Jan. 21, 1941. L. F. LITTWIN 2,229,104

DEMAGNETIZER

Filed May 25, 1938 2 Sheets-Sheet 1

Fig. 1

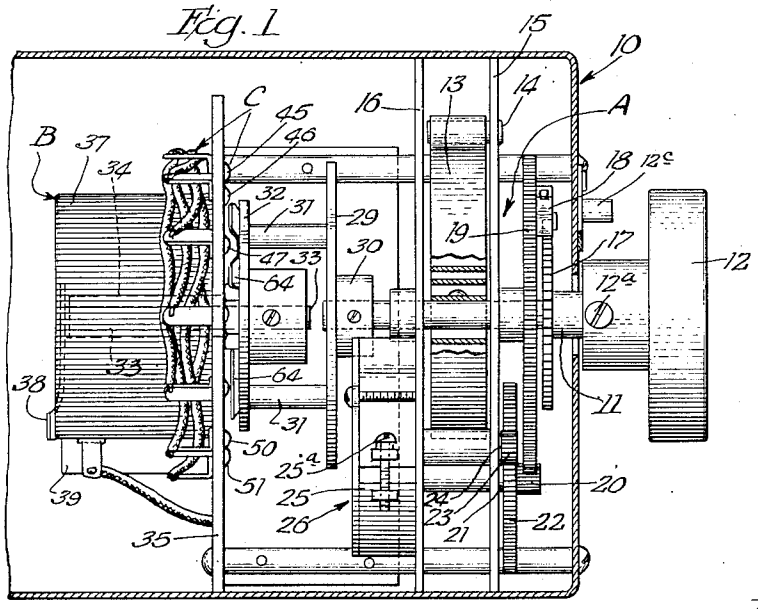

Fig. 4

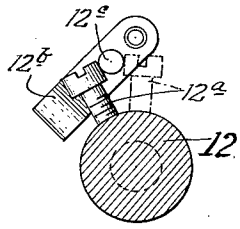

Fig. 2

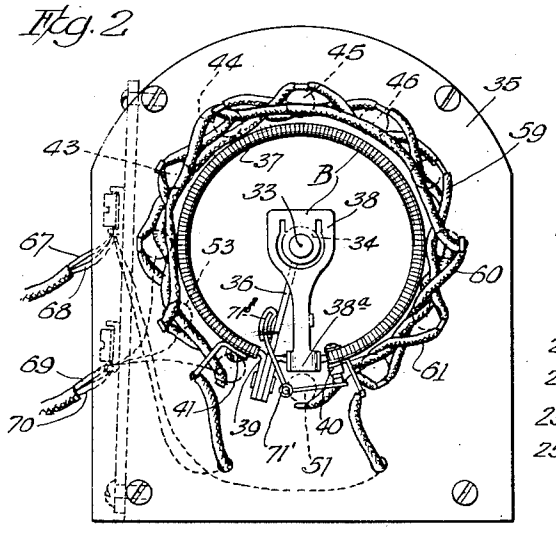

Fig. 3

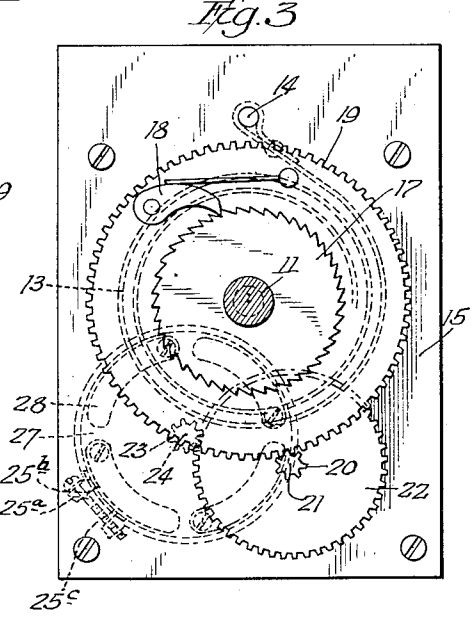

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Fig. 5

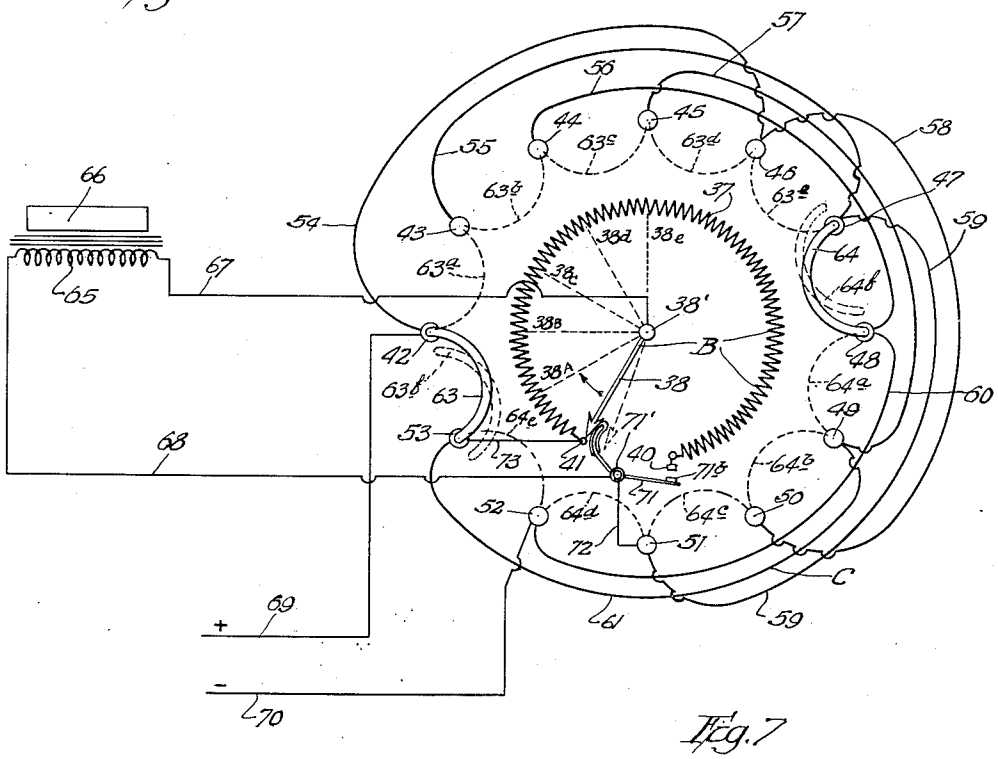


Fig. 7

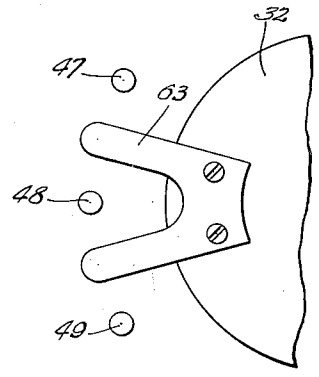
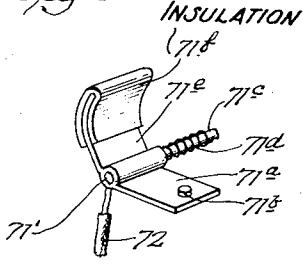


Fig. 6



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UNITED STATES PATENT OFFICE

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DEMAGNETIZER

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Application May 25, 1938, Serial No. 209,891

4 Claims. (Cl. 175—181)

This invention relates to improvements in demagnetizing devices adapted for use in removing residual magnetism from electromagnets as magnetic chucks and work pieces on such chucks, for example.

In the use of magnetic chucks for holding pieces of iron or steel during a milling, grinding or like machine operation, the residual magnetism of the chuck and of the work pieces frequently render the removal of the work pieces difficult. Some workmen resort to a sliding movement in removing such work pieces, thus abrading the face of the chuck and sometimes scratching the work pieces.

For the purpose of dissipating such residual magnetism, it is more or less common to use a simple reversing switch which, when manually closed, causes current of the same strength as the original current to flow through the magnet winding in a direction opposite the direction of flow of the original current. The result of such reversal of polarity of the magnet is not as satisfactory as is desirable since it is practically impossible to time the duration of such reversed current so accurately as to dissipate the original residual magnetism completely without building up magnetism of the opposite polarity which likewise renders the removal of the work pieces difficult.

