and **83** are moved to the left into engagement with their respective contacts. Upon engagement of blade **82** with contact **84** a maintaining circuit for coil **81** is produced which is independent of thermostat blade **77** and is as follows: from line conductor **93** to wire **94**, wire **48**, contact strip **38**, the head

of the screw bridging contact strips 38 and 39, contact strip 39, wire 50, coil 46, wire 95, contact 78, thermostat blade 76, element 75, wire 99, contact 84, blade 82, wire 102, coil 81, wire 97, overload cut-out 86 and wire 98 back to line conductor 92. By reason of this latter maintaining circuit relay 80 will not be deenergized until the temperature has risen to a value above 72° at which blade 76 will separate from contact 78 interrupting the maintaining circuit thus providing for a fixed operating differential at the thermostat. When blade 83 engages its associated contact the coil 46 of relay 10 becomes energized through the following circuit (it being recalled that unit 54 is not in use but that screws are in place as seen in outline in Figure 2): from line conductor 93 through wire 94, coil 46, wire 49 (see Figure 2), contact strip 40, the head of the screw on the right, contact strip 41, wire 51, wire 100, switch blade 83, contact 85, and wire 101 back to line conductor 192. The circuit energizing the other relay coil 47 is as follows: from line conductor 93 to wire 94, wire 48 (see Figure 2), contact strip 38, the head of the screw on the left, contact strip 39, wire 50, coil 47, wire 100, switch blade 83, contact 85, and wire 101 back to line conductor 92. From the foregoing circuits it is apparent that the coils 46 and 47 are now connected in parallel and by reason of their energization the armature 14 of relay 10 is rotated in a counter-clockwise direction bringing load contacts 25 and 26 into engagement with each other which energizes the motor 91 through the following circuit: from line conductor 93 to wire 102, contact 25, contact 26, wire 103, resistance 90, wire 104, motor 91, and wire 105 back to line conductor 92. Motor 91 will remain energized until blade 76 of thermostat disengages from contact 78 as described.

From the above it is to be noted that the wire 95 which forms part of the original energizing circuit for relay 80 as well as the maintaining circuit for relay 80 is connected to the left end of coil 47 and thus line voltage is available for impression on the relay 80 as is apparent from the said circuits.

In the circuit arrangement of Figure 1 the contacts 29 and 30 are not used. In this particular figure the arrangement is one wherein the relay 10 is relatively large and the pilot relay 80 is employed so that the operating current for the relatively large relay 10 will not have to be carried by the contacts of the thermostat 74. The maintaining circuit controlled by the thermostat is established by the switch blade 82 of the pilot relay 80. When smaller relays corresponding to the relay 10 are used it is not necessary to use the pilot relay 80 and under these circumstances the contacts 29 and 30 serve to establish the maintaining circuit controlled by blade 76 on the thermostat. When the pilot relay 80 is not to be used wire 95 would be omitted and wire 100 would be connected to contact 78. Wire 96 would be connected directly to line conductor 92. Also wire 99 would connect to contact 29 and contact 30 would be connected to line conductor 92. The pilot relay being omitted the switch of the overload cut-out 86 would be connected in series with wire 100. The operation of the arrangement just described would be similar to the operation with the pilot relay with the function of the pilot relay of course omitted.

Assume now that the line conductors 92 and 93 are connected to a source of alternating current power of 220 volts at a frequency of 60 cycles. Under these circumstances only one screw will be inserted in the block 37 and that in the opening 45 so as to bridge the contact strips 39 and 40. Upon a demand for motor operation by the thermostat 74 the pilot relay 80 will now be energized through the following circuit: from line conductor 93 through wire 94, coil 46, wire 49 (see Figure 2), contact strip 40, the head of the screw, contact strip 39, wire 50, wire 95, contact 78, thermostat blade 76, thermostat blade 77, contact 79, wire 96, coil 81, wire 97, overload cut-out 86, and wire 98 back to line conductor 92. As soon as coil 81 is energized switch blades 82 and 83 move to the left into engagement with their respective contacts, engagement of blade 82 with contact 84 completing a maintaining circuit for coil 81 as follows: from line conductor 93 through wire 94, coil 46, wire 49 (see Figure 2), contact strip 40, the head of the screw, contact strip 39, wire 50, wire 95, contact 78, thermostat blade 76, element 75, wire 99, contact 84, switch blade 82, wire 102, coil 81, wire 97, overload cut-out 86, and wire 98 back to line conductor 92. Engagement of switch blade 83 with contact 85 energizes the relay 10 as follows, the coils 46 and 47 now being connected in series: from line conductor 93 through wire 94, coil 46, wire 49 (see Figure 2), contact strip 40, the head of the screw, contact strip 39, wire 50, coil 47, wire 100, switch blade 83, contact 85, and wire 101 back to line conductor 92. Energization of relay 10 again causes counter-clockwise rotation of armature 14 moving contacts 25 and 26 into engagement causing energization of motor 91 through the same circuit as was described above.

