

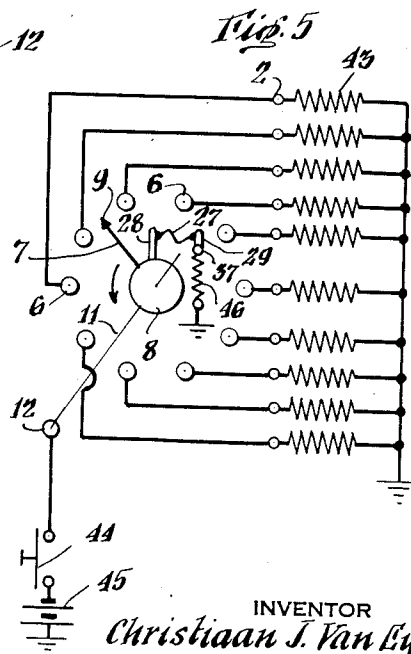
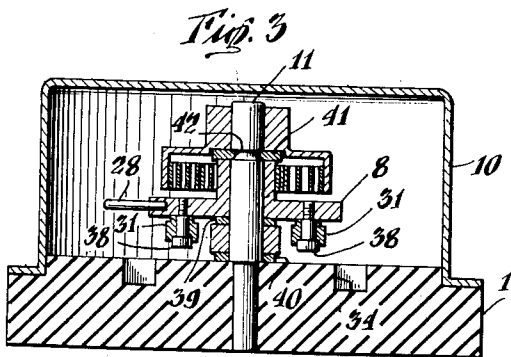
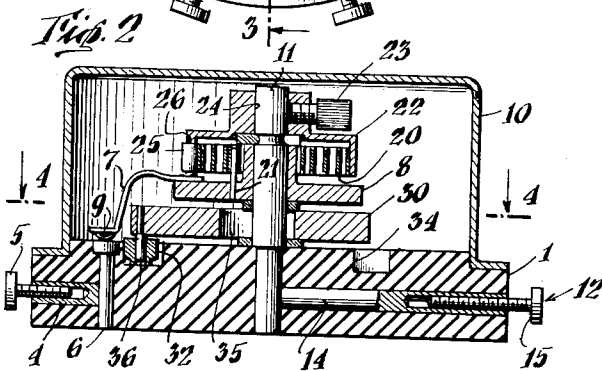
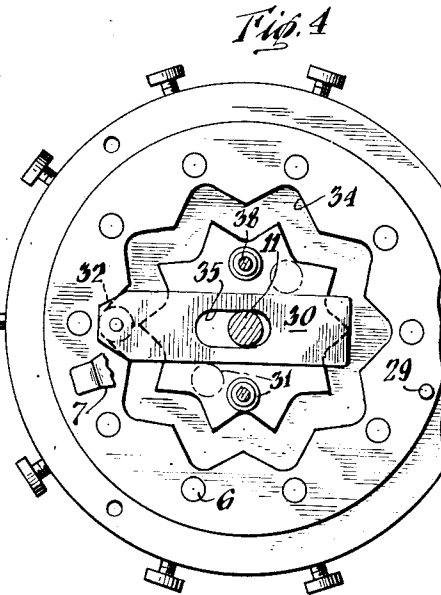
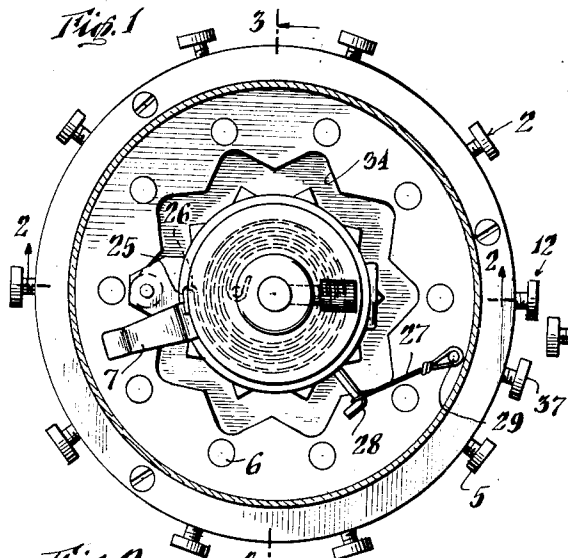
Sept. 11, 1956