It is an object of the present invention to provide a device which will automatically effect the demagnetization of an electromagnet, such as a magnetic chuck and work piece or other magnetized article, by means of a series of current impulses which pass through the magnet windings in consecutively opposite directions for reversing the polarity of the magnet and of regularly decreasing strength from the maximum value to a value where it can no longer effectually energize the magnet.

Another object of the invention is to provide a demagnetizing device which not only effects alternations in the direction of flow and the value of the current impulses which dissipate the residual magnetism but time-spaces such impulses to afford suitable intervals for the self-induced voltage of the magnet coils to be dispelled after each break of the magnetic circuit.

In the drawings:

Fig. 1 is a vertical section through a casing of a device embodying the present improvements and showing the device in broken elevation;

Fig. 2 is a front plan view of the device;

Fig. 3 is a rear plan view thereof;

Fig. 4 is a detail view showing means for retaining the device in wound-up or circuit-closing position;

Fig. 5 is a diagrammatic view of certain of the circuits of the apparatus;

Fig. 6 is a broken detail view of a switch which controls the flow of current through the voltage reducing means; and

Fig. 7 is a detached broken view of the rear of disc 32 illustrating one of the bridging members thereon.

In Fig. 1 of the drawings, a casing 10 of any suitable construction is shown which houses the demagnetizing apparatus. The mechanism shown comprises a shaft 11 having an operating knob 12 at one end thereof, which shaft is arranged for manually energizing the operating mechanism of the device. This operating mechanism may comprise a coil spring 13 attached at one end to the shaft 11 and at the other end to a pin 14 carried by a transverse supporting plate 15. The shaft passes through the plate 15 and a second similar supporting plate 16. Mounted on the shaft for rotation therewith is a ratchet 17 which cooperates with a spring pressed pawl 18 secured to a face of a gear 19 which is relatively free on the shaft 11 when the latter is rotated in a direction to wind up the spring. Meshing with the gear 19 is a pinion 20 mounted on a stub shaft 21 which is supported by the plates 15 and 16. On shaft 21 is a gear 22 which meshes with and rotates a pinion 23 on shaft 24 which extends into the interior of a stationary drum 25 which constitutes the casing of a governor indicated generally by the numeral 26. The governor is attached to the plate 16. Within the drum 25 of the governor is a disc 27 which is secured to the shaft 24 and is rotatable therewith, said disc being provided with a plurality of friction members 28 pivoted to the disc and which are arranged to be forced by centrifugal action against the inner surface of the drum for controlling the driving action of the spring 13 and consequently of the shaft 11.

As shown in Fig. 3, when the shaft 11 is rotated by means of the knob 12 in a clockwise direction as viewed in Fig. 3, the pawl 18 will click over the teeth of the ratchet 17, thereby winding the spring 13. Unless restrained by means hereinafter referred to, the spring will, when the knob has been released, rotate the shaft 11 in counter-clockwise direction whereby the ratchet will drive the pawl and the pawl in turn effect rotation of the gear 19 and the gear train comprising pinion 20, gear 22 and pinion 23, thereby rotating the shaft 24 at a relatively high velocity

and causing the friction members to bear against the inner surface of the drum and retard the rotation of the shaft 11 in the counter-clockwise direction. The spring driving mechanism above described and which is energized by means of the knob or handle 12 constitutes the actuating mechanism of the device and is indicated generally by the letter "A."

In the embodiment of the invention illustrated, the inner end of the shaft 11 carries an insulating disc 29 secured thereto as by means of a collar 30 and is in turn connected by means of spacing pins 31 with a second insulating disc 32 mounted on a shaft 33 which is journaled in a sleeve 34 carried by a transverse plate 35 of insulating material.

Supported by a radial arm 36 of the sleeve 34 is a resistor or potentiometer 37, the resistor being secured concentrically of the shaft 33. The forward end of said shaft carries a conducting arm 38 having a contact end 38*a* arranged to contact the resistor during the rotation of the shaft, the shaft being driven from shaft 11 by means of the insulating discs 29 and 32 and the interposed spacer pins 31. The resistor comprises a core 39 around which is wound numerous turns of wire as will be understood, the wire being connected at its ends to terminals 40 and 41 as shown in Fig. 2. The resistor 37 and the rotatable arm 38 constitute means B for reducing the value of the current supplied to the magnet windings during the demagnetizing operation as will be explained more fully hereinafter.