It will be noted from the foregoing that when line conductors 92 and 93 are connected to 220 volt power that both the original and the maintaining circuit for energizing relay 80 are connected across the coil 46 of relay 10. As the two coils 46 and 47 are now in series the voltage drop across each one will be substantially 110 volts. Therefore the voltage impressed on relay 80 will be 110 volts even though the voltage of the power source is 220 volts. It is obvious therefore that by reason of my particular way of interconnecting the pilot relay I need provide no means for adapting the pilot relay to voltages other than 110 even though I change the wiring of the main relay 10 when different voltages are to be employed. This manner of employing the pilot relay forms an important feature of my invention.

I will now describe the manner of using my relay with direct current power sources and alternating current power sources having frequencies of other than 60 cycles. With such power sources I employ the adaptor unit 54 and for 110 volts direct current or for 110 volts alternating current at frequencies of 25 or 40 cycles, for example, I employ the adaptor unit 54 in the position in which it is shown in Figure 1. The system of Figure 1 now operates in the same manner as described above for 110 volts alternating current at 60 cycles except that coils 46 and 47 are now in parallel but with a resistance in series with each coil. Also a resistance is placed in series with coil 81 of pilot relay 80. As I have pointed out above a coil which may operate properly at 110 volts alternating current will overheat when 110 volts direct current is impressed on the coil unless a resistance is placed in series with the coil. Similarly if a coil operates properly at 110 volts alternating current at 60 cycles, at a lower frequency even

though the voltage be the same a resistance should be placed in series with the coil to prevent overheating. Having the foregoing in mind, when thermostat 74 now indicates a demand for burner operation the circuit for energizing relay 80 is as follows: from line conductor 93 through wire 94, wire 48, contact strip 38, contact strip 55, resistance 68, contact strip 56, contact strip 39, wire 50, wire 95, contact 78, thermostat blade 76, thermostat blade 77, contact 79, wire 96, coil 81, wire 97, overload cut-out 86, and wire 98 back to line conductor 92. immediately upon energization of coil 81 switch blades 82 and 83 are again moved to the left into engagement with their respective contacts, blade 82 establishing a maintaining circuit as follows: from line conductor 93 to wire 94, wire 48, contact strip 38, contact strip 55, resistance 68, contact strip 56, contact strip 39, wire 50, wire 95, contact 78, thermostat blade 76, thermostatic element 75, wire 99, contact 84, switch blade 82, wire 102, coil 81, wire 97, overload cut-out 86, and wire 98 back to line conductor 92. Engagement of blade 83 with contact 85 energizes coils 46 and 47 through parallel circuits, the circuit for coil 46 being as follows: from line conductor 93 through wire 94, coil 46, wire 49, contact strip 40, contact strip 57, resistance 69, contact strip 58, contact strip 41, wire 51, wire 100, blade 83, contact 85, and wire 101 back to line conductor 92. The parallel circuit for coil 47 is as follows: from line conductor 93 through wire 94, wire 48, contact strip 38, contact strip 55, resistance 68, contact strip 56, contact strip 39, wire 50, coil 47, wire 100, blade 83, contact 85 and wire 101 back to line conductor 92. Energization of the two coils of relay 10 now operates that relay in a manner corresponding to that already described for energizing the motor 91.

