Feb. 23, 1937. L. A. TROFIMOV 2,071,595

ARC DISSIPATING DEVICE

Filed Dec. 31, 1932 3 Sheets-Sheet 1

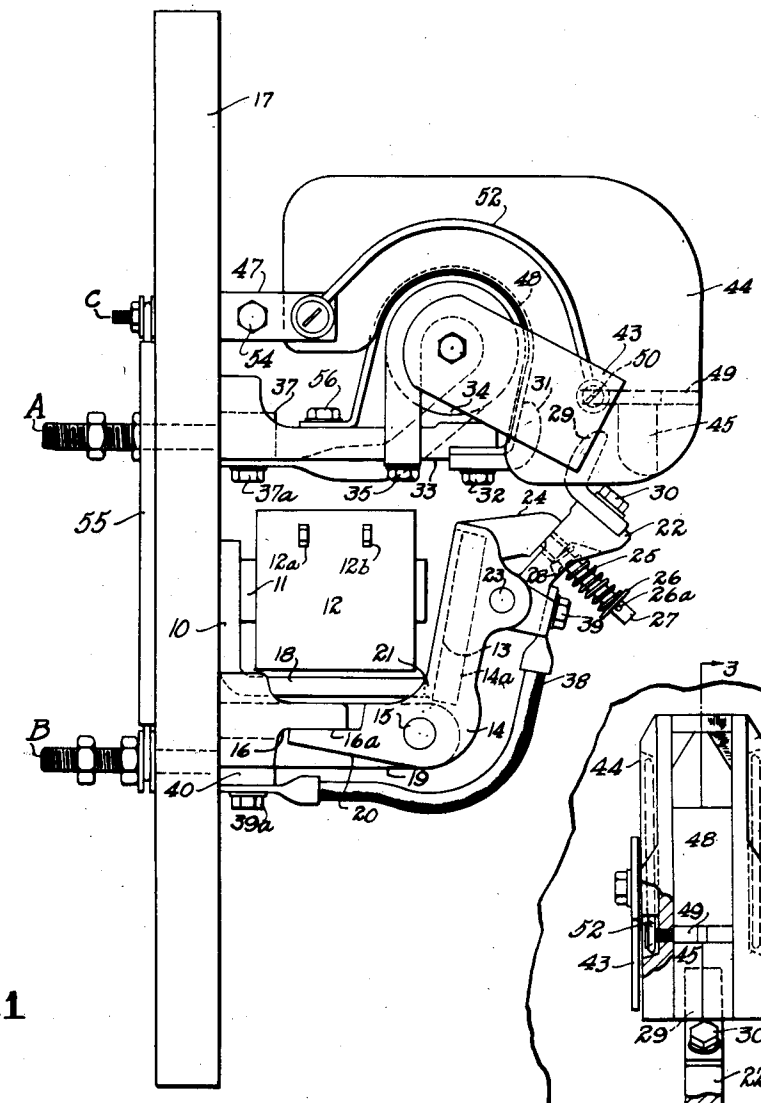


Fig.1

Fig.2

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ARC DISSIPATING DEVICE

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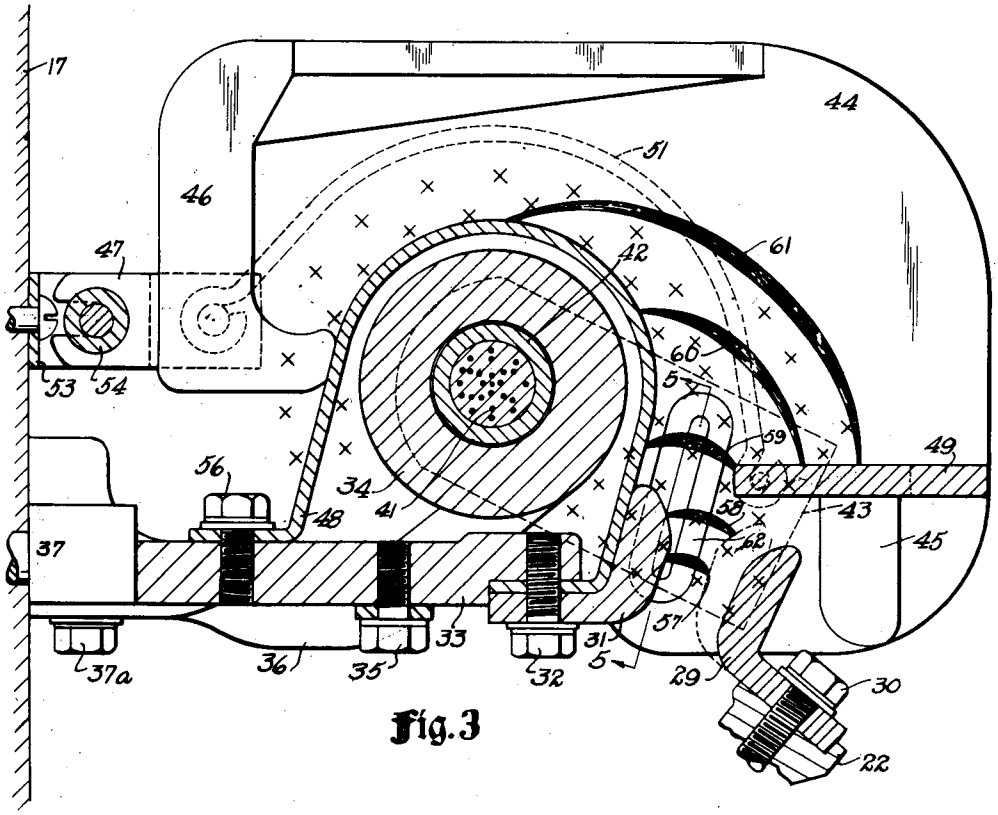


