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2,379,602

ELECTRICAL APPARATUS

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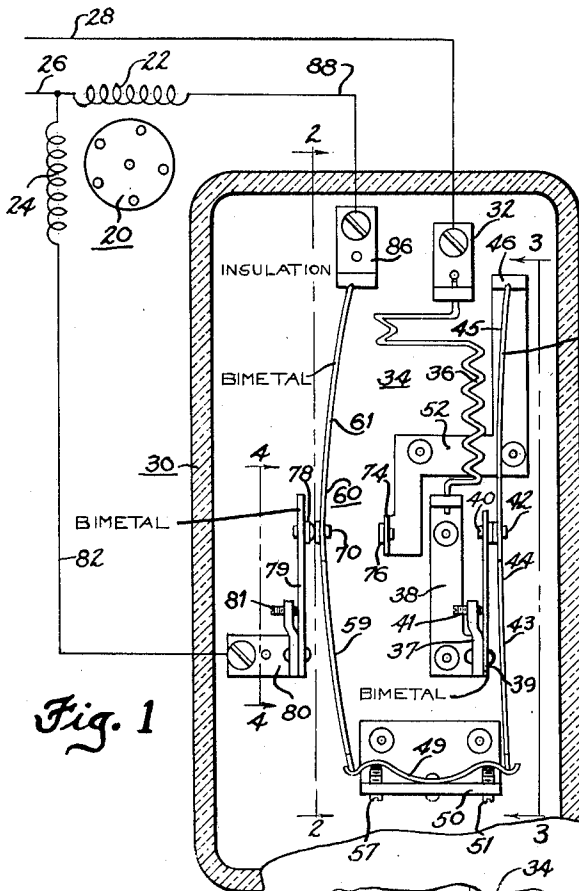


Fig. 1

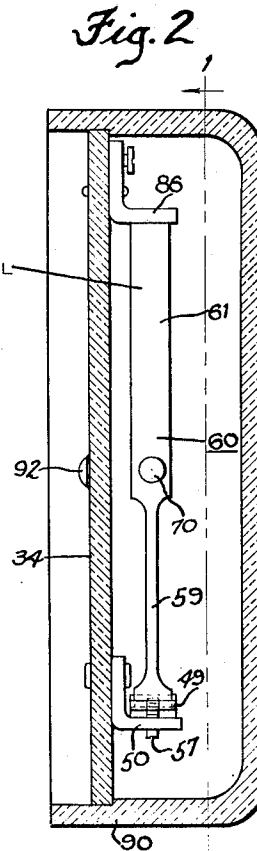


Fig. 2

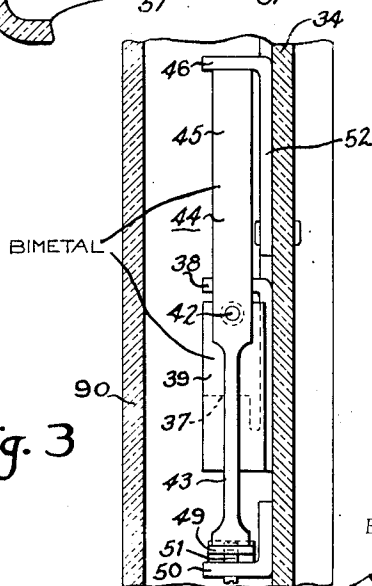


Fig. 3

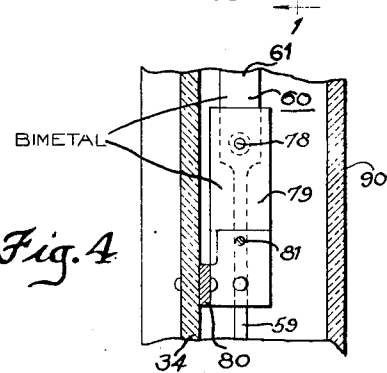


Fig. 4

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ELECTRICAL APPARATUS

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15 Claims. (Cl. 172-279)

This invention relates to electrical apparatus and more particularly to electric motor starting and overload controls having bimetal actuating elements.

In bimetal phase winding controls it is necessary to provide a great amount of heat initially to operate the controls from the starting to the running position at the proper time since under ordinary starting conditions and motor loading the desirable period that the starting winding should be connected is very short, for example from 0.3 to 0.8 second. Thereafter the heat should be reduced to prevent overheating of the bimetal and to reduce the power consumption and yet the heating during the running period should be sufficient to keep the control from returning to the starting position. In bimetal overload protectors the heat during the starting period should be sufficient to provide rapid heating and tripping in the case of a stall on starting, but if adequate heat is provided during the starting period then the heat would be too great during the running period.