Cooperating with the portions A and B of the apparatus are means C for effecting consecutive reversals of polarity of a magnet electrically connected with the improved demagnetizing device, such means comprising a plurality of contacts 42—53, carried by the plate 35, jumpers or tap connectors 54 to 61, inclusive, and a pair of bridging members 63 and 64 carried by the insulating disc 32 and arranged to connect certain pairs of the contacts 42 to 54 in predetermined circuits through certain of the wires 54—61 which so deliver current to the magnet as to effect successive reversals of its polarity. During such reversals of direction of current flow, the means B operates to effect reduction in value of the current surges delivered by means C for dissipating the residual magnetism which remains after each such surge except the latter which is so reduced in value as to be incapable of effectually energizing the magnet windings and serves merely to dissipate the residual magnetism induced by the previous surge. This leaves the magnet and a work piece thereon so devoid of magnetism that the latter may be removed freely from the former.

In Fig. 5, the improved apparatus is illustrated diagrammatically in the circuit of an electromagnet such as an electro-magnetic chuck 65 having a work piece 66 in position thereon. In the preferred construction and arrangement of the improved device, it serves as a switch for controlling the flow of current to the magnet during the use of the same, and after such use and the completion of the operation of the device to remove the residual magnetism of the magnet and the work piece, holds the magnet circuit open.

The contacts 42 to 53, inclusive, are carried on the rear of the insulating plate 35 as shown in Fig. 1 and at the forward face of the plate are the jumper wires 54 to 61, inclusive, which connect certain of the contacts as shown in the circuit diagram of Fig. 5. The device is connected in the magnet circuit by wires 67 and 68 which lead from the arm terminal 38' and switch terminal 71', respectively. Direct current supply conductors 69 and 70 are connected to a contact 42 and to contact 52, respectively.

The switch 71 which is electrically connected to contact 51 by conductor 72 is illustrated more in detail in Fig. 6. The switch comprises a conducting blade 71*a* provided with a contact portion 71*b* adapted to make contact with contact 40 during the operation of the demagnetizing apparatus. The switch is provided with a pivotal mounting member 71*c* which may carry a coil spring 71*d* which urges the blade 71 into circuit closing relation with resference to the contact 40. A second arm 71*e* of the switch is insulated as at 71*f* and projects into a position adjacent the contact 41 where it may be engaged by the movable resistor arm 38 when in the position shown in Fig. 5 to effect separation of the contacts 40 and 71*b*.

In using a magnet equipped with the present improvements, the knob 12 is rotated in a clockwise direction as viewed in Fig. 3 to a position wherein a pin or screw 12*a* (see Figs. 1 and 4) passes over a spring catch 12*b* in the rear wall of casing 10 and against a stop 12*c*. The arm 38 will then have been moved from the position shown in Fig. 2 to the full line position of Fig. 5 while the bridging members 63 and 64 will have been moved to the full line position of Fig. 5. When the arm 38 is in the position shown in Fig. 5, the switch 71 is in open position, that is, it will have been swung by arm 38 out of contact with terminal 40.

Current from supply wire 69 can flow to contact 42, through the bridging member 63 to terminal 53, through conductor 73 which connects terminal 53 with contact 41, thence through the arm 38, conductor 67 to the windings of the magnet 65, thence through conductor 68 to the switch 71, from which it flows through the conductor 72 to contact 51. From contact 51, it flows through jumper 59 to contact 47, thence through bridging member 64 to contact 48 and from the latter through jumper 60 to terminal 52 and thence to the negative supply line 70.

Since the switch 71 is in the position of Fig. 5 while the arm 38 is in the position shown therein, no current flows through the resistor 37, the resistor circuit being open by virtue of the separation of contacts 40 and 71*b*.

The magnet is thus energized, the device acting as a switch for supplying current to the magnet, as will be seen, although the device may be used for demagnetizing a magnet, if desired, without utilizing the described features of the device as a switch for the magnet. After the machine operation on the work piece 66 of the chuck has been completed and the workman wishes to turn off the current and to demagnetize the magnet and the work piece, he rotates the knob 12 counter-clockwise as viewed in Fig. 4 sufficiently to move the locking pin 12*a* over the catch 12*b*, and then releases the knob. It will be understood that in turning the knob in a counter-clockwise direction to close the magnet circuit initially, the spring 13 was wound up and hence upon release of the pin 12*a* from the catch 12*b*, the actuating mechanism A including the gear train and the spring will rotate the shaft 11 and the shaft 33 in a counter-clockwise direction as viewed in Fig. 3 or clockwise as viewed in Figs. 2 and 5. This rotation is retarded by the governor 26 as above

described to provide current impulses and intervals therebetween of suitable duration.