For adapting the relay now to direct current voltages of 220 volts or to alternating current voltages at frequencies below 60 cycles of 25 or 40 cycles, for example, the unit 54 is removed, inverted and placed in the block 37 with a single screw to retain it in position in the manner shown in outline in Figure 2 with the head of the screw bridging the contact strips 56 and 57. Contact strips 59 and 60 will now be mating with contact strips 39 and 40 of the block 37. The circuit for energizing the relay coil 81 now includes in series both the resistances 68 and 69 as well as the coil 46. The circuit for energizing coil 81 will now be as follows: from line conductor 93 through wire 94, coil 46, wire 49 (see Figure 2), contact strip 40, contact strip 60, connection 71, contact strip 58, resistance 69, contact strip 57, the head of the screw, contact strip 56, resistance 68, contact strip 55, connection 70, contact strip 59, contact strip 39, wire 50, wire 95, contact 78, blade 76, blade 77 of thermostat 74, contact 79, wire 96, coil 81, wire 97, overload cut-out 86, and wire 98 back to line conductor 92. Energization of coil 81 again moves blades 82 and 83 to the left blade 82 completing a maintaining circuit as follows: from line conductor 93, wire 94, coil 46, wire 49 (see Figure 2), contact strip 40, contact strip 60, connection 71, contact strip 58, resistance 69, contact strip 57, the head of the screw, contact strip 56, resistance 68, contact strip 55, connection 70, contact strip 59, contact strip 39, wire 50, wire 95, contact 78, thermostat blade 76, thermostatic element 75, wire 99, contact 84, blade 82, wire 102, coil 81, wire 97, overload cut-out 86, and wire 98 back to line conductor 92. Engagement of blade 83 with contact 85 completes a circuit through the coils 46 and 47 and resistances 68 and 69 as follows: from line conductor 93 through wire 94, coil 46, wire 49 (see Figure 2), contact strip 40, contact strip 60, connection 71, contact strip 58, resistance 69, contact strip 57, the head of the screw, contact strip 56, resistance 68, contact strip 55, connection 70, contact strip 59, contact strip 39, wire 50, coil 47, wire 100, blade 83, contact 85, and wire 101 back to the line conductor 92. Energization of relay 10 again causes operation of motor 91 in the manner already described. From the foregoing it is to be seen that both resistances 68 and 69 are in series with the two coils 46 and 47 also in series. It is pointed out that when 110 volts direct current or 110 volts alternating current at a frequency lower than 60 is supplied that a resistance is placed in the circuit of the pilot relay coil 81 and if this type of direct current or alternating current power is supplied at 220 volts an additional resistance as well is placed in circuit with the coil 81 of the pilot relay.

The problems solved by the present invention will be understood by those skilled in the art and the novel and unique manner in which they have been met so as to render the inventive device very flexible as regards its adaptability to various power sources will be appreciated. Frequently the relay and associated adaptor unit, the overload cut-out and the pilot relay of Figure 1 will be combined in a single compact housing or casing and marketed as a unit. Obviously by reason of the various coils and resistances the amount of heating of each must be reduced as much as possible in order to preclude the temperature from rising to a value exceeding the limit established by underwriters' standards. The present invention presents satisfactory ways and means of reducing production and development costs and facilitating distribution by providing considerably more flexible and more universally adaptable apparatus.

Figure 3 of the drawings represents a modification of my invention wherein I employ a different form of adaptor unit but wherein the relay itself is the same as the relay of Figure 1 except that the armature 14 carries an additional member 310 forming an operating finger which cooperates with the adaptor unit of this figure in a manner which will be described. The contact strips 38 to 41 of Figure 3 can be bridged by inserting screws in the openings between them in the same manner as shown in Figure 2 and described in connection therewith. As has been pointed out, the screws are used for effecting either a series or parallel connection between the coils when the relay is used with alternating current power. When using the relay with direct current or very low frequency alternating current the amount of current flow which is necessary to cause the relay to pull in is more than enough to hold the relay in its in position and will cause overheating of the coils unless the current flow is reduced after the relay has been pulled in. The adaptor unit 354 of Figure 3 is therefore constructed so that a relatively large current flow will take place through the coils for causing the relay to pull in and the amount of current flow will be automatically reduced as soon as the relay has been pulled in so as to prevent any overheating of the coils.