It is an object of my invention to provide a simple bimetal starting control in which the period during which the phase winding is connected in starting arrangement is substantially ideal for the motor and motor loading for which it is designed under all conditions of temperature and voltage and thereafter the control is held continuously in the running arrangement without overheating and under normal conditions without the opening and closing of the contacts.

It is another object of my invention to provide a simple bimetal motor protector which will have quick tripping upon a starting stall and yet be accurate and sensitive during the running period.

It is another object of my invention to provide a simple means for readjusting the heating of the bimetal starting control at the end of the starting period.

It is another object of my invention to provide a simple means for readjusting the heating of the overload protector at the end of the starting period.

It is another object of my invention to provide a simple means whereby the operation of the starting control at the end of the starting period is employed to readjust the heating of the overload protector.

It is another object of my invention to provide a simple means for compensating the starting and overload controls for changes in ambient temperature and to provide a simple adjusting means for the starting and overload controls as a part of the ambient temperature compensating means.

These objects are obtained by a very simple construction providing a starting bimetal strip pivotally mounted at its ends and provided with a contact at its mid-portion which, when the bimetal strip is cold engages the starting contact connected to the phase or starting winding. One pivotal mounting is connected to the main or running winding while the current passing through the overload protector is transmitted to the other pivotal mounting to feed current through the narrow first half of the starting bimetal strip which carries both the phase and main winding current during the starting period. From the mid-point of the starting bimetal strip the phase winding current passes through the starting contacts and the phase winding while the main winding current passes through the wide second half of the bimetal strip and the main winding. The first half of the starting bimetal strip is made narrow to increase the ohmic resistance enough to cause rapid self-heating of the strip to separate the starting contact at the ideal time with the help of the second half which is made much wider. Upon the separation of the starting contacts, a second contact is engaged which shunts the first half of the starting bimetal to prevent its overheating. The second half of the starting bimetal is of such width and ohmic resistance as to supply sufficient self-heating with or without the help of external heat to keep the second contact engaged under normal running conditions.

The overload protector bimetal strip generally resembles the starting bimetal strip. During starting, the current from the power supply is fed through the overload contacts to the mid-portion of the overload bimetal strip, thence both through the narrow first half of the overload bimetal strip to the common pivotal mounting of the overload and starting bimetal strips. When the second starting or back contact is engaged at the end of the starting period, the first half of both the starting and overload bimetal strips are

shunted by causing the current to flow through the wide second half of the overload bimetal strip and through a shunt connecting the adjacent pivotal support with the second contact. The wide second half of the overload bimetal strip should be of such width as to provide sufficient self-heating with or without external heat to trip at the proper value during the running period while the narrow first half of the overload bimetal strip should be narrow to provide initial heating for quick tripping under starting stall conditions. Further control over the starting and overload bimetal strips during the running period may be provided by an external heater located between the second halves of each strip connected in series with the overload contacts to provide a form of heat having a greater time lag than the self-heating of the bimetal strips.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred form of the present invention is clearly shown.

In the drawing:

Fig. 1 is a sectional view taken along the line 1—1 of Fig. 2 showing one form of motor control embodying my invention connected to a diagrammatic split phase winding;

Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 1; and

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 1.

Referring now to the drawing and more particularly to Fig. 1, there is shown a split phase electric motor 20 having a main or running winding 22 and a phase or starting winding 24. This electric motor is supplied with electric energy through the supply conductor 26 which connects to the common junction of the windings 22 and 24 and a supply conductor 28 which connects to the starting and overload control designated generally by the reference character 30.

The overload protector

The conductor 28 specifically connects to a terminal 32 mounted upon the switch mounting base 34. The terminal 32 forms the support for one end of an electric heater 36, the other end of which is supported by a connector 38. The connector 38 is also supported by the base 34 which is made of some suitable insulating material. This connector 38 has one ear turned up for receiving the end of the heater 36 and a second ear 37 is turned up and carries a short bimetal strip 39 which is riveted to the ear 37 and carries at its opposite end a normally stationary overload protector contact 40. The ear 37 is provided with an extending arm carrying a set-screw 41 for adjusting the location of the normally stationary contact 40. The bimetal 39 is made wide and comparatively stiff so as to reduce its tendency to spring. It is of such a length and thickness as to substantially compensate for the effect of changes in the environment temperature upon the overload bimetal. It may under-compensate or over-compensate or exactly compensate according to choice.