Fig.3

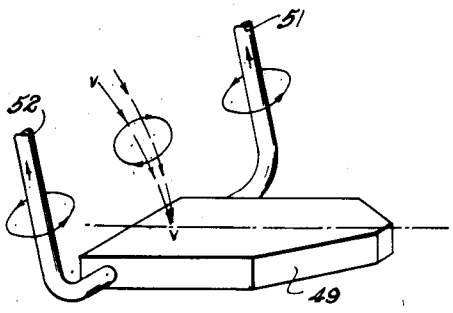


Fig.4

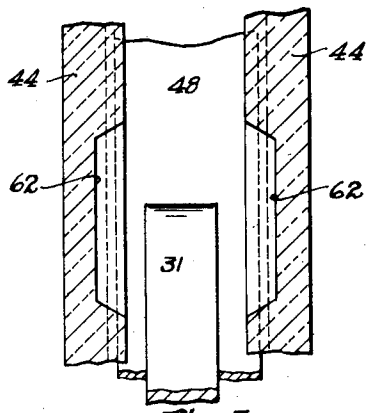


Fig.5

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ARC DISSIPATING DEVICE

Filed Dec. 31, 1932 3 Sheets-Sheet 3

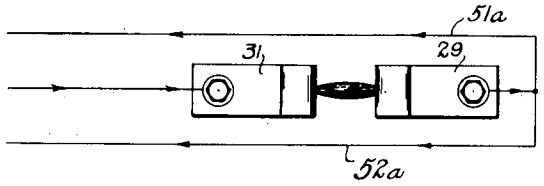


Fig.6

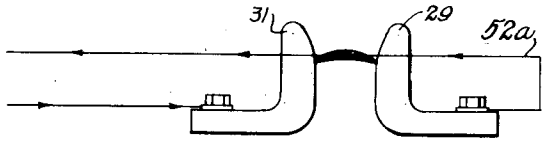


Fig.7

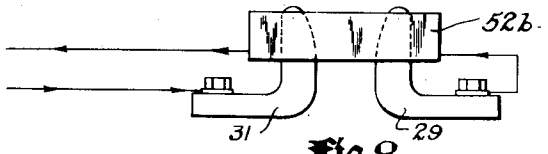


Fig.8

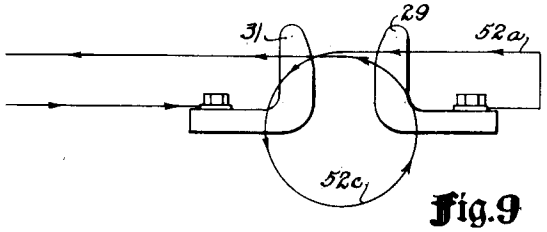


Fig.9

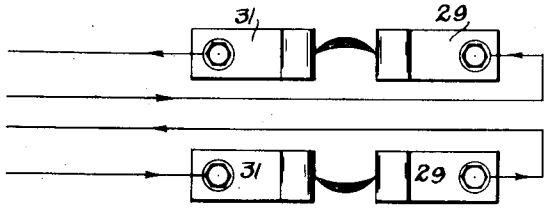


Fig.10

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UNITED STATES PATENT OFFICE

2,071,595

ARC DISSIPATING DEVICE

Lev A. Trofimov, Cleveland Heights, Ohio, assignor to The Electric Controller & Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

Application December 31, 1932, Serial No. 649,726

22 Claims. (Cl. 200—147)

My invention relates to a current making and breaking device for use in opening and closing electrical circuits. In particular, my invention relates to such a device having means embodied therein for uniformly extinguishing the arc formed upon opening a circuit in such a manner as to materially reduce the possibility of damage to the parts therein.

My invention, while useful in either alternating or direct current electrical circuits, is particularly adapted for use in direct current circuits. In such circuits it is well known that on interrupting the current flow with contactors, switches or the like, an arc is formed between the current carrying contacting elements, with the result that the heat from the arc usually causes some damage thereto. Various devices have been developed from time to time to overcome this objection, and while some of these have been more or less successful, my invention embodies an improvement upon these. It is an object, therefore, of my invention to provide means for extinguishing the arc formed between the current carrying contacting elements upon opening of a current carrying circuit without burning or other serious damage to either the contacting elements or the adjacent parts.

It is also well recognized that in contactor mechanisms now used the time of extinguishing the arc formed upon opening such a device varies over a wide range for a given set of electrical and air conditions. Such variation is in many cases undesirable, and it is therefore an object of my invention to provide a circuit opening and closing switch or contactor device in which the time of extinguishing the arc formed on opening thereof may be made substantially uniform or constant for a given set of air and electrical conditions.

When current is flowing in circuits having inductance or inductive apparatus connected therein, energy is stored up in the inductive elements of the circuit, which upon quickly opening the circuit is released, giving rise to induced or impulse voltages of very high magnitude in the inductive parts of the circuit. These high voltages are undesirable in that they oftentimes result in the breaking down of the circuit insulation or of the insulation of apparatus connected therein. My invention contemplates a device for opening such circuits with a more uniformly lengthened time than heretofore attainable and in such a manner as to greatly reduce the induced or impulse voltages incident thereto, with consequent less possibility of damage in the circuit.