C. J. VAN EYK
ELECTRICAL CONTACTOR

2,762,884

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2 Sheets-Sheet 1



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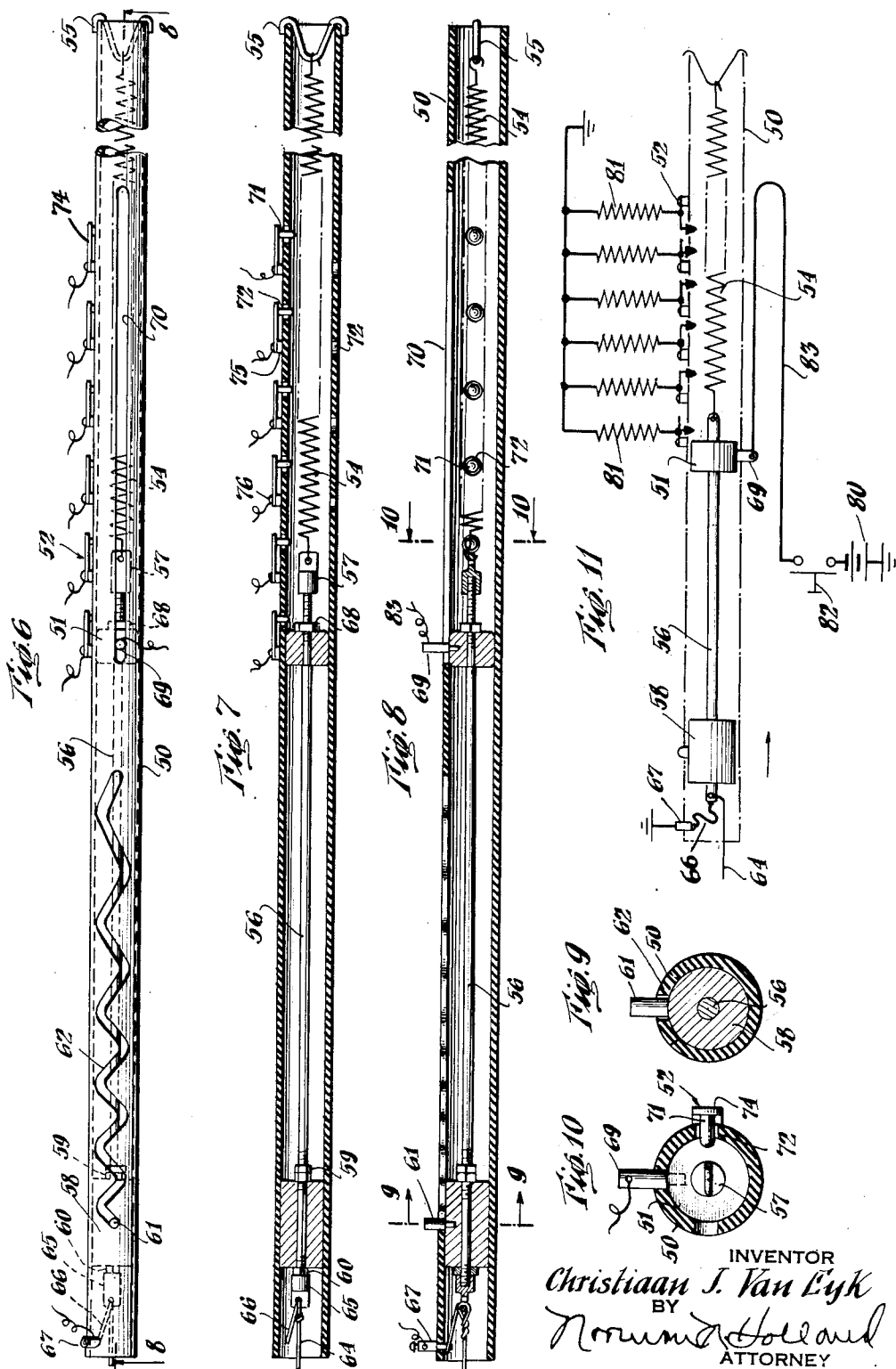
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ELECTRICAL CONTACTOR

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16 Claims. (Cl. 200—117)

The present invention relates to a contactor and more particularly to a spring-powered constant-rate contactor in which a moving contact sweeps across a series of spaced fixed contacts at a substantially constant rate momentarily touching each of the contacts in succession. The contactor has an automatic activation feature whereby the same voltage that is applied to the contacts for distribution to their associated circuits also is used to set it into motion. The contactor is especially adapted for rapid switching of high currents of the order of fifteen amperes or higher at speeds of one hundred switchings or more per second. The design is simple and rugged and may be readily manufactured at relatively low cost so that it may be economically used in expendable equipment. Such contactors are useful, for example, in setting off a series of blasting charges in sequence where each contact is attached to one squib or blasting cap in a spaced explosive pattern and where it is desired to use high currents and consecutive firing of the fuses.