In engagement with the protector contact 40 is the movable protector contact 42 which is carried by the middle of the column loaded overload bimetal strip 44 forming the actuating bimetal of the overload protector. The first half

43 of the overload bimetal strip 44, is pivotally supported by a main bracket 50 which is provided with an adjusting member 49 riveted to the main bracket 50 and provided with notches at both ends. One of the notches supports the first half 43 of the overload bimetal strip 44 and may be adjusted by the set-screw 51 to provide the desired column loading to the strip 44. The second half 45 of the strip 44, is supported by a Z-shaped connector 52 having a turned up ear 46 at one end provided with a notch for receiving and pivotally supporting the second half 45 of the overload bimetal strip 44. The second half 45 is shown as being two and one-half times as wide as the first half 43. The other end of the connector 52 is provided with a turned up ear 74 for supporting the second or back contact 76 of the starting control.

The starting control

The member 49 serves as an electric conductor connecting the ends of the first half of both the overload bimetal strip 44 and the starting bimetal strip 60. This member 49 has a notch supporting the lower end of the strip 60 and is provided with a set-screw 57 for adjusting the column loading applied to the bimetal starting strip 60. At its mid-point the starting bimetal strip 60 carries a double-ended contact 70 extending upon opposite sides of the strip 60. When the bimetal strip 60 is cold, one end of the movable starting contact 70 is adapted to contact a normally stationary contact 78 which is mounted upon the end of a compensating bimetal strip 79 riveted to an up-turned ear provided upon the starting connector 80 which has an adjusting screw 81 for locating the position of the stationary contact 78. The compensating bimetal strip 79 should be relatively stiff and of such thickness and length as to either exactly compensate or under or over-compensate for the effect of changes in environment temperature upon the starting bimetal strip 60 as is found most suitable. A conductor 82 connects the starting connector 80 to the other end of the phase winding 24. The second half 61 of the starting bimetal strip 60 is pivotally supported by the main winding connector 86 which is provided with a turned up flange having a notch for pivotally supporting the one end of the strip 60. This connector 86 is connected by the conductor 88 to the other end of the main winding 22. The first half 59 of the starting bimetal strip 60 is made of such a narrow width as to provide the necessary ohmic resistance and consequent self-heating to move the strip 60 and the movable contact 70 out of contact with the starting contact 78 and into contact with the back contact 76 at the ideal time for deenergizing or, in the case of a capacitor motor, changing the capacitor connections of the phase winding 24 as in the Pearce Patent No. 2,255,437. The second half 61 is made of such a width that after the contact 70 engages the back contact 76 its ohmic resistance will provide sufficient self-heating which together with the external heat provided by the external heater 36 and the snap action provided by the column loading will keep the contact 70 in engagement with the contact 76 under all normal running conditions. As shown, the second half 61 is about three times as wide as the first half 59.

All the elements shown mounted upon the switch mounting base 34 in Fig. 1, are covered

by the cover 90, also of insulating material, which slips over the base as is better shown in Fig. 2 and is held in place by the bosses or projections 92 formed upon the inside of the side walls of the cover. The cover 90 has sufficient flexibility to allow the insulating base to be pressed into position where it rests between the shoulders on the projection 92.

Operation

In operation, when the motor 20 is idle and the motor control device is at ordinary room temperatures, the bimetals 44 and 60 will assume the position shown in Fig. 1. Under such circumstances electric energy will flow through the conductor 28 to the connector 32 thence through the overload heater 36 which will gradually heat up to heat the wide second half 45 of the overload bimetal 44 and the wide second half 61 of the starting bimetal 60. This overload heater 36 may be moved closer or further away from the overload bimetal and the starting bimetal and may have its resistance and length varied to supply whatever amount of external heat is necessary to provide the correct operating characteristics for both the starting and overload controls. Where it is found that external heating is unnecessary, this heater 36 may be eliminated and the conductor 28 may then be connected directly to the connector 38.