It is another object of my invention to provide a contactor device in which the arc formed upon opening of a current carrying circuit is quickly transferred from the normally current conducting elements to special and separate relatively cold arc conducting and dissipating surfaces whereon the arc is subsequently caused to extinguish itself, thereby greatly minimizing damage to the normally current carrying contactor elements.

It is another object of my invention to provide means for causing rapid and uniform movement of the arc over the said dissipating surfaces during the extinguishing stage, whereby no one portion of the surface is in contact with the arc or subjected to the high temperature of the arc for more than a very short period of time, thereby reducing possible damage to the dissipating surfaces due to such temperature or contact.

It is yet another object of my invention to provide means for causing the arc formed on opening of a set of contacts to be not only rapidly conducted away from the normally current carrying contact elements but at the same time to definitely control its path of movement to keep it from contact with other associated parts and thereby prevent possible damage to them.

It is yet another object of my invention to provide a contactor switch adapted to close with relatively great rapidity and which may likewise quickly open and yet delay the interruption of current for a definite period of time after the switch has opened.

It is still another object of my invention to provide a switch or contactor mechanism of the character referred to which is rugged, easily manufactured at a low cost, which will require little attention over a relatively long period of time, and which by virtue of the novel features used is subjected to very little wear, thereby greatly increasing the life of such a device.

In illustrating a form which my invention may take in the attached drawings,

Fig. 1 is a side elevation of a clapper type contactor switch embodying my invention.

Fig. 2 is a partial front elevation of the view shown in Fig. 1.

Fig. 3 is a partial sectional view of the parts shown in Fig. 2 along the lines 3—3.

Fig. 4 is a diagrammatic view illustrating the relative current directions in certain parts of the device.

Fig. 5 is a fragmentary sectional view of the

arc shields surrounding the contactor elements along lines 5—5 of Fig. 3.

Fig. 6 is a diagrammatic plan view of an arrangement of contacts and conductors connecting therewith.

Fig. 7 is an elevation of the diagrammatic view of Fig. 6.

Fig. 8 is similar to Fig. 7 with a modified form of conductor.

Fig. 9 is another view similar to Fig. 7.

Fig. 10 is a diagrammatic plan view of another arrangement of contacts and conductors.

Briefly stated, and referring particularly to Figs. 1 and 3, the form of my invention therein illustrated comprises a pair of contacts **29** and **31** adapted to close to complete a suitable circuit connected therewith, and directly above the contact **29** is positioned an arc dissipating plate **49**, while rising upwardly from and connected to the contact **31** is a U-shaped guard or arc dissipating and conducting member **48**. In series with the contact **31** is a magnetic blowout coil **34** having a core **41** of highly permeable material. The core **41** has a pair of ears **43** of like magnetic material connected therewith and extending toward and partially enveloping the contacts **29** and **31**. When the contacts **29** and **31** are carrying current the blowout coil **34** is likewise carrying current and thereby energized. A magnetic flux is therefore caused to be established between the complementary faces of the blowout coil ears **43**. When an arc is formed on the opening of the contacts **29** and **31** the relative direction of the current conducted by the arc and the direction of the magnetic field is such that the arc is forced upwardly as is shown at **57**, **58**, **59**, **60** and **61**. As the arc moves upwardly it passes from the face of the contacts **29** and **31** onto the surfaces of the arc dissipating member **48** and the plate member **49**. The arc is thus quickly conducted away from the normally current carrying contact elements **29** and **31** and as it rises upwardly under force of the magnetic field of the blowout coil **34** it continually increases in length until finally extinguished by virtue of dissipation of the energy maintaining it. The movement of the arc stream, as it passes upwardly, is kept in a plane centrally of the shield members **44** by virtue of interaction of the current in the arc with the current in the current carrying conductors **51** and **52** on either side of the arc shields **44**. (See Fig. 2.) The upward movement of the arc is maintained after it passes from the field between the complementary faces of the magnetic ears **43** by virtue of interaction with the leakage field around the blowout coil **34**. Thus from the beginning of formation of the arc on opening of the contact members **29** and **31** it is quickly and uniformly forced upwardly, gradually increasing in length with a corresponding increase in surface exposure until a port is reached where the energy supplied to the arc is insufficient to maintain its existence and it is thereupon extinguished.

While the foregoing brief statements explain the outstanding function of my invention, other important features will be hereinafter discussed in more detail.

Considering now a more detailed description, and referring to the drawings, there is shown a stationary contact member **31** secured to a supporting bracket **33**, as by a bolt **32**. The supporting bracket **33** may be secured to a panel **17** in any suitable manner, as by screws or bolts. One end of the blowout coil **34** is secured to the supporting bracket **33** by a bolt **35**. The other end of the blowout coil is secured to a stud **37** by a bolt **37***a*. These connections are rigid enough to support the weight of the blowout coil. The blowout coil **34** has a magnetic core **41**, the ends of which are suitably secured by bolts or other means to a pair of magnetic ears **43** extending diagonally downward to embrace the region adjacent and above the upper tips of the contacts **29** and **31**. The core **41** is spaced from the magnetic blowout coil **34** by a suitable insulating member **42**. Between the magnetic ears **43** are a pair of arcing shields **44**, which are preferably of heat resisting material and held together by the clamping members **47** and the bolt **54**. These arcing shields **44** are spaced apart by the boss members **45** and **46**, and may be partially supported by the shield **48**. It will be noted that the member **45** is disposed intermediate the contact tip **29** and the outer end of the member **49** and provides a support for the member **49**. The member **45** also prevents an arc traveling below the member **49** from the outer end thereof toward the contact tip **29** from re-striking the contact tips **29** and **31**.