The present invention uses a spring source for power together with an integral mechanical control mechanism which smooths out the release of energy from the spring to allow a substantially constant velocity for the moving contact.

Previous switching for high-current, high-speed applications has been done by a variety of methods and devices which lack the desirable features of the present switch. One previous method to consecutively detonate a series of fuses with high currents placed all the fuses across sources of power simultaneously with a voltage divider being used to place each fuse at a different voltage. The fuses detonate in the order of decreasing voltage, however such a circuit is hard to control and is unreliable. Other contactors in use are complicated and expensive and use spring or electrical motors which are difficult to manufacture and which are too expensive for expendable uses.

The contactor of this invention has a relatively simple spring motor and is capable of handling high-speed switching of high currents with accurately predetermined timing and reliability. No external power is required except for the power actually used in the various connected circuits which are controlled by the switch.

The purpose of the invention is to provide an improved high speed contactor.

Another object of the invention is to provide a high-speed contactor which will handle high currents.

Another object of the present invention is to provide a relatively simple constant speed drive for a high-speed contactor.

Another object of the present invention is to provide a contactor which has a relatively simple and reliable governor mechanism.

Another object of the present mechanism is to provide an efficient and reliable contactor which is relatively inexpensive and which is thus suitable for expendable equipment.

A still further object of the present invention is to

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provide a contactor which is relatively easily controlled from a remote position by an electrical signal.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

In describing my invention in detail, reference will be had to the accompanying drawing forming part of the specification wherein like characters denote like or corresponding parts and wherein:

Fig. 1 is a top view of one embodiment of the contactor of the present invention with the top of the cover cut away;

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;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 2;

Fig. 5 is a schematic diagram of the electrical circuit of the contactor of Figs. 1 through 4;

Fig. 6 is a top view of an alternate embodiment of the contactor;

Fig. 7 is a top view in section of the contactor of Fig. 6;

Fig. 8 is a sectional view taken along the line 8—8 of Fig. 6;

Fig. 9 is a sectional view taken along the line 9—9 of Fig. 8;

Fig. 10 is a sectional view taken along the line 10—10 of Fig. 8; and

Fig. 11 is a schematic diagram of the electric circuit of the contactor of Figs. 7 through 10.

The contactor will first be generally described with particular reference to Figs. 1 through 4.

The contactor parts are mounted on a terminal board 1 made of a suitable non-conducting material such as fiber or plastic. Spaced around the edge of board 1 are the spaced terminals 2 through which the load circuits are connected to the contactor. These terminals 2 comprise embedded conducting sleeves 4 and terminal screws 5. The sleeves 4 are electrically connected to a plurality of circularly arranged and spaced contacts 6.

Spaced contacts 6 are contacted one at a time by rotating contact 7 on contact wheel 8 as wheel 8 is turned by the spring drive mechanism which will be more completely described below. Thus as contact 7 rotates, terminals 2 and their associated circuits are momentarily and successively connected to rotating contact 7 and its associated circuits. For example, if contact 7 is connected to a source of power, the power is switched momentarily to each of the terminals 2 by rotating contact 7. Contact 7 has a rounded contact point 9. A suitable cover 10 fits over board 1 to enclose the contacts 6 and the contact 7 with its associated motor and governor elements.

The contact wheel 8 which mounts contact 7 turns on a vertical shaft 11 set into board 1. Shaft 11 is made of a conducting material and it completes the electrical connection between contact 7 and fixed terminal 12 on base 1 through the intermediation of wheel 8 which is also made of a conducting material. Terminal 12 comprises a conductive sleeve member 14 embedded in board 1 and having its inner end in contact with shaft 11 and its outer end threaded for a terminal screw 15.