The adaptor unit 354 is constructed similarly

to that of Figures 1 and 2 but it will be seen that it has an integral right hand portion 311 which forms a housing for mechanism which I am about to describe. Numerals 312 and 313 represent a pair of similar resistances which are suitably mounted within the portion 311. The adjacent end terminals 323 and 324 of the two resistances 312 and 313 form electrical contacts with which cooperate flexible switch blades 314 and 315. The blades 314 and 315 have an angular shape as shown, each having a portion attached to an intermediate point on its respective resistance and a longer part which is normally in engagement with the end terminal of its respective resistance. When the switch blades 314 and 315 are in the position shown on Figure 3 they serve to shunt that portion of their respective resistances which they bridge. Engaging the free ends of both switch blades 314 and 315 is the end of a plunger 316 which extends through a side wall of the portion 311 of the adaptor unit. The protruding end of the plunger 316 is so arranged that it is engaged by the operating finger 310 of the relay when the armature 14 moves in a counter-clockwise direction so that the plunger is pushed to the left separating the switch blades 314 and 315 from the end terminals of their associated resistances. The electrical connections within the adaptor unit 354 may, as in the previous embodiment, be in the form of wires or metal strips. In the present embodiment of the invention the ends of resistance 312 are connected to contact strips 55 and 56 by connections 317 and 318. Contact strip 59 is connected to connection 317 by a connection 319 and contact strip 60 is connected to contact strip 58 by a connection 320. One end of resistance 313 is connected to contact strip 57 by a connection 321 and the other end of resistance 313 is connected to connection 320 (leading to contact strip 58) by a connection 322. The unit 354 may be attached to the block 37 by means of a screw 63 in the same manner as the adaptor unit is attached as shown in Figure 1. The adaptor unit 354 is substantially symmetrical about a tranverse horizontal axis passing through the axis of the plunger 316. The adaptor unit 354 is therefore invertible in the same manner as the adaptor unit of Figures 1 and 2, the projection 61 extending into the small recess 42 when the unit is inverted. Due to the fact that the plunger 316 has an axis coinciding with the axis of symmetry, when the adaptor unit is inverted the plunger is in the same relative position as it was before with respect to the operating finger 310. Therefore when the adaptor unit is inverted the relay armature operates the plunger 316 in exactly the same manner.

The relay 10 of Figure 3 may be connected in a system the same as the one shown in Figure 1 either in combination with a pilot relay or having a thermostat or similar instrument directly controlling the relay 10. That is, the wire 94 of Figure 3 would be connected to one side of the line and the wire 100 of Figure 3 would be connectible to the other side of the line either through the pilot relay or directly through the thermostatic contacts. By comparing the adaptor unit 354 and the adaptor unit of Figures 1 and 2 it can be seen that the electrical connections of the units themselves in the two embodiments are the same, the difference between the units being the switches which cooperate with two resistances 312 and 313.

With the adaptor unit 354 in the position shown in Figure 3 the relay coils 46 and 47 are connected in parallel with part of each of the resistances 312 and 313 in series with each coil. Upon energization of the relay 10 in a manner similar to that described in connection with the previous embodiment the electrical circuit for coil 46 is as follows: from wire 94 through coil 46, wire 49, contact strip 40, contact strip 57, connection 321, terminal 324, switch blade 315, part of resistance 313, connection 322, part of connection 320, contact strip 58, contact strip 41, wire 51 to wire 100, it being understood as pointed out above that wire 94 is connected to one side of the line and wire 100 is connectible to the other side of the line either through a pilot relay or thermostatic contacts as in the previous embodiment. The circuit through coil 47 is as follows: from wire 94 through wire 48, contact strip 38, contact strip 55, connection 317, part of resistance 312, switch blade 314, terminal 323, connection 318, contact strip 56, contact strip 39, wire 50, coil 47 back to wire 100. As soon as the relay armature 14 moves to in position upon energization of the coils operating finger 310 pushes plunger 316 to the left moving switch blades 314 and 315 away from the terminals 323 and 324. Upon this occurring the shunts established by the switch blades are interrupted and the circuit of each of the coils 46 and 47 now will include that part of the resistances 312 and 313 which was shunted by their associated switch blades. Obviously therefore there was less resistance in the circuit of each coil upon initial energization of the relay permitting a relatively large current flow for causing the relay to be moved to in position and upon the relay armature reaching its in position operation of the plunger 316 caused additional resistance to be placed in the circuit of each coil. This additional resistance reduces the current flow and prevents excess heating of the coils.

By inverting the unit 354 in the same manner as the adaptor unit of Figures 1 and 2 the coils 46 and 47 may be connected in series with each other and with resistances 312 and 313, the plunger 316 operating in the same manner to add a part of each resistance to the series circuit upon pulling in of the relay. When the unit 354 is inverted a single screw is used to retain it in in position and to bridge the contact strips 56 and 57 in the same manner as may be seen in the upper part of Figure 1. The series circuit through the coils and resistances when the unit 354 is inverted is as follows: from wire 94 through coil 46, wire 49, contact strip 40, contact strip 60, connection 320, connection 322, part of resistance 313, switch blade 315, terminal 324, connection 321, contact strip 57, the head of the screw bridging contact strips 57 and 56, contact strip 56, connection 318, terminal 323, switch blade 314, part of resistance 312, connection 317, connection 319, contact strip 59, contact strip 39, wire 50, coil 47 back to wire 100. As soon as the relay 10 is energized upon completion of this circuit the armature 14 moves in a counter-clockwise direction pushing plunger 316 to the left and interrupting the shunts established by switch blades 314 and 315 and adding the shunted portions of resistances 312 and 313 to the series circuit. The unit 354 would be in an inverted position for 220 volt operation as described in connection with previous embodiments and as already described the additional resistance placed in the coil circuit upon pulling in of the relay prevents excess heating of the coils.