The arc shute **44** is provided with an arc limit stop which spans the space between the side walls of the arc chute **44** and extends from the end wall thereof into contact with the arc horn **48** to abut the arc horn **48** at a point intermediate the ends thereof. The arc limit stop prevents the end of the arc traveling on the arc horn **48** passing therepast into contact with the conducting bracket **33**, and limits the travel of the end of the arc engaging the arc horn **48**. The end wall, side walls and arc limit stop of the chute **44** cooperate with the arc horn **48** to form a blowout chamber where the final rupturing of the arc takes place.

The movable contactor **29** is secured to a rocking arm **22** as by a bolt **30**. The rocking arm **22** is pivotally secured to a main actuating arm **14**, as by a pin **23**. The rocking arm **22** is slidable along a pin **27** and normally urged against the stop **24** of the main arm **14** by a spring **25** on the pin **27**, the spring reacting against a washer **26** held fixed by a securing pin **26***a*. Electrical contact between the movable contact member **29** and the circuit connecting stud block **40** is established by the flexible connector **38** which is secured to the rocking arm **22** as by a bolt **39**, and to the contact block **40** as by the bolt **39***a*. The main arm **14** is pivotally secured to a supporting bracket **16** as by a pin at **15**. In the open position of the contact members **29** and **31** the main arm **14** has a stop extension **20** engaging a coacting and similar stop **16***a* on the bracket **16**. Secured in a recess **14***a* of the main arm **14** is a magnetic armature **13**. In the closed position of the contacts **29** and **31**, this magnetic insert completes a magnetic circuit comprising a core **11** of an electromagnet having a coil **12** and L-shaped yoke member having the upwardly extending arm **10** and the horizontal arm **18**. The contactor device is connected to an exterior circuit through the studs A and B. The circuit within the switch shown is through the stud A, stud block **37**, the blowout coil **34**, the supporting arm **33**, stationary contactor **31**, movable contactor **29**, flexible connector **38**, stud block **40**, and thence to the stud B, or vice versa.

Between the arcing shields **44**, and immedi-

ately above the spacing lug 45, is located an arc dissipating block 49 which is electrically connected to the stud member B by conductor 55, auxiliary stud C, contacting bracket member 53, fingers 47, conductors 51 and 52 (which are in parallel and secured to the sides of the arcing shields 44), final connection to the arc extinguishing block 49 being made by screws 50. Secured between the stationary contact 31 and the supporting bracket 33 by a bolt 32 is a second arc dissipating member 48 which extends upwardly over and embraces the magnetic blowout coil 34, terminating in contact with and secured to the supporting bracket 33 by the bolt 56. The member 48 may be heat insulated from the contact 31, or it may terminate at a point adjacent the upper tip of this contact, as it is electrically connected thereto through the supporting bracket 33 by the bolt 56. However, when connected to the contact 31 as shown in Fig. 3, the arc dissipating member 48 is supplied with current from two points, namely at bolts 56 and 32, thereby providing a parallel supply circuit.

The operation of the contactor device is as follows. Assuming the device to be connected in a direct current circuit such that current enters at the stud A and leaves by the stud B, the closing action of the switch is initiated by energization of the coil 12 through terminals 12*a* and 12*b*, which causes attraction of the armature 13 toward the core 11, whereupon the movable contact 29 moves toward and contacts with the stationary contact 31. This contact is made against the pressure of the spring 25 and the contact surface of the contact members 29 and 31 thereupon engage with sufficient pressure to form a good electrical contact. Current thereupon flows into the stud A through the blowout coil 34, across contacts 31 and 29, thence through the flexible connector 38 and out the stud B. Immediately thereupon a magnetic flux is established by the blowout coil 34 between the complementary faces of the magnetic ears 43 whereupon a region immediately within and above the tips of the contacts 29 and 31, of high flux density, is formed. In a similar manner a region surrounding and exterior to the magnetic blowout coil 34 of a somewhat lower average flux density is formed. Referring to Fig. 3 the direction of the fields created by the blowout coil 34 is indicated by crosses which represent lines of force traveling away from the observer and by dots in the core 41 which represent lines of force traveling toward the observer.

Upon de-energization of the coil 12 the pull on the armature 13 is released and the action of gravity plus that of the spring 25 causes the movable contactor 29 to spring away from the stationary contactor 31. At the instant the contact surfaces of contacts 29 and 31 separate an arc is formed therebetween, as indicated at 57 in Fig. 3. Interaction between the current carrying arc stream and the magnetic field in which it is formed causes the arc to immediately move upwardly in numerous successive positions, as indicated at 58, 59, 60 and 61. As soon as the arc reaches the upper tips of the contacts 29 and 31 it immediately passes to and between the arc dissipating plate 49 and the arc dissipating member 48. The arc thereafter contacts only with the dissipating plate members 48 and 49 and the circuit to the stud B is through the conductors 51 and 52, as heretofore described. The arc continues to move upwardly and the end in contact with the dissipating member 48 continues to move upwardly over the curved surface of the member 48, while the other end moves across the surface of the plate 49 to the right. During the upward movement of the arc it passes out of a highly concentrated field between the magnetic ears 43 into the less dense field surrounding the magnetic blowout coil 34, but this weaker field is of sufficient strength to cause a continuance of the upward movement of the lengthening arc. During this upward movement the arc is continually elongating with consequent greatly increasing exposed surface of the arc itself, whereupon the dissipation of the energy in the arc is constantly increased until a point is reached where the rate of dissipation of energy from the arc is equal to or greater than the rate of energy supplied to the arc, and the arc is therefore extinguished. It will be noted that during this upward travel of the arc its length is increasing at a uniform rate and that the ends of the arc in contact with the arc extinguishing members are rapidly and uniformly moving over the surface thereof and at such a rate that the end of the arc is never in contact with the surface of the dissipative members for a sufficient length of time to cause melting or damage thereof.