The spring drive for the rotating contact 7 is mounted about shaft 11 above contact wheel 8 and comprises a spiral drive spring 20 having its inner end fastened to wheel 8 by a pin 21 and its outer end clipped to a spring housing 22. The spring motor is wound by relative counterrotation of wheel 8 and housing 22. Housing 22 has

a bearing surface 24 on which it rotates on shaft 11. The outer end of drive spring 20 is fastened to the outer rim of housing 22 by a suitable means such as a hook 25 on spring 20 engaging a slot 26 in housing 22.

Wheel 8 is restrained from rotation by a fuse 27 connecting conducting post 28 on wheel 8 with conducting post 29 set in board 1 when spring 20 is wound by the rotation of housing 22 about shaft 11. A thumb screw 23 is tightened against shaft 11 to hold housing 22 in the wound position.

When the fuse 27 is melted, as will be further explained below, wheel 8 is released and is turned around shaft 11 by drive spring 20.

In order to control the rate of rotation and in order to smooth out the energy release of the spring 20, a control means is provided between wheel 8 and board 1. This control means comprises a reciprocable slug 30 whose inertia controls the spring's unwinding, as will be more fully explained below, drive rollers 31 on wheel 8 to rotate the slug 30 around shaft 11, a cam roller 32 on slug 30 to impart a reciprocal motion to it and a cam groove 34 to guide cam roller 32.

The details and the theory of operation of the control means will now be described in greater detail. As seen in Fig. 1, the cam groove 34 surrounds shaft 11 and has a zig-zag shape. Cam roller 32 on the end of slug 30 is approximately as wide as groove 34 so that as slug 30 is rotated about shaft 11, roller 32 follows groove 34 and thus imparts a radially directed reciprocal motion to slug 30. As is seen in Fig. 4, slug 30 is mounted on shaft 11 by an elongated slot 35 which allows the slug 30 to have a radial motion. Roller 32 is rotatably mounted on slug 30 by a shaft pin 36. The rotation of wheel 8 by unwinding spring 20 is transferred to slug 30 by two rollers 31 spaced from the sides of slug 30 at diametrically opposed locations on the lower surface of wheel 8. As wheel 8 turns, these rollers 31 straddle slug 30, as seen in the dotted position in Fig. 4, and cause it to turn at least as fast as wheel 8. By being spaced from the sides of slug 30 they allow the slug to jiggle ahead of the rollers 31 to compensate for jars during the unwinding. Rollers 31 are rotatably attached to wheel 8 by shaft pins 38.

Slug 30 is mounted loosely between washers 39 and 40 so that it may freely reciprocate. Wheel 8 is held loosely against washer 39 by a lock washer 41 in slot 42.

It has been observed that with the above described control means, the rotation of contact 7 around contacts 6 is at a relatively constant rate for one or more turns as spring 20 unwinds. The slowing down of the spring's unwinding is controlled by the continuing force required to accelerate slug 30 first in one direction and then in the other as it reciprocates in a radial direction under the control of cam slot 34. The mass of slug 30 may be set to control the rotational rate of contact 7 as desired.

The relatively constant rate of rotation of contact 7 for several turns in spite of the decreasing spring force is believed to result from the following effect. As slug 30 reverses its radial direction in following cam slot 34, it remains motionless for a period of time. This motionless or dwell period is of longer duration than the time the slug requires to move to its next reversal and it appears to be independent of the spring force. This dwell time thus makes up a major portion of the actual time of rotation of contact 7 around shaft 11. Since its length is independent of the spring force, it remains the same as the spring winds down and it thus tends to equalize the rotational rate of contact 7 during the unwinding of spring 20.

An electrical schematic of the contactor of Figs. 1 through 4 is shown in Fig. 5. Contacts 6 are each connected to ground through terminals 2 and a load 43. Rotating contactor 7 is connected through conducting wheel 8, shaft 11 and terminal 12 through a switch 44 to a source of voltage 45. Fuse 27 is connected between conducting post 28 on wheel 8 and conducting post 29 which

is embedded into board 1 and connects to terminal 37. Fuse 27 is grounded through a resistor 46 connected to terminal 37.

When switch 44 is closed, current flows through terminal 12, shaft 11, wheel 8, post 28, fuse 27, post 29 and resistor 46 to ground. This current melts fuse 27, releasing wheel 8 which rotates contactor 7 under the force of wound spring 20. Energized contactor 7 on wheel 8 switches current into the loads 43 consecutively as it touches contacts 6.