Since the insulating disc 32 rotates with the shaft 33 and likewise the two diametrically positioned bridging members 63 and 64 carried by said disc, said bridging members will move from the full line position shown in Fig. 5 to the dotted line position shown in said figure and indicated by the reference characters 63*a* and 64*a*, respectively. In this position of the bridging members, they will bridge contacts 42 and 43 and contacts 48 and 49, respectively, this bridging action taking place only momentarily during the continuous movement of the disc 32 in a clockwise direction as viewed in Fig. 5. When the bridging members 63 and 64 move from the position shown in full lines in Fig. 5, the flow of magnetizing current through the magnet will be momentarily interrupted as will be seen due to the shape of said members as shown in Fig. 7. Upon the bridging members taking the positions 63*a*—64*a* of Fig. 5, current will pass through the coils of the magnet in a direction opposite the direction of the original demagnetizing current. This first surge of demagnetizing current through the magnet windings will be of slightly less voltage than the original current due to the fact that the voltage of that surge of current will have been reduced slightly by the fact that the arm 38 of the resistor 37 will have moved along the resistor to the dotted line position 38*a* when the bridging members 63 and 64 will have moved to the position 63*a*—64*a*.

Current will thus flow from conductor 69 to terminal 42, through the bridging member 63 in position 63*a* to contact 43, thence by jumper 55 to contact 47 and then by means of jumper 59 to contact 51 by conductor 72 to the switch terminal through conductor 68 to the magnet, through conductor 67 to the arm 38 in position 38*a*, through a portion of the resistor 37 between the end of the arm 38 and the contact 41 to the latter by conductor 73 to contact 53, through jumper 61 to contact 49, through bridging member 64 in position 64*a* to contact 48 and thence by jumper 60 to contact 52 and to the negative supply wire 70.

It will thus be seen that while the original magnetizing current entered the windings through conductor 67, the first surge of demagnetizing current entered in the opposite direction, namely, through conductor 68 as just described. That first surge of demagnetizing current was reduced somewhat in voltage but not sufficiently to preclude the dissipation of the residual magnetism of the magnet and the work piece and consequently it will have built up magnetism of the reverse polarity but of less magnitude than that of the original current.

As the bridging members 63 and 64 move from the positions 63*a*—64*a* to the dotted line positions 63*b*—64*b*, respectively, that first demagnetizing surge of current is broken by the bridging members, as will be seen, and a second surge is sent through the windings of the magnet but in a direction opposite to the direction of flow of the first demagnetizing surge. Thus, when the bridging members 63 and 64 are in positions 63*b* and 64*b*, respectively, and the conductor arm 38 has moved to the dotted line position 38*b*, current will flow from conductor 69 to contact 42, through jumper 54 to contact 46, through jumper 58 to contact 50, through bridging member 64 in position 64*b* to contact 49, through jumper 61 to contact 53, through conductor 73 to terminal 41, through the resistor 37 to the arm 38 in the position 38*b*, through conductor 67 to the magnet, thence through conductor 68 to the switch 71, through conductor 72 to contact 51, through jumper 59 to contact 47, through jumper 55 to contact 43, thence through bridging member 63 in the position 63*b* to contact 44, through jumper 56 to contact 48, thence through jumper 60 to contact 52 and to supply line 70.

Such second surge of current will thus be of reduced magnetude and in a direction opposite the direction of the first demagnetizing surge of current and will be of sufficient value to reverse the polarity of the magnetism of the magnet and the work piece and residual magnetism remaining after said second surge of current will be of reduced value.