After the arc has moved upwardly and between the arc dissipating members 48 and 49 the normally current carrying contact elements 29 and 31 are no longer in the current supply circuit, and current is supplied to the arc from the arc dissipating surfaces through connections thereto as heretofore described. The arc is thereafter maintained for a length of time after the main contacts 29 and 31 have been opened. Since the conductors 51 and 52 are transmitting current from the arc dissipating plate 49 in a direction substantially opposite to that flowing in the arc to the plate the interaction between the current in the arc and that in these conductors is such as to cause the arc stream to maintain a position substantially intermediate of these two conductors and hence midway between the arc shields 44. This results in the arc rising upwardly in a plane between the arc shields 44, so that there is practically no contact between the hot arc and the sides of the shields 44, hence there is little or no deterioration of these parts. As a result, it is possible to use materials having a lower heat resisting property than is otherwise possible for such shields.

In Fig. 4 is shown diagrammatically the relative current directions in the conductors 51 and 52 and that in the arc stream therebetween. The heavy broken lines, indicated by *v*—*v*, diagrammatically indicate the current flow in the arc stream toward the arc extinguishing block 49. The conductors 51 and 52 on either side of the arc stream conduct current in a substantially opposite direction to that flowing in the arc whereupon the interaction between the current in these conductors and that in the arc at all times causes the arc to maintain a position intermediate of these conductors as described.

I have observed that if the current carrying conductors 51 and 52 are disposed adjacent to, on either side of and substantially parallel with the arc stream between the contacts 29 and 31, the interaction is such as to cause the arc stream to move upwardly over the contact surfaces and centrally thereof. Such an arrangement is illustrated diagrammatically in Figs. 6 and 7, in which the adjacent current carrying conductors

are indicated at 51*a* and 52*a*, and the relative current directions are indicated by arrows. The conductors 51*a* and 52*a* may be of any suitable shape, for example composed of flat strips adjacent the contacts or arc stream as indicated at 52*b* in Fig. 8. In order to provide a greater force of interaction between the arc stream and the adjacent conductors, I may loop the adjacent conductors one or more times, so that a plurality of ampere-turns are disposed adjacent the arc stream such as is illustrated diagrammatically at 52*c* in Fig. 9. It will be obvious that as many turn loops may be used as is desirable.

Fig. 10 is another illustration of this general principle adapted for the two poles of a circuit. It will be noted in this figure that the arcs are shown as bowed outwardly. This will be true where a single current carrying conductor is disposed on only one side of the contacts. With the conductor disposed immediately adjacent, or slightly below, the point of arc formation the first action upon the arc is to force it to one side. The natural tendency of the arc is to rise, and when even a slight distance above the horizontal plane of the conductor the vertical component of the force between currents in the arc and conductor forces the arc up rapidly. With conductors on either side of the contacts the upward movement is centrally of the contacts.

Adjacent to the contact members 29 and 31, cavities may be formed in the arc shields 44 as indicated at 62, for the purpose of providing additional space for the expansion of the gases formed around the contact members 29 and 31 during the formation of the arc therebetween. As this arc begins to form the air adjacent thereto is rapidly heated and if an enlarged gas space is provided in this vicinity in which the gases may expand on being heated, the rise in temperature thereof is greatly inhibited. These cavities or recesses are therefore very effective in keeping down the temperature incident upon initial formation of the arc between the contact members, thus keeping this temperature to a low and safe value until the arc has been moved upwardly by the action of the magnetic field thereupon.

It will thus be seen that as the contact members are separated the arc is caused to be continually moved upwardly and to be transferred from the normally current carrying contact members to fixed or stationary surfaces across which it continues to move until lengthened to the point where it is extinguished. It will be quite apparent that the arc dissipating or extinguishing surfaces may be of any suitable configuration, for example, one surface may be curved to serve as a guard for the blowout coil, such as that shown at 48 in Fig. 1, or these surfaces may be of any other configuration which is adaptable for the apparatus with which they are to be used.

In the conventional type contactor the contact tips are placed relatively far away from the blowout coil and its leakage field, so that the arc originally forms between the contact tips, then travels first in the field between the blowout ears and later out into a field-free space. In the border space just above the blowout ears the lines of force are curved, due to the fringing effect of the magnetic flux; therefore, since an arc always tends to cross the magnetic lines at right angles, it will inevitably assume a curved path and frequently collide with parts of the blowout arrangement and destroy them. I consider it of great importance, therefore, that the one arc dissipating surface, as for example, that of the element 48, be maintained in close proximity to the blowout coil 34, so that the upward movement of the arc across such surfaces will be maintained uniform by action of the leakage field of the blowout coil 34 thereupon. In other words, the leakage flux straightens the fringing about the edges of the blowout ears. Further, by placing the one element 48 close to the blowout coil, and hence in a strong magnetic field, and the other element 49 partly in a strong field and partly in a weak field, the movement of the arc across the first surface is made more rapid than across the other surface. This permits the arc surface, namely that of the element 49, to be much shorter than the other. It is important therefore that the element 49 be positioned with due regard for the field between the ears 43, otherwise the arc may not be properly lengthened to utilize the two surfaces to best advantage. Such an arrangement provides for a definite control of the arc and assures that it always travels in a plane parallel to the arc shields and between them. With such a construction as shown in Fig. 1, full advantage is taken of the leakage field of the blowout coil 34 and the movement of the arc across the dissipating surfaces is kept continuous up to the extinguishing point.