Figure 4 represents a further embodiment of

my invention wherein I have shown improvements in changing over the relay for use with direct current or very low frequency alternating current. The relay 10 of Figure 4 is the same as the relay of Figure 1 with the exception that the armature member 15 does not have the brass band 21 encircling its extremity. As I have already pointed out, this brass band is more necessary when using direct current than when using alternating current. I have therefore provided an arrangement whereby a brass element is interposed between the core 12 and armature member 15 only when direct current or very low frequency alternating current is used with the relay, the brass element being part of the adaptor unit which is attached to the relay when direct current or very low frequency alternating current is to be used. The adaptor unit 454 of Figure 4 is constructed similarly to the adaptor unit of Figure 3, also having a portion 411 forming a housing for resistances 412 and 413 disposed therein. The unit 454 has only four contact strips 55 to 58 coresponding to similarly numbered contact strips of previous embodiments it not being intended that this unit be inverted. The unit 454 is held in place in the block 37 by means of a screw 463. The plunger 416 of the present embodiment operates the switch blades 414 and 415 in a manner similar to that of the embodiment of Figure 3 but the mechanism for operating the plunger is slightly modified. Integral with the unit 454 is a lug 430 to which is pivoted an operating lever 431, the upper end of which operatively engages the end of the plunger 416 which protrudes through the housing portion 411. The lower end of lever 431 extends to a point adjacent the upper leg of the core 12 and fastened to this end of the lever 431 is a small brass strip or plate 432 which normally takes a position in the path of movement of the armature member 15 when the armature is moved in a counter-clockwise direction. When the relay of Figure 4 is energized and the armature moved in a counter-clockwise direction the armature member 15 engages the brass element 432 rotating lever 431 in a clockwise direction and moving element 432 into contact with the end of the upper leg of the core 12. Clockwise movement of lever 431 moves plunger 416 to the right separating switch blades 414 and 415 from their associated terminals 423 and 424, this operation corresponding to that of the embodiment of Figure 3. The brass strip element 432 serves the same purpose as the brass ring 21 of Figure 1. The resistances 412 and 413 are connected between the contact strips 55 to 58 in the same way as the corresponding resistances of the adaptor unit 354 of Figure 3. The coils 46 and 47 are connected in parallel when the adaptor unit 454 is in place and the circuits through the coils when the relay is energized are the same as the circuits through the coils of Figure 3 when the adaptor unit 354 of that figure is in the position in which it is shown. Therefore it is not necessary that these circuits be traced again, the operation of the switch blades associated with resistances being substantially the same.

In Figure 5 I have shown a detail portion of a relay which relay is constructed exactly the same as the relay 10 of Figure 3. In Figure 5 I have shown a still further form of adaptor unit, the particular purpose of which is to enable adjustments to be made of the amount of resistance which is added to the coil circuit or circuits for directing current operation. The adaptor unit 554 of Figure 5 is constructed somewhat similarly to the unit of Figure 1 with respect to the resistances and similarly to the unit of Figure 3 with respect to invertibility. In addition to the resistances 68 and 69 the unit 554 has a resistance 535 connected between the contact strips 56 and 57. In addition to the opening 62 extending through the unit for receiving a screw the unit has two additional openings 536 and 537 extending through the unit between contact strips 55 and 56 and between the contact strips 57 and 58 for retaining the unit in place and for bridging the contact strips adjacent to the openings. In addition to the projection 61 corresponding to that of previous embodiments the unit 554 has in addition a corresponding projection 561 on the opposite side of the unit which has the same purpose of preventing the retaining screw from bridging the contact strips adjacent to the projection. The unit 554 has a housing portion 511 similar to that of Figure 3 but encloses instead of resistances, a switch comprising a contact 538 and a flexible switch blade 539. A plunger 516 cooperates with the switch blade 539 and extends through a side wall of the housing 511. The plunger 516 is operated by an operating finger 510 associated with the relay in the same manner as the plunger of Figure 3 is operated, the switch within the housing 511 being opened when the relay is energized. Contact strips 55 and 59 are joined by a connection 570 and contact strips 58 and 60 are joined by a connection 571. The contact strips 56 and 57 and therefore the ends of the resistance 535 are connected to the contact 538 and the switch blade 539 by connections 540 and 541, respectively. The axis of plunger 516 coincides with an axis of symmetry of the unit 554. Corresponding to the description of the unit 354 of Figure 3, the unit 554 may therefore be inverted and the plunger 516 will be in exactly the same relative position with respect to the operating finger 510 when it is inverted so that the plunger 516 is operated in the same manner in both positions.