Figs. 6 through 11 illustrate another embodiment of the contactor. This embodiment operates in a straight line rather than in a rotary manner as the embodiment shown in Figs. 1 through 5.

This contactor may be described generally with particular reference to Fig. 6. A tube 50 formed of insulating material has a moving contact 51 which is drawn across a series of spaced fixed contacts 52 by the contraction of a spiral spring 54. Spiral spring 54 has one end attached by a clip 55 to one end of tube 50 and the other end attached by nut 57 to a rod 56 on which the moving contact 51 is mounted. Mounted beyond contact 51 on rod 56 is a slug 58 which slides along the inside of the tube as the contactor moves under the force of spring 54. Slug 58 is rotatably mounted on rod 56 between nuts 59 and 60. The radial position of slug 58 with regard to rod 56 is controlled by a radial follower pin 61 which moves in slot 62 in tube 50.

As slug 58 and contact 51 move along tube 50 due to the contraction of spring 54, the slug 58 is rotated from side to side by the zig-zag shape of slot 62. This changing direction of rotation of slug 58 requires a continuing acceleration force from spring 54 which slows down its contraction and thus tends to control the movement of contact 51.

Slug 58 is drawn from its position at the right-hand end of slot 62 to its position at the left-hand end of slot 62 by a suitable cord or wire 64 attached to an end nut 65 on rod 56. As slug 58 is drawn to the left-hand position, spring 54 attached to the nut 57 on the end of rod 56 is stretched to provide the force to return slug 58 to the right-hand end of slot 62 and at the same time to move movable contact 51 across fixed contacts 52 when slug 58 is released.

Slug 58 is held in position at the left-hand end of slot 62 against the force of spring 54 by a fuse link 66 which is connected between end nut 65 and a ground post 67 mounted on tube 50.

Moving contact 51 is made of a conducting material and is fitted within tube 50 to slide freely therein. It is tightly attached to rod 56, which is also made of conducting material, by nut 68. Contact 51 has a terminal pin 69 fitted into it to connect it with exterior circuits. Pin 69 slides in a slot 70 cut into the side of tube 50.

Fixed contacts 52 are mounted in spaced relationship along tube 50. A contact point 71 is held inside tube 50 in an aperture 72 (Fig. 10) by a resilient conducting mount 74. Mount 74 is spaced from tube 50 and held in position by washer 75 and screw 76. As moving contact 51 slides past contacts 52 when rod 56 is released, it contacts point 71 and forces it outwardly as mount 74 bends and allows contact 51 to slide past.

The electrical circuit for the embodiment shown in Figs. 6 through 10 is shown in Fig. 11. Battery 80 has one end grounded and has its other terminal connected through a switch 82 and wire 83 to terminal pin 69 on moving contact 51. Conducting rod 56 connects contact 51 to fuse 66 which is connected to ground through terminal 67. When switch 82 is closed, fuse 66 burns out, releasing rod 56 and thus allowing contact 51 to be moved to the right across contacts 52 by stretched spring 54. Loads 81 connected between contacts 52 and ground are connected to battery 80 as moving contact 51 passes fixed contacts 52. The length of time that the battery 80 is in contact with a load 81 is determined by

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the widths of contact 51 and points 71 of contacts 52, which may be varied as desired, and the speed of movement of contact 51. The speed of movement of contact 51 varies with the strength of the spring 54 and the mass of restraining slug 58. As noted above, the mass of slug 58 being rotated from side to side by pin 61 in slot 62 provides a drag force on the spring to control its retraction.

As seen in Fig. 6, the shape of the zig-zag slot 62 may be non-uniform. Slot 62 has the direction changes of the zig-zag progressively further apart towards its right-hand end which results in a decreasing acceleration of slug 58 from side to side. This compensates for the progressively reduced spring force as the spring contracts towards its unstretched position and tends to hold the axial rate of slug 58 along tube 50 more constant.

Similarly the shape of the zig-zag groove 34 on the embodiment shown in Figs. 1 through 5 may have a decreasing slope on the zig-zag pattern near the end of the turn of contact 7 to compensate for the reduced spring force as spring 20 unwinds.