The importance of conducting the arc away from the normally current carrying contact members to separate arc dissipating surfaces is more readily understood when considered in the light of permitting the arc to be extinguished between the normally current carrying contact members. In the usual type of contactor switch, upon opening of the contacts the arc forms either between the tips of the main contact or between special arcing tips attached thereto. If the main contacts have been intermittently interrupting current for any appreciable length of time, they have reached a fairly high temperature, due to the energy loss within and between them. Therefore, in the ordinary switch, upon each opening, an arc is formed between initially hot bodies, whereupon thermionic emission has, practically speaking, already begun, and the formation of an arc is thereby greatly accelerated, with the result that it is more difficult to extinguish or dissipate the arc than if it were immediately transferred to separate cold bodies. It will be noted that in the construction illustrating my invention I have spaced arc dissipating surfaces a sufficient distance from the main current carrying contact members so that they receive little or no heat therefrom, and consequently when the arc is transferred to these surfaces and moved rapidly across them it is free of the highly conducting vapors that result from an arc formed between initially hot bodies, and therefore less destructive in its effect.

The transfer of the arc from the main contact tips to the arc dissipating surfaces occurs without hesitation because one of these surfaces is already directly in electrical contact with the stationary contact 31, while the other surface is directly above the movable contact 29, and the arc steps readily from the movable contact to the plate body 49 as the polarity of this plate body is the same. Although there may have been electronic emission at the instant the arc was formed between the main contact members, as soon as the arc is transferred to the arc dissipating surfaces 48 and 49, electronic emission due to heat of the bodies is arrested and cannot further take place, as at no time is the end of the arc in contact with a sufficient portion of the sur-

face of the arc dissipating surfaces to raise them to a temperature sufficient to produce electronic emission. As a consequence of this, the time of interruption of the arc is very uniform and does not vary to any appreciable extent with variations in external surrounding conditions with given circuit conditions. The life of the main contact tips, although made of ordinary contact material, is thereby greatly increased to an extent which it was previously impossible to attain.

Further, due to the ability to control the arc while it is being ruptured, that is, by controlling the path of the arc and the time required to extinguish it, it is possible to interrupt a current in highly inductive circuits in such a manner that the voltage rise in the inductive portions of the circuit during the interruption of the current is less than that observed with any known type of conventional contactor.

In order to provide a magnetic switch which may be closed with greatly increased speed and likewise be opened with increased speed, I provide a contactor carrying arm 14 preferably made of a light material, such for example as aluminum, pressed metal, or the like, in which the magnetic armature 13 is suitably secured. In a similar manner the rocking arm 22 may be of a light material, whereupon energizing the coil 12 the whole movable mechanism is quickly attracted to the core member 11. When the contact 29 is in its closed position a gap 21 is maintained between the lower end of the armature 13 and the horizontal portion 18 of the electro-magnet yoke, which gap prevents the establishment of a residual field within the magnetic parts, and upon deenergization of the coil 12 the opening pressure exerted by combined force of gravity and that of the spring 25 is sufficient to cause the contact 29 and its associated mechanism to quickly move to the open position.

I claim:

1. A contactor switch comprising a pair of contacts, means for causing said contacts to open and close, a blowout coil associated with said contacts adapted to produce a magnetic flux, a magnetic core associated with said blowout coil having extending ears adjacent said contacts and adapted to produce a concentrated flux enveloping said contacts, an arc dissipating surface in electrical connection with one of said contacts and embracing said blowout coil, a second arc dissipating surface adapted to receive current of the same polarity as the other of said contacts, arc shields having their inner surfaces adjacent said contacts and arc dissipating surfaces, a pair of conductors forming a branched circuit with one branch extending along the outer surface of each of said arc shields, each of said conductors being adapted to supply approximately one-half the current passing from the first arc dissipating surface to the second arc dissipating surface, said concentrated magnetic flux being adapted to transfer from said contacts to said arc dissipating surfaces the arc formed upon opening of said contacts when carrying current, and the other flux being adapted to move said arc along said surfaces, the current in said conductors connected to the second arc dissipating surface interacting with the current in said arc to cause said arc to move along said surfaces intermediate of said arc shields, said surfaces being divergent whereby the length of the arc is uniformly increased to the point of rupture.

2. A circuit interrupter having contacts, an expanding arc stream produced when the contacts open, a loop comprising a conductor positioned to substantially completely surround the length of said expanding arc stream, and means for energizing said conductor so that the flux generated by the current flowing in the conductor reacts with the current in the expanding arc stream, confining the expanding arc stream in a plane passing through the contacts and the center of the loop.

3. In a circuit interrupter, arc termini, means for forming an expanding arc stream between said termini, a conducting loop comprising a plurality of conductors located some on either side of a plane containing the termini and arc stream when formed, means connecting the opposite ends of each of said conductors to said arc termini to form a continuous loop circuit surrounding substantially the length of said arc stream, and means for causing the current in the arc stream to divide and pass through the said conductors in parallel.

4. In combination with a movable contact member, a stationary arc dissipating surface adapted to receive an expanding arc from said member, a loop circuit comprising conductors connected to said arc dissipating surface adapted to be energized consequent upon an arc being formed on said arc dissipating surface, and means for causing an expanding arc formed on said arc dissipating surface to enter and at all times pass through the central portion of said loop circuit.