When the bridging members have moved to the positions 63*c*—64*c*, respectively the arm 38 will have moved to the dotted line position 38*c*. This third surge of demagnetizing current will pass from conductor 69 to contact 42, through jumper 54 to contact 46, through jumper 58 to contact 50, through bridging member 64 in position 64*c* to contact 51, through conductors 72 and 68 to the magnet 65, thence through conductor 67 to the arm 38 in position 38*c*, through the resistor section lying between the arm 38 and the terminal 41 to the latter, through conductor 73 to contact 53, through jumper 61 to contact 49, through jumper 57 to contact 45, thence through bridging member 63 in position 63*c* to contact 44, through jumper 56 to contact 48 and thence by jumper 60 to contact 52 and to the negative supply wire 70.

When the bridging members 63 and 64 have moved to the respective positions 63*d*—64*d*, and the arm 38 has moved to position 38*d*, current flows from the positive line 69 to terminal 42, through jumper 54 to contact 46, through bridging member 63 in position 63*d* to contact 45, thence through jumper 57 to contact 49, then through jumper 61 to contact 53 and conductor 73 to the resistor terminal 41. It then flows through the resistor to contact arm 38 in position 38*d* and through conductor 67 to the magnet and thence through conductor 68 to the terminal of switch 71, conductor 72 to contact 51, thence through bridging member 64 in position 64*d* to contact 52 and to the negative supply line 70.

When the bridging members 63 and 64 have reached the positions indicated at 63*e* and 64*e*, current will flow from conductor 69 to contact 42, through jumper 54 to contact 46, through bridging member 63 in position 63*e* to contact 47, through jumper 59 to contact 51, thence by lead 72 to the terminal switch 71, conductor 68 to the magnet windings, thence through conductor 67 to the arm 38 in position 38*e* to the resistor 37. From resistor 37 current flows through conductor 73 to contact 53, thence through bridging member 64 in position 64*e* to contact 52 to the negative supply line 70. The next surge of current through the magnet windings will take place when bridging member 64 is in the position of bridging member 63 as shown in full lines in Fig. 5 and bridging member 63 is in the position of bridging member 64 in said figure. The circuit by means of which the impulse of current is directed in proper direction through the magnet windings while the bridging members are in said position was described above in describing the initial demagnetizing surge of the apparatus. The circuits by means of which the remaining demagnetizing surges are set in their proper directions through the magnet correspond respectively to the circuits traced in de-

scribing the positions of the bridging members in positions 63*a*, 64*a*, 63*b*, 64*b* and so forth.

The circuit as shown in Figure 5 is such that the resistor 37 is shunted across the magnet leads 67 and 68 as the arm 38 moves clockwise during the demagnetizing operation. The constantly decreasing portion of the resistor between the moving arm 38 and the contact 40 remains in shunt relation with respect to the magnet windings as the circuit is broken intermittently by the movement of the bridging members 63 and 64 from the respective contacts 42 to 53, inclusive. Each such break of the circuit tends to induce a relatively high voltage in the magnet windings, the residual magnetism of which would not be dispelled by the succeeding demagnetizing surge of current. In fact, upon such interruptions of the circuit the induced voltages in the magnet windings generally would be seven or eight times the normal voltage and would be of a polarity opposite that of the interrupted current and therefore would be the same as that of the succeeding surge of demagnetizing current and hence would not be dissipated by such succeeding surge, nor by the lower induced voltage following that succeeding surge. By shunting the magnet windings by the resistor coil 37, however, this induced voltage is suppressed or dissipated so that its remagnetizing effect is less than that of the succeeding surge of demagnetizing current. It will be seen that as the voltage of the demagnetizing surge is decreased by the movement of the arm 38 clockwise, as viewed in Figure 5, the portion of the resistor 37 that is shunted across the magnet windings is decreased in like ratio and that the operation of the device in suppressing or dissipating induced voltages and thereby preventing remagnetizing by such induced voltages is effective throughout the voltage range of the demagnetizing surges.

When the arm 38 has reached the position shown in Fig. 2, in which position it is out of contact with the resistor 37, the rotation of the operating mechanism will be halted by the engagement of the screw 12*a* with the stop pin 12*c* as shown in dotted lines in Fig. 4. The circuit through the demagnetizing device as well as through the magnet will be open since in such position of the arm 38, the bridging member 63 will be in the position indicated at 63*f* while bridging member 64 will be in the position indicated at 64*f*. The apparatus thus constitutes an automatic switch shutting off current not only to the magnet but to itself upon the delivery of the last demagnetizing surge of current to the magnet.