With the unit 554 in the position shown the coils are connected for series operation. The unit may be retained in this position by two screws if desired, the outlines of which are shown on Figure 5. When two screws are used in the manner shown none of the resistors within the adaptor unit are in circuit with the coils when the relay is energized and before the armature has been pulled in. The circuit for the coils is as follows: from wire 94 through coil 46, wire 49, contact strip 40, contact strip 60, connection 571, contact strip 58, the head of the screw bridging contact strips 57 and 58, contact strip 57, connection 540, contact 538, switch blade 539, connection 541, contact strip 56, the head of the screw bridging contact strips 55 and 56, contact strip 55, connection 570, contact strip 59, contact strip 39, wire 50, and coil 47 back to wire 100. As soon as the relay is energized by this circuit and the armature is moved in a counter-clockwise direction so as to operate the plunger 516 switch blade 539 is moved away from contact 538 so that the series circuit no longer extends through the switch within housing 511 but instead is as follows: from wire 94 through coil 46, wire 49, contact strip 40, contact strip 60, connection 571, contact strip 58, the head of the screw bridging contact strips 57 and 58, contact strip 57, resistance 535, contact strip 56, the head of the screw bridging contact strips 55 and 56,

contact strip 55, connection 570, contact strip 59, contact strip 39, wire 50, and coil 47 back to wire 100.

From the foregoing it is seen that the opening of the switch within housing 511 has caused resistance 535 to be placed in series circuit relationship with the coils so as to reduce the current flow for the purpose already described in connection with previous embodiments. If it is desired to still further reduce the amount of current passing through the coils 46 and 47 when the unit 554 is in use either or both of the two screws shown in outline can be removed and a single retaining screw inserted through the opening 62. For example, if the screw bridging contact strips 57 and 58 is removed the above described circuit instead of extending through the head of this screw would instead have to pass through the resistance 69 connected between contact strips 57 and 58. Similarly if the screw bridging contact strips 55 and 56 were removed the above described circuit instead of passing through the head of this screw would have to extend through resistances 68 connecting contact strips 55 and 56. In this manner the operating current for the coils may be suitably adjusted when the unit 554 is in place for use with direct current or with alternating current at relatively lower frequencies.

When the unit 554 is inverted it is retained in position by a screw passing through the opening 62, the projection 61 preventing the head of the screw from bridging the contact strips 59 and 60 the unit now taking the position corresponding to the position of the unit 54 as seen in Figure 1. In inverted position of the unit 554 the coils 46 and 47 are connected in parallel with the resistance 68 in series with coil 46 and resistance 69 in series with coil 47. These circuits correspond to circuits previously traced in connection with the description of other embodiments and need not be traced again. When the unit 554 is in inverted position it is to be seen that there is also a series connection between the coils 46 and 47 provided by the switch within the housing 511 when the relay is out and provided by the resistance 535 when the relay is in its in position. However the parallel circuit paths are of less resistance than the series circuit path through the coils and inasmuch as electrical current will always follow the path of least resistance the series connection does not disturb the proper functioning of the apparatus as intended to be brought about by the parallel connection of the coils.

The disclosed embodiments of my invention are illustrative of varied forms and aspects which it may take. The invention is not to be restricted to the specific forms of construction and arrangements which have been disclosed inasmuch as it is apparent that the apparatus, particularly the adaptor units may be somewhat differently formed and constructed by those skilled in the art without departing from the invention. The boundaries of my invention are to be determined in accordance with the scope of the appended claims.

I claim as my invention:

1. In a relay, in combination, a pair of coils adapted to be connected to a source of power supply, contacts connected to said coils and adjustable means for bridging said contacts whereby said coils may be connected either in series or in parallel, said means comprising a removable unit having contacts for engaging said aforementioned contacts and screws insertable through said unit for retaining said unit in position, said unit having contacts bridgable by said retaining screws, said unit embodying resistances which become connected in predetermined circuit relationship with said coils when said unit is in position.

2. As an article of manufacture a relay comprising in combination, a pair of coils, a source of power for said coils, contact members connected to said coils, said members being arranged adjacent each other whereby adjacent members may be bridged, said coils becoming connected in series or in parallel depending upon which members are bridged, and a unit having contacts spacedly arranged so that said unit may be placed in a position with its contacts engaging said contact members, said unit having resistances connected between its contacts whereby when the unit is in position said resistances are in circuit with said coils.