5. In a circuit interrupter, a movable contact, a stationary arc dissipating surface therefor, means for transferring an arc formed on the contact to the said arc dissipating surface when the contact moves from its closed to its open position and for expanding the arc, an elongated conducting loop connected in series with the arc dissipating surface, and means for causing the arc to pass through the central portion of the conducting loop, the current in both the elongated sides of said loop reacting upon the current in the expanding arc to at all times center it substantially midway between the said elongated sides of the loop out of contact with the sides of the same.

6. In a circuit interrupter, a pair of current conducting members adapted to be connected in series in a circuit to be interrupted and to have an arc formed therebetween, means to position said arc stream, immediately from the time it is produced until it is broken, in a plane extending substantially intermediate the sides of the current conducting members, said means comprising a pair of current conducting members extending in planes substantially parallel to the first mentioned plane, one of said current conducting members being positioned on each side of the first named current conducting members, said last-named current conducting members being connected in series with one of the first-named current conducting members, the current flow in the second named current conducting members being opposite in direction to that in the arc stream intermediate the two first named current conducting members.

7. In a circuit interrupter, a pair of contacts, means to move one of said contacts relative to the other of said contacts to effect opening and closing of said contacts, an arc dissipating surface rigidly connected to one of said contacts and adapted to be electrically connected with the said contact, a second arc dissipating surface spaced from the first arc dissipating surface and fixedly secured relative thereto, means for transferring from said contacts to said arc dissipat-

ing surfaces an arc formed upon opening of said contacts when carrying current and for expanding the arc, said means comprising a magnetic blowout coil disposed adjacent said contacts, and means to position said expanding arc stream in a plane intermediate the sides of the arc dissipating surfaces, said means comprising a pair of conductors electrically connected to said second arc dissipating surface and adapted to be energized by current supplied to said second arc dissipating surface by said expanding arc stream, one of said conductors being positioned adjacent each side of the arc dissipating surfaces, the current in said conductors interacting with the current in said expanding arc stream to cause said expanding arc stream to always take a position intermediate said conductors and out of contact with the same.

8. In a circuit interrupter, a pair of contacts, one of said contacts being movable, each of said contacts being connected to a line terminal, the contacts being adapted to have an arc formed therebetween when the contacts are opened, a stationary arc horn adapted to receive an arc formed on said movable contact, means for causing an arc formed on said movable contact to be transferred to said stationary arc horn and for expanding the arc, a pair of conductors connected to the stationary arc horn and to the line terminal to which the movable contact is connected, said conductors being spaced apart, the current in said conductors interacting with the current in the expanding arc stream to cause said expanding arc stream to take a position at all times in the space between the conductors, out of contact with said conductors, the current flow in said conductors being opposite in direction to that in the expanding arc stream.

9. A circuit controller, comprising: a plurality of contacts between which an expanding arc is adapted to be formed upon separation of said contacts; arc terminal means having a portion disposed near one of said contacts, one end of said expanding arc being adapted to be transferred to said arc terminal means; electrical conducting means connected to said arc terminal means, adapted to be initially energized through said expanding arc when said one end of said expanding arc is transferred to said arc terminal means for maintaining said arc in a predetermined path; and means for preventing said arc from contacting said electrical conducting means.

10. A circuit interrupter, comprising: a plurality of contacts between which an expanding arc is adapted to be formed upon separation of said contacts, means to expand said arc along a theoretical path predetermined before formation of the expanding arc, arc controlling means lying closely along each side of said theoretical path and adapted to be initially energized electrically when said contacts are separated, the current in said energized arc controlling means flowing in a direction opposite to the current in said expanding arc for causing said expanding arc to remain in said theoretical path and constraining said arc in said theoretical path therebetween.

11. A circuit controller, comprising: arc terminal means; a plurality of contacts between which an arc is adapted to be formed upon separation of said contacts, one end of said arc being adapted to be transferred to said arc terminal means; and electrical conducting means connected to said arc terminal means and adapted to be initially energized when said one end of said arc is transferred to said arc terminal means to maintain said arc in a path spaced from said electrical conducting means, said electrical conducting means extending from said connected terminal means across said contacts and substantially parallel to the plane of said arc.

12. A circuit controller, comprising: a plurality of contacts between which an arc is adapted to be formed upon separation of said contacts, arc terminal means having a portion disposed adjacent said contacts, one end of said arc being adapted to be transferred to said arc terminal means, blow-out means for expanding said arc, electrical conducting means in addition to said blow-out means connected to said arc terminal means and adapted to be energized when said one end of said arc is transferred to said arc terminal means to control the path of said arc, said electrical conducting means acting substantially coextensively with the path of said arc from one horn to the other and closely adjacent thereto at all times during energization to maintain said arc in a path predetermined before the formation of said arc, and shielding means interposed between said electrical conducting means, said shielding means being protected by said electrical conducting means from direct contact with said arc.

13. A circuit controller, comprising: a plurality of contacts between which an arc is adapted to be formed upon separation of said contacts; arc terminal means upon which said arc is adapted to be transferred upon separation of said contacts; electrical conducting means connected to said arc terminal means for controlling the arc path; and arc shielding means interposed between said arc and said electrical conducting means for restricting said arc path, said arc shielding means supporting said arc terminal means, and having means for supporting said electrical conducting means.