Since the several surges of demagnetizing current pass through the magnet in successively opposite directions and are of reduced value due to the voltage dividing action of the resistor 37 and the arm 38, the work piece 63 will not be retained by the magnet due to the dissipation of the residual magnetism of the magnet and the work piece. The constant stepping down of the value of the demagnetizing surges of current is such that each successive surge dissipates the residual magnetism of the previous surge and leaves residual magnetism of reduced value. The last surge through the current is of such reduced value as to be incapable of building up any substantial magnetism and hence, at its termination, leaves the magnet and the work piece demagnetized.

The duration of the demagnetizing surges of current of successively opposite directions is controlled by the governor 26 by reason of the fact that the governor controls the velocity of movement of the shaft 23 and of the bridging members 63 and 64. The duration of the surges as well as the intervals therebetween can be varied, if desired, by adjusting the governor by any suitable means such as by contracting or expanding the drum 25 by adjusting screw 25*a*, the drum having overlapping ends as shown at 25*b*, 25*c* in Fig. 3.

The device is adapted to be mounted on or adjacent a magnet to be controlled thereby and in the embodiment illustrated, serves as a switch for sending energizing current through the windings of the magnet preparatory to use thereof. During such use, no current flows through the resistor 37, and hence, the full available voltage of the supply line is applied to the magnet windings. Since the act of closing the magnet circuit by turning the knob 12 counter-clockwise to the position shown in Fig. 5, as above described, winds up the spring 13, the device is ready for demagnetizing action by releasing the catch member 12*a* upon completion of the use of the magnet for holding a work piece. As the resistor contact arm 38 moves under the action of the timing or actuating means A, the voltage of the successive demagnetizing surges is reduced in the proportion that the arm has traveled along the resistor from the full line position shown in Fig. 5 to the final position shown in Fig. 2, that is, if the voltage drop along the resistor from contact 41 to contact 40 is 110 volts, the voltage of successive demagnetizing surges will drop proportionately, that is, the first surge will be at slightly less than 110 volts and the last surge will be so feeble as to be incapable of effectually re-energizing the magnet but only sufficient to dissipate any magnetism remaining from the previous surge.

The timing of the intervals between the successive surges as controlled by the governor 26 is important in that it enables the self-induced voltage occurring in the winding upon each break of the circuit to be dissipated prior to the occurrence of the next successive demagnetizing surge.

I claim:

1. Apparatus for demagnetizing an electromagnet comprising means for delivering to the magnet intermittent surges of current of consecutively opposite polarity for effecting corresponding reversal of polarity of the magnet, means operable concurrently with said reversing means for decreasing the strength of each successive surge of current and comprising a resistor shunting the magnet, the effective portion of which resistor decreases by decrements to suppress the voltages induced by the breaking of the current delivering means, means for actuating said reversing and reducing means, and governing means for controlling the actuation of said actuating means.

2. Apparatus for demagnetizing an electromagnet comprising means for delivering to the windings of the magnet a series of intermittent surges of current of consecutively opposite polarity, means for reducing the magnitude of each successive surge of current and comprising a resistor shunting the magnet windings between successive demagnetizing surges to prevent remagnetization of the magnet by voltages induced by the breaks in the demagnetizing current, and timing means for regulating the action of said

surge delivering means for controlling the duration of and intervals between said surges.

3. Apparatus of the class described comprising power actuating means, means actuated thereby for delivering successive surges of current to a magnet in opposite directions for reversing the polarity thereof comprising a plurality of conductors and rotary circuit make and break means cooperating therewith, and means comprising a resistor shunting the magnet windings and a conductor movable over the resistor by said actuating means for reducing the value of said successive surges of current by predetermined decrements and simultaneously reducing the effective length of the shunting resistor.

4. Demagnetizing apparatus for an electromagnet adapted to be electrically connected therewith comprising a rotary actuating means comprising a governor for timing the operation thereof, circuit make and break means comprising a plurality of circuit contacts and movable bridging means operable by said actuating means into successive engagement with said contacts for establishing intermittent circuits for delivering surges of current through the windings of the magnet of a duration and at intervals predetermined by said governing means, and means for controlling the magnitude of said successive surges of current and for suppressing voltages induced by the successive interruptions of the demagnetizing current comprising a resistor shunting the magnet windings and a relatively movable cooperating arm actuated by said actuating means.

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