The spacing of the contacts 52 on tube 50 or contacts 6 on board 1 may also be changed as desired to control the timing of the contactor. Thus, for example, the contacts 52 (Fig. 11) or 6 may be spaced progressively closer together to compensate for a reduction in the moving contact speed as the spring force decreases.

Operation

The circular contactor shown in Figs. 1 through 5 is connected into the circuit shown in Fig. 5 by connecting terminals 2 to one side of the respective loads 43. The other side of the loads are grounded. Terminal 12 is connected through open switch 44 and voltage source 45 to ground. Wheel 8 is moved to its starting position with contact 7 located between two contacts 6 as desired. A fuse link or fuse wire 27 is now connected between post 28 on wheel 8 and post 29 on board 1 to hold wheel 8 in position against the force of spring 20 as it is wound. Spring 20 is wound by rotating housing 22 in a clockwise direction on shaft 11 (Fig. 1) after loosening thumb screw 23. After housing 22 has been turned for one or more turns, thumb screw 23 is tightened leaving spring 20 in a wound condition. Fuse 27 is now connected to ground by connecting terminal 37 to ground through a current limiting resistor 46.

The contactor is now set into operation by closing switch 44 which melts fuse 27 and releases wheel 8. Wheel 8 is turned by spring 20 sweeping contact 7 over fixed contacts 6.

Where loads 43 are fuses or squibs or similar loads which are fired by a single shot of current, only one turn of wheel 8 is generally necessary, however even in this case additional turns are desirable to re-apply voltage to the contacts 6 in case one of the loads 43 fails to fire during the first rotation of contact 7. Where numerous turns are required, spring 20 is appropriately proportioned to provide the necessary force.

The embodiment shown in Figs. 6 through 11 is connected into the circuit shown in Fig. 11 by connecting terminal 69 to ground through open switch 82 and battery 80. Loads 81 are connected with one terminal of each connected to a terminal 52 and with their opposite terminals grounded. Cord 64 is now pulled to move rod 56 to the left and to thus move slug 58 and contact 51 to their starting positions. A fuse link 66 connected between rod 56 and terminal 67 holds rod 56 in its starting position with spring 54 stretched. Terminal 67 is connected to ground. Switch 82 is closed to connect fuse 66 with voltage source 80, causing fuse 66 to melt and rod 56 to be released. Moving contact 51 now moves across fixed contacts 52 to consecutively and momentarily connect loads 81 to the voltage source 80.

It will be seen that the present invention provides an improved electrical contactor of relatively simple con-

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struction which has a controlled action and a high current capacity. The simplified mechanical drive is readily manufactured and makes the contactor suitable for use in expendable applications. The contactor requires no external power aside from that distributed to the connected circuits and it has a positive and easily controlled trigger action which makes it especially adaptable for remote control. Additionally, the contactor is rugged and inherently free from the adverse effects of altitude, humidity, vibration and temperature.

As various changes may be made in the form, construction and arrangement of the parts herein without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim:

1. A contactor comprising the combination of a drive means, a moving contact operatively connected to said drive means, a plurality of spaced fixed contacts along the path of movement of said moving contact adapted to be contacted consecutively by said moving contact when it is moved by said drive means and a control means for said moving contact comprising a mass coupled to move with said moving contact, a cam having a generally zig-zag shape, and a cam follower for said cam connected to said mass to reciprocate it in accordance with the cam as said mass is moved with said moving contact whereby the force required to reciprocate said mass controls the rate of motion of said moving contact by said drive means.

2. A contactor comprising the combination of a drive spring, a moving contact driven by said spring, a plurality of fixed contacts spaced along the path of movement of said moving contact adapted to be contacted consecutively by said moving contact when it is driven by said drive spring and a control means for said moving contact comprising a mass operatively coupled to said spring to move with said moving contact, a cam having a generally zig-zag shape, and a cam follower for said cam connected to said mass to reciprocate it in accordance with the cam as said mass is moved along the cam and with said moving contact whereby the force required to reciprocate said mass controls the rate of movement of said moving contact.

3. The contactor as claimed in claim 2 in which the spacing between a first fixed contact and the next succeeding one is greater than that between the said first contact and the preceding one to compensate for the decreasing rate of movement of said moving contact.

4. The contactor as claimed in claim 2 in which the curvature of said zig-zag cam is continually decreased to reduce the reciprocation rate of said mass as said drive spring moves said cam follower from one end of said cam to the other.