14. A circuit breaker, comprising: a plurality of arc terminal means for receiving the ends of an expanding arc; means for expanding the arc and for bowing the expanding arc away from said expanding means and for causing the ends of the expanding arc to travel along said plurality of arc terminal means; and a plurality of spaced apart conductors connected in parallel with each other and in series with said plurality of arc terminal means to form a loop circuit, said expanding means causing the bowing portion of the expanding arc to pass transversely through and beyond the area defined between said spaced apart conductors forming part of said loop circuit, said conductors being operable when one end of the expanding arc travels along one of said arc terminal means to control the locus of the expanding arc in a path passing between said conductors and out of contact with said conductors.

15. A circuit breaker, comprising: arc shielding means, a plurality of contact tips between which an expanding arc is adapted to be first formed upon separation of said contact tips; a plurality of arc terminal means disposed adjacent to said contact tips for receiving the ends of the expanding arc from said contact tips; blow-out means for transferring the ends of the expanding arc to said arc terminal means and for expanding the arc and causing the ends of the expanding arc to travel along said arc terminal means until the expanding arc breaks; current conducting means in addition to said blow-out means connected to one of said plu-

rality of arc terminal means and initially energized upon striking of said one end of the expanding arc on said one arc terminal means, operable when said one end of the expanding arc travels along said one arc terminal means to control the locus of the expanding arc in a path out of contact with said arc shielding means.

16. A circuit breaker, comprising: arc shielding means, a plurality of arc terminal means for receiving the ends of an expanding arc, one of said arc terminal means being carried by said arc shielding means; expanding means for expanding the arc and for causing the ends of the expanding arc to travel along said plurality of arc terminal means until the expanding arc breaks; and current conducting means in addition to said expanding means carried by said arc shielding means and connected to said one arc terminal means and initially energized upon striking of said one end of the arc on said one arc terminal means, operable when said one end of the expanding arc travels along said one arc terminal means to constrain the expanding arc from striking said arc shielding means.

17. An arc controlling device adapted to be attached to a circuit breaker to control the arc formed by opening of the circuit breaker and comprising: an arc chute having a pair of opposed spaced apart insulating walls adapted to be disposed on opposite sides of the locus taken by an expanding arc formed by the circuit breaker; line terminal means carried by said arc chute and adapted to be detachably connected to a terminal of the circuit breaker; arc terminal means interposed between said spaced apart insulating walls and carried by the same and along which one end of the expanding arc is adapted to travel until the expanding arc breaks; and current conducting means having a pair of conductors each supported by one of said spaced apart insulating walls on opposite sides of and coextensively along the locus of the expanding arc, said conductors having one of their adjacent ends connected to said arc terminal means and the opposite adjacent ends connected to said line terminal means to form a loop circuit supported entirely by said arc chute, said conductors being operable when said one end of the expanding arc travels along said arc terminal means to prevent the expanding arc from striking said spaced apart insulating walls.

18. An arc controlling device adapted to be attached to a circuit breaker to control the arc formed by opening of the circuit breaker and comprising: an arc chute having a pair of opposed spaced apart insulating walls adapted to be disposed on opposite sides of the locus taken by an expanding arc formed by the circuit breaker; arc terminal means interposed between said spaced apart insulating walls and carried by the same walls and along which one end of the expanding arc is adapted to travel until the expanding arc breaks; and current conducting means having a pair of conductors each supported by one of said spaced apart insulating walls on opposite sides of and coextensively along the locus of the arc; one end of each of said conductors being connected to said arc terminal means, said conductors being operable when said one end of the expanding arc travels along said arc terminal means to prevent the expanding arc from striking said spaced apart insulating walls.

19. An arc controlling device, comprising: arc terminal means along which one end of an expanding arc is adapted to travel normally along a given path until the expanding arc breaks, a shielding means on opposite sides of the normal path of the arc, a blow-out means for effecting expansion of said arc, and current conducting means in addition to said blow-out means connected to said arc terminal means and initially energized upon striking of said one end of the arc on said arc terminal means operable when energized to constrain said expanding arc in a path out of contact with said current conducting means and shielding means while said one end of the expanding arc travels along said arc terminal means.

20. An arc controlling device, comprising: arc terminal means along which one end of an expanding arc is adapted to travel until the expanding arc breaks; and current conducting means having portions connected in parallel with each other and in series with said arc terminal means, for controlling the movement of said expanding arc in a path out of contact with said conducting means while one end of the expanding arc travels along said arc terminal means.

21. A circuit breaker, comprising: relatively movable contact tips between which an expanding arc is adapted to be formed upon separation of said contact tips; an arc shield having opposed spaced apart insulating walls disposed about said contact tips; arc terminal means carried by said insulating walls and having an arc terminal surface intermediate said spaced apart insulating walls extending away from adjacent said contact tips, for receiving one end of the expanding arc transferred from one of said relatively movable contact tips upon separation of said contact tips; and an insulated member, disposed between said spaced apart insulating walls and extending from said arc terminal means to project intermediate one of said contact tips and the remote end of said arc terminal surface, for preventing retransfer of said arc from said arc terminal means to one of said contact tips.

22. A circuit breaker, comprising: an arc horn along which one end of an expanding arc is adapted to travel; and an arc box comprising opposed spaced apart side walls, an end wall spaced from said arc horn connecting said side walls together, and an arc limit stop projecting inwardly of said end wall between said side walls into abutting relation with said arc horn intermediate the ends thereof, said side walls, end wall and arc limit stop cooperating with said arc horn to form a blow-out chamber for the expanding arc, and said arc limit stop operating to prevent passage of said one end of the expanding arc between and beyond the point of abutment of said arc limit stop with said arc horn.

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