After passing through the overload heater, the current flows through the connector 38 and the compensating bimetal strip 39 to the normally stationary overload protector contact 40. The compensating bimetal strip 39 may be made of ample cross-section to minimize any heating due to the current flow through it. The current passes from the contact 40 to the movable overload protector contact 42, thence through the first or narrow half 43 of the overload bimetal strip 44 to the main bracket 50 which transmits the current to the end of the first or narrow half 59 of the starting bimetal 60. The current passes through this narrow first half 59 and a portion of it passes from the contact 70 to the contact 78 and through the compensating bimetal 79, the connector 80, the conductor 82 and the phase winding 24 to the source conductor 26. Another portion flows through the wide second half 61 of the starting bimetal strip 60, the connector 86, the conductor 88 and the main winding 22 to the source conductor 26. This will provide a small amount of self-heating in the wide second half 61 and a much greater amount of self-heating in the narrow first half 59. The column loading applied to the strip 60 by the set-screw 57 and the position of the contact 78, as located by the set-screw 81 together with the width, length, thickness and material of the starting bimetal strip 60 should be so chosen as to cause tripping of the strip 60 and the movable contact 70 out of engagement with the contact 78 and into engagement with the contact 76 at the ideal time for changing the connection or deenergizing the phase winding 24. This action terminates the starting period and begins the running period.

During the running period the current flows at a considerably reduced rate in the same manner from the supply conductor 28 to the overload protector contact 42. From the contact 42, however, during the running period, the current flows through the second or wide half of the overload protector bimetal 44 to the ear 46 and thence through the connector 52 to the back contact 76 from which point the current flows through the

second or wide half 61 of the starting bimetal strip 60 and through the connector 86, the conductor 88 and the main winding 22 to the source conductor 26. Thus during the running period under normal conditions no current flows through the narrow first half 43 of the overload protector bimetal strip 44, the main bracket 50 or the narrow first half 59 of the starting bimetal strip 60, or the compensating bimetal strip 79, the connector 80, the conductor 82 and the phase winding 24.

However, should the heating of the wide second half 61 and the starting bimetal strip 60 be insufficient, it may separate the contact 70 from the back contact 76. Upon any such separation, current will again flow through the narrow first half 43 of the overload protector bimetal strip 44 and the narrow first half 59 of the starting bimetal strip 60 to provide an additional amount of self-heating which will send the contact 70 back into contact with the contact 76. This, however, should take place only under unusual conditions of low current flow. It should be understood that the contacts 70 and 42 need not be placed at the mid-point of the starting overload bimetal strips 60 and 44 but may be shifted in either direction to increase or decrease the length of the narrow portion to provide better characteristics. Thus by this particular construction a great many factors can be varied in order to obtain the most desirable operating characteristics of both the starting and overload mechanism. For example, the width and length of each half of each bimetal may be varied independently even though each bimetal be made of a single piece of bimetal material. The thickness of the different bimetals may be varied and the column loading of each bimetal may be varied and also the contact pressure may be varied by the location and adjustment of the normally stationary contacts. In addition, the length, width and thickness of each compensating bimetal may be varied independently and the external heater may be varied in size and location. Furthermore the bimetal strips 60 and 44 may have either or both ends placed closer together or further apart. With this great choice of variables many different sizes and types of motors can be accommodated with ideal starting and overload protection by this form of starting and overload control.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. A control device for an electrical device comprising a thermally responsive element having two different portions of different rates of electrical resistance to current flow per unit length, means for conducting electrical energy through said two portions responsive to the energization of said electrical device, a shunt for shunting only one of said two portions, control means operated by the heating of said thermally responsive element for controlling the energization of said electrical device and also for controlling the shunting of said one portion.

2. A control device comprising a bimetal strip portion, means for supporting the ends of the strip portion, one end portion of the strip portion having a greater cross-sectional area and a lower ohmic resistance than the other end portion, a movable contact carried by and movable with said strip portion intermediate the ends thereof,

a stationary contact located in the path of movement of said movable contact limiting the movement of said strip portion in one direction, and means for connecting said strip portion and said stationary contact in separate electric circuit portions.

3. A control device comprising a bimetal strip portion, means for supporting the ends of the strip portion, one end portion of the strip portion having a greater cross-sectional area and a lower ohmic resistance per unit length than the other end portion, a movable contact carried by and movable with said strip portion intermediate the ends thereof, a stationary contact located in the path of movement of said movable contact limiting the movement of said strip portion in one direction, and means connecting one end portion of said strip portion and said stationary contact in one electric circuit portion and the other end portion in another electric circuit portion.

4. A control device comprising a bimetal strip portion, means for supporting the ends of the strip portion, one end portion of the strip portion having a greater cross-sectional area and a lower ohmic resistance per unit length than the other end portion, a movable contact carried by and movable with said strip portion intermediate the ends thereof, a stationary contact located in the path of movement of said movable contact limiting the movement of said strip portion in one direction, a second stationary contact located upon the opposite side of said strip portion in the path of movement of the movable contact limiting the movement of said strip portion in the other direction, and means for connecting said strip portion and stationary contacts in separate electric circuit portions.