3. As an article of manufacture a relay comprising in combination a pair of coils, a source of power for said coils, contact members connected to said coils, said members being arranged adjacent each other whereby adjacent members may be bridged, said coils becoming connected in series or in parallel depending upon which members are bridged, a unit having a plurality of contacts spacedly arranged so that said unit may be placed in a position with some of its contacts engaging said contact members, means for bridging other of said contacts, said unit having connections including resistances between its contacts whereby when the unit is in position said resistances are in circuit with said coils according to a relationship depending on which of said contacts are bridged.

4. As an article of manufacture a relay comprising in combination a pair of coils, a source of power for said coils, contact members connected to said coils, said members being arranged adjacent each other whereby adjacent members may be bridged, said coils becoming connected in series or in parallel depending upon which members are bridged, a unit having a plurality of contacts spacedly arranged so that said unit may be placed in a position with some of its contacts engaging said contact members, means for bridging other of the contacts of said unit, said unit having connections including resistances between its contacts, said unit, bridging means, and said contact members being mutually cooperable whereby said coils may be connected in series relationship including at least one of said resistances or in parallel relationship with at least one coil having a resistance in series therewith.

5. As an article of manufacture a relay comprising in combination, a pair of coils, a source of power for said coils, contact members connected to said coils, said members being arranged adjacent each other whereby adjacent members may be bridged, said coils becoming connected in series or in parallel depending upon which members are bridged, a unit having a plurality of contacts spacedly arranged so that said unit may be placed in a position with some of its contacts engaging said contact members, means for bridging other of the contacts of said unit, said unit having connections including resistances between its contacts, said unit including a switch connected in shunt relation with a resistance, means whereby said switch may be actuated by said relay when said unit is in position, said unit, bridging means, and contact members being mutually cooperable whereby said coils may be connected in series relationship including at least one of said

resistances or in parallel relationship with at least one coil having a resistance in series therewith and said switch interrupting the aforementioned shunt connection upon operation of the relay.

6. As an article of manufacture a relay comprising in combination, a pair of coils, a source of power for said coils, contact members connected to said coils, said members being arranged adjacent each other whereby adjacent members may be bridged, said coils becoming connected in series or in parallel depending upon which members are bridged, a unit having contacts spacedly arranged so that said unit may be placed in a position with its contacts engaging said contact members, said unit having other contacts and connections including resistances between its contacts, means for bridging said other contacts whereby when said unit is in position said coils are connected in series with each other and with at least one resistance.

7. As an article of manufacture a relay comprising in combination, a pair of coils, a source of power for said coils, contact members connected to said coils, said members being arranged adjacent each other whereby adjacent members may be bridged, said coils becoming connected in series or in parallel depending upon which members are bridged, a unit having contacts spacedly arranged so that said unit may be placed in a position with its contacts engaging said contact members, said unit having other contacts, connections including resistances between its contacts, and a switch connected in shunt relationship with a resistance, means whereby said relay may operate said switch, means for bridging said other contacts whereby when said unit is in position, said coils are connected in series with each other and with the resistance with which said switch is connected in shunt relationship and said switch interrupting said shunt connection upon operation of the relay.

8. As an article of manufacture a relay comprising in combination, a pair of coils, a source of power for said coils, contact members connected to said coils, said members being arranged adjacent each other whereby adjacent members may be bridged, said coils becoming connected in series or in parallel depending upon which members are bridged, an adaptor unit having a plurality of spacedly arranged contacts arranged so that said unit may be placed in a plurality of positions in each of which some of its contacts engage said contact members, said unit having connections including a resistance between its contacts whereby said coils become connected when said unit is in position, said unit embodying switch means connected in shunt relationship with said resistance, said unit being so constructed and structurally related to said relay that said switch means is engaged and operated by said relay when said unit is in any one of a plurality of positions, said shunt connection becoming interrupted upon operation of the relay.

9. As an article of manufacture, in combination, a relay having windings and an armature, means comprising an adaptor unit cooperable with said relay and detachable from said relay, said unit embodying switch means and being attachable to said relay in a plurality of different positions, said unit being so constructed and structurally related to said relay that in a plurality of its positions said switch means is in position to be engaged and operated by said armature.