5. An electrical contactor comprising a mounting board of insulating material, a conducting shaft fixedly mounted on said board and projecting therefrom for mounting a rotating contact, a plurality of fixed electrical contacts spaced on said board around said shaft and connected to terminals on said board, a rotating contact mounted on said shaft which successively touches said fixed contacts during rotation about said shaft and electrically connected to a terminal on said board through said shaft, a spiral drive spring for said rotating contact positioned around said shaft having one end connected thereto and the opposite end connected to said rotating contact whereby said spring will rotate said rotating contact in one direction after being wound in the opposite direction by relative rotation between said rotating contact and said shaft, a slug loosely mounted on said shaft for both rotary and radial motion with respect to said shaft and operatively connected to said rotating contact to rotate therewith, a cam slot in said board surrounding said shaft and having a generally wavy path,

and a cam follower for said cam slot mounted on said slug whereby said slug is reciprocated in a radial direction by said cam slot as it rotates about said shaft.

6. The contactor as claimed in claim 5 in which said spring is connected to said shaft by a housing mounted for rotation on said shaft and removably fixed thereto whereby said spring may be wound by rotation of said housing about said shaft while said rotatable contact is held stationary.

7. The contactor as claimed in claim 6 in which said rotating contact has a first conducting fuse mounting post electrically connected to said rotating contact and in which said board has a second conducting fuse mounting post fixedly mounted thereon and connected to a terminal whereby said rotating contact may be restrained from rotation by said spiral spring by a fuse link connected between said first and second posts and whereby said rotating contact may be released by melting the fuse link by a current passed between said rotating contact and said terminal connected to said second post.

8. The contactor as claimed in claim 5 in which said fixed contacts are spaced in a pattern in which beginning with a starting contact the contacts are spaced progressively closer together whereby as said rotating contact is moved across said fixed contacts by said spring and beginning at said starting contact the decreased contact spacing compensates for the winding down of said spring.

9. An electrical contactor comprising an elongated support means, a plurality of fixed contacts spaced along said support means, a moving contact slidably mounted to move along said support means and to consecutively contact said fixed contacts, an elastic means connected between said moving contact and a first end of said support means to return said moving contact across said fixed contacts to a position adjacent to the first end of said support means after it has been moved toward the second end of said support means by stretching said elastic means, a slug operatively connected to move along said support means with said moving contact and rotatably mounted for rotation laterally with respect to said support means, a generally zig-zag cam running along said support means and a cam follower for said cam on said slug whereby said slug is reciprocally rotated as it moves lengthwise of said support means with said moving contact and whereby the force required to rotate said slug controls the rate of said moving contact.

10. The contactor as claimed in claim 9 in which said slug is electrically connected to said moving contact and in which a fuse mounting terminal is fixed on said support means adjacent to the second end whereby a fuse wire connected between said fuse mounting ter-

minal and said slug to hold said elastic means in a stretched position may be melted by current passing between said moving contact and said fuse mounting terminal to release said moving contact.

11. The contactor as claimed in claim 9 in which the spacing between said fixed contacts is progressively decreased in the direction of the first end of said support means.

12. The contactor as claimed in claim 9 in which the zig-zag shape of said cam is smoothed out as the cam approaches the first end of said support means.

13. The contactor as claimed in claim 9 in which said support means is a tube and in which said moving contact and said slug are shaped to slide within said tube.

14. A control mechanism comprising a spring motor, a driven member operatively connected to said spring motor and mounted for motion in a first direction, a mass operatively connected to said driven member and movably mounted for motion in said first direction with said driven member and mounted for reciprocal motion in a second direction during motion in said first direction, an elongated cam surface having a generally zig-zag shape, and a cam follower connected to said mass and engageable with said cam surface to impart the reciprocal motion to said mass in the second direction as the motion of the mass in the first direction moves said cam follower along the cam surface.

15. The control mechanism as claimed in claim 14 in which said driven member comprises a rotatable shaft, said elongated cam surface comprises a closed path around said shaft, and said mass comprises a slug operatively connected to said shaft to rotate therewith while said cam follower reciprocates it radially of the rotatable shaft.

16. The control mechanism as claimed in claim 14 in which said driven member is mounted for motion along a generally straight path, said zig-zag shaped cam surface extends along the straight path, and said mass is mounted for reciprocal rotary motion about an axis corresponding to the straight path.

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