5. In combination, an electric motor having main and phase windings, a bimetal strip portion, means for supporting the ends of the strip portion, a movable contact connected to and movable with an intermediate portion of said strip portion, a first stationary contact located on that side of said strip portion and in the path of movement of said movable contact toward which the strip portion moves upon cooling limiting the movement in a first direction, a second stationary contact located on the opposite side of said strip portion in the path of movement of the movable contact limiting the movement in a second direction, conductor means connecting one side of the power source to one end of each winding, conductor means connecting the other end of the phase winding and said first contact, conductor means connecting the other end of the main winding and the support means at one end of said strip portion, conductor means connecting the support means at the other end of said strip portion with the other side of the power source, and conductor means electrically connecting said second contact and the support means at one of the ends of said strip portion.

6. In combination, an electric motor having main and phase windings, a bimetal strip portion, means for supporting the ends of the strip portion, a movable contact connected to and movable with an intermediate portion of said strip portion, a first stationary contact located on that side of said strip portion and in the path of movement of said movable contact toward which the strip portion moves upon cooling limiting the movement in a first direction, a second stationary contact located on the opposite side of said strip portion in the path of movement of the movable contact limiting the movement in a second direc-

tion, conductor means connecting one side of the power source to one end of each winding, conductor means connecting the other end of the phase winding and said first contact, conductor means connecting the other end of the main winding and the support means at one end of said strip portion, and conductor means connecting the support means at the other end of said strip portion and said second contact with the other side of the power source, the cross-sectional area of a portion of said strip portion between said movable contact and the end connected to the other side of the power source being reduced to increase its ohmic resistance to increase the heat generated therein to shorten the time the movable contact is in contact with said stationary contact.

7. In combination, an electric motor having main and phase windings, a bimetal strip portion, means for supporting the ends of the strip portion, a movable contact connected to an intermediate portion of said strip portion, a first stationary contact located on that side of said strip portion and in the path of movement of said movable contact toward which the strip portion moves upon cooling limiting the movement in a first direction, a second stationary contact located on the opposite side of said strip portion in the path of movement of the movable contact limiting the movement in a second direction, conductor means connecting one side of the power source to one end of each winding, conductor means connecting the other end of the phase winding and said first contact, conductor means connecting the other end of the main winding and the support means at one end of said strip portion, and conductor means connecting the support means at the other end of said strip portion and said second contact with the other side of the power source, the cross-sectional area of a portion of said strip portion between said movable contact and the end connected to the main winding being of such a cross-section to substantially provide sufficient ohmic resistance and heat generation to hold the movable contact in contact with said second contact during the normal running period of the motor.

8. In combination, an electric motor having main and phase windings, a bimetal strip portion, means for supporting the ends of the strip portion, a movable contact connected to an intermediate portion of said strip portion, a first stationary contact located on that side of said strip portion and in the path of movement of said movable contact toward which the strip portion moves upon cooling limiting the movement in a first direction, a second stationary contact located on the opposite side of said strip portion in the path of movement of the movable contact limiting the movement in a second direction, conductor means connecting one side of the power source to one end of each winding, conductor means connecting the other end of the phase winding and said first contact, conductor means connecting the other end of the main winding and the support means at one end of said strip portion, and conductor means connecting the support means at the other end of said strip portion and said second contact with the other side of the power source, the cross-sectional area of a portion of said strip portion between said movable contact and the end connected to the other side of the power source being reduced to increase its ohmic resistance to increase the heat generated therein to shorten the time the movable contact is in contact with said station-

ary contact, the cross-sectional area of the strip portion between the movable contact and the other end of the strip portion being such to provide sufficient ohmic resistance and heat generated to prevent the movable contact from being returned by the strip portion to the first contact during the running period of the motor.