10. As an article of manufacture, in combination, a relay having windings and an armature, means comprising an adaptor unit cooperable with said relay for adapting it to various different power sources by connecting said windings in different circuit relationships, said means including contact members and said unit having a plurality of contacts and being attachable to said relay in a plurality of positions with contacts engaging said contact members, said contacts having connections including a resistance therebetween whereby the circuit relationship between said coils depends on the position of the unit, said unit having switch means connected in shunt relationship with said resistance, said unit being so constructed and arranged that in a plurality of its positions said switch means is in the same relative position with respect to said armature whereby it can be engaged and actuated thereby.

11. As an article of manufacture a relay comprising in combination, two coils, means comprising contact members connected to said coils, said contact members being so arranged that different members may be bridged, means comprising a detachable adaptor unit capable of being attached to said relay for bridging said contact members, said unit embodying a resistance and contacts capable of being connected for effecting various circuit relationships between said coils and resistance.

12. In apparatus of the character described, in combination, a main relay having windings and an armature, means cooperable with said windings for adapting said main relay to various different power sources by connecting said windings in various different circuit relationships, a pilot relay cooperating with said main relay, said pilot relay being so interconnected to said main relay that the voltage impressed on said pilot relay is substantially the same even though the circuit relationship of said windings is changed for power sources of different voltage whereby said pilot relay need not be adaptable to different voltages.

13. In a relay in combination, two windings, an armature cooperating with said windings, a source of power for said relay, said armature being movable to an in position upon energization of the relay and being movable to an out position upon deenergization of the relay, contact members connected to said windings and arranged adjacent each other, means comprising screws insertable between said contact members for bridging adjacent contact members, the arrangement being such that said contact members can be bridged for connecting said coils either in series or parallel circuit relationship.

14. As an article of manufacture in combination, a relay having windings, and an armature, means forming electrical contacts connected to said windings, and means comprising an adjustable unit having contact members adapted to engage with said contacts, said unit embodying an electrical resistance and switch means connected in circuit relationship with said contact members, said unit being adjustable to various positions wherein its contact members engage with said contacts and said unit being so constructed and arranged that in a plurality of its positions said switch means is in a relative position so as to be actuable by said armature.

15. As an article of manufacture, in combination, a relay having windings and an armature means, means comprising an adjustably mounted

unit cooperating with said relay, said unit embodying switch means adapted to be actuated by said armature means, said unit being so constructed and structurally related to said relay that it may be adjusted to a plurality of positions with said switch means remaining in a relative position to be engaged and operated by said armature.

16. In apparatus of the character described, means forming a panel having a plurality of electrical terminals, means connecting said terminals to electrical current carrying devices, means comprising a unit cooperable with said panel having terminals adapted to engage and contact with said first mentioned terminals, said unit embodying resistance means connected between certain of its terminals and being adjustable relative to said panel and mutually cooperable therewith whereby different of said unit terminals may cooperate with different panel terminals for effecting various circuit connection relationships between the various terminals, said unit terminals being so arranged that when the unit is in one position said devices are connected in parallel and when in another position said devices are connected in series.

17. As an article of manufacture, means forming a panel having a plurality of electrical terminals, means comprising a unit cooperable with said panel having terminals adapted to engage and contact with said first mentioned terminals, said unit having connections between certain of its terminals and switch means forming part of said connections, said unit being adjustable relative to said panel and mutually cooperable therewith whereby different of said unit terminals may cooperate with different panel terminals for effecting various circuit connection relationships between the various terminals, and means forming a relay having armature means adapted to actuate said switch means, said unit being so constructed and arranged that in a plurality of positions said switch means is in a relative position wherein the switch means can be actuated by said armature means.

18. In apparatus of the character described, means forming a panel having a plurality of spaced electrical contact members, means connecting said member to electric current carrying devices, means comprising a unit cooperable with said panel and having a plurality of spaced contact members adapted to cooperate with said first mentioned contact members, said unit having means forming connections between its contact members, said unit being adjustable to various positions relative to said panel and being mutually cooperable therewith whereby different of said unit contact members may cooperate with different panel contact members for effecting various circuit relationships between the panel contact members through the said connection forming means of the unit, said unit contact members being so arranged that in one position of the unit said devices are connected in parallel and in another position said devices are connected in series.

19. As an article of manufacture, means forming a panel having a plurality of electrical terminals, means comprising a unit cooperable with said panel having terminals adapted to engage and contact with said first mentioned terminals, said unit embodying resistance means connected between certain of its terminals and being adjustable relative to said panel and mutually cooperable therewith whereby different of said unit terminals may cooperate with different panel terminals for effecting various circuit connection relationships between the various terminals, and means for bridging certain of said unit terminals.

ALWIN B. NEWTON.