9. In combination, an electric motor having main and phase windings, a bimetal strip portion, means for supporting the ends of the strip portion, a movable contact connected to an intermediate portion of said strip portion, a first stationary contact located on that side of said strip portion and in the path of movement of said movable contact toward which the strip portion moves upon cooling limiting the movement in a first direction, a second stationary contact located on the opposite side of said strip portion in the path of movement of the movable contact limiting the movement in a second direction, conductor means connecting one side of the power source to one end of each winding, conductor means connecting the other end of the phase winding and said first contact, conductor means connecting the other end of the main winding and the support means at a first end of said strip portion, a second bimetal strip portion, means for supporting the ends of said second strip portion, conductor means connecting the support means at first end of said second strip portion and said second contact, said support means for said first and second strip portions being provided with means for electrically connecting the second ends of each strip portion, said second strip portion being provided with a second movable contact, a third stationary contact cooperating with said second movable contact, and conductor means connecting said third contact and the other side of said power source.

10. In combination, an electric motor having main and phase windings, a bimetal strip portion, means for supporting the ends of the strip portion, a movable contact connected to an intermediate portion of said strip portion, a first stationary contact located on that side of said strip portion and in the path of movement of said movable contact toward which the strip portion moves upon cooling limiting the movement in a first direction, a second stationary contact located on the opposite side of said strip portion in the path of movement of the movable contact limiting the movement in a second direction, conductor means connecting one side of the power source to one end of each winding, conductor means connecting the other end of the phase winding and said first contact, conductor means connecting the other end of the main winding and the support means at a first end of said strip portion, a second bimetal strip portion, means for supporting the ends of said second strip portion, conductor means connecting the support means at first end of said second strip portion and said second contact, said support means for said first and second strip portions being provided with means for electrically connecting the second ends of each strip portion, said second strip portion being provided with a second movable contact, a third stationary contact cooperating with said second movable contact, electric heating means connected to said third contact and located close to said first end of said second and first strip portions to heat both strip portions, and conductor means connecting said heating means and the other side of said power source.

11. In combination, an electric motor having main and phase windings, a bimetal strip portion, means for supporting the ends of the strip portion, a movable contact connected to an intermediate portion of said strip portion, a first stationary contact located on that side of said strip portion and in the path of movement of said movable contact toward which the strip portion moves upon cooling limiting the movement in a first direction, a second stationary contact located on the opposite side of said strip portion in the path of movement of the movable contact limiting the movement in a second direction, conductor means connecting one side of the power source to one end of each winding, conductor means connecting the other end of the phase winding and said first contact, conductor means connecting the other end of the main winding and the support means at a first end of said strip portion, a second bimetal strip portion, means for supporting the ends of said second strip portion, conductor means connecting the support means at first end of said second strip portion and said second contact, said support means for said first and second strip portions being provided with means for electrically connecting the second end of each strip portion, said second strip portion being provided with a second movable contact, a third stationary contact cooperating with said second movable contact, and conductor means connecting said third contact and the other side of said power source, said first end portion of said second strip portion having a sufficiently small cross-sectional area and large ohmic resistance to provide initial quick heating for quick tripping under starting stall conditions.

12. A control device comprising a column loaded bimetal strip portion, means for supporting said strip portion and for applying a column loading thereto, a first electrical contact carried by said strip portion, a second electrical contact located in the path of movement of said first contact limiting the movement of said strip portion in one direction, and temperature responsive means responsive to environment temperatures for moving said second contact in said path of movement for partially compensating for the effect of environment temperatures upon said strip portion.

13. A control device comprising a bimetal strip portion, a first electrical contact carried by said strip portion, a second bimetal strip portion, a support for said second strip portion provided with an arm, a second electrical contact mounted on said second strip portion and located in the path of movement of said first contact, a set screw carried by said arm for engaging and adjusting the position of said second strip portion and said second contact.

14. A control device comprising a column loaded bimetal strip portion, a supporting means for supporting and applying the column loading to the column loaded bimetal strip portion with the strip portion being free from the supporting means between the points of application of the column loading, a first electrical contact carried by an intermediate movable portion of said column loaded strip portion, a second electrical contact supported by said supporting means and located in the path of movement of said first contact limiting the movement of said strip portion in one direction, and compensating means responsive to ambient temperatures for substantially compensating for the effect of ambient

temperatures upon the column loaded bimetal strip portion.

15. In combination, an electric motor having main and phase windings with one end of each connected to one side of a power source, a starting control for controlling the energization of the phase winding, an overload protector provided with a column loaded bimetal strip portion carrying a movable contact at an intermediate portion, a stationary contact connected to the other side of said power source cooperating

with said movable contact, the portions of said bimetal strip portion in opposite directions from said movable contact having a different resistance to current flow, said starting control being provided with means connecting with one end of said strip portion and disconnecting the other end from the motor circuit during the starting period and during the running period disconnecting said one end and connecting with said other end of said strip portion.

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