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MOTOR CONTROL FOR CONTACT ADJUSTING MACHINE

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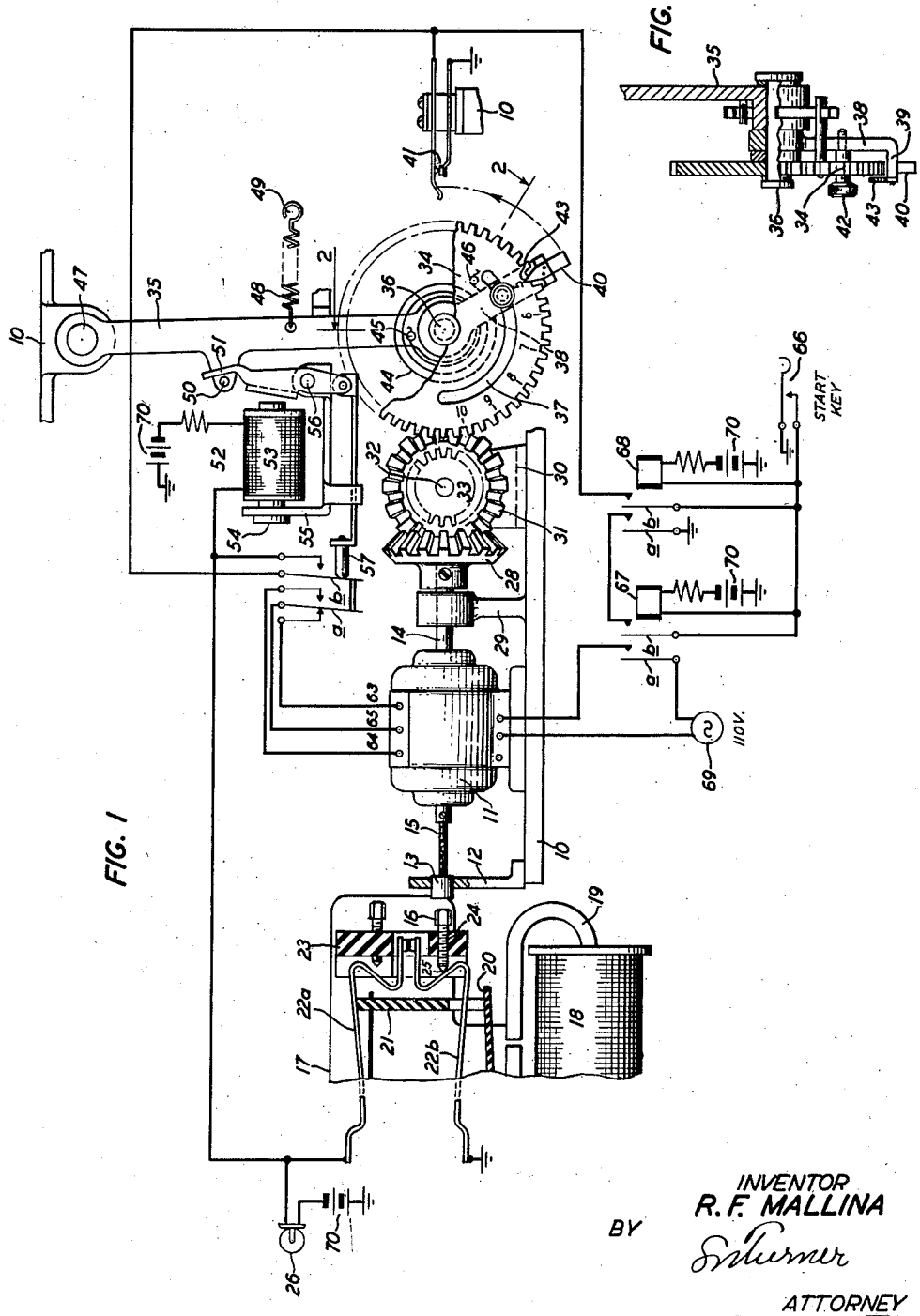

FIG. 1

FIG. 2

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MOTOR CONTROL FOR CONTACT ADJUSTING MACHINE

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This invention relates to contact adjusting machines and more particularly to machines for adjusting the separation between relay contacts.

An object of the invention is to accurately adjust the contact separation between cooperating pairs of springs on relays.

Another object of the invention is to adjust contacts simply and easily without regard to the disposition of the springs of a cooperating pair when a relay is assembled.

Yet another object of the invention is to automatically adjust contact separation to a preselected value.

A particular object of the invention is to place the entire adjustment of relay contact separation under the accurate control of an automatic machine.

A feature of the invention resides in the technique of using the engagement of the cooperating contact surfaces as a reference point of departure to obtain a preselected contact separation.

Another feature of the invention involves the use of detecting means which is connectable, when a pair of contacts engage, to the means provided for rotating a threaded member, such as a machine screw, to measure the number of degrees the rotating means has rotated with respect to the reference point of departure.

Yet another feature of the invention pertains to the provision of a scale whereby these degrees of rotation are correlated with the separation between cooperating contact springs so that a preselected amount of contact separation may be chosen.

Still another feature relates to the provision of circuitry for automatically bringing the contacts together by causing the rotating means to turn in one direction, reversing the direction of rotation and connecting the detecting means to the rotating means when the contacts come together, and interrupting the circuit when a preselected separation has been obtained.

More particularly, a feature of the invention entails, in combination, a reversible electric motor and a cooperating flexible shaft screwdriver capable of engaging a threaded member such as an adjusting screw, means for causing the motor to rotate in one direction to close the contacts, a gauging gear connectable to the motor shaft, means for reversing the direction of rotation of the motor and connecting the gauging gear to the motor when the contact surfaces of the cooperating pair of springs come together, and a measuring bar working cooperatively with the gauging gear and correlated with the lead of the adjusting screw to measure a preselected separation between the contacts.

Generally speaking the adjustment of relay contacts, including those employing the camming action of machine screws, is attained by using gap plugs premachined to various thicknesses or by using visual or manual estimation. While such methods are ordinarily satisfactory in cases where accurate contact separations are not required, they are less than satisfactory in many other situations. Two basic purposes of adjusting relay contacts by the camming action of machine screws are to secure a simple means of adjustment which does not require that the contact springs be deformed by some adjusting tool or by hand and to provide an adjustment less likely to change over a long period of time. These purposes are attained by using screw adjusted relays. Where close tolerances between the contact surface are desired, gap plugs and the like have definite drawbacks. For instance, the contact springs in many cases may be overstressed against a gap plug in situ and thus, when the plug is removed, the springs assume unrestrained positions closer to one another than that desired.

The instant invention overcomes such objections by providing an apparatus which automatically moves a pair of contact springs to contact each other irrespective of their assembled positions and then separates their contact surfaces a preselected amount.

A plurality of adjusting machines in accordance with the instant invention may be provided whereby a plurality of contact pairs may be adjusted simultaneously, even to different separations. This renders it economically possible and technically feasible to mass adjust all of the contacts on a relay at one time.

The foregoing and other objects and features of the invention will be more clearly understood when the following detailed description of the instant apparatus is read with reference to the drawing in which:

Fig. 1 is an electromechanical schematic representing a preferred embodiment of the adjusting machine; and

Fig. 2 is a partial cutaway view through section 2—2 of Fig. 1.

Referring to the drawing, the apparatus for automatically adjusting contact separations comprises a frame **10** upon which is fixedly mounted a reversible motor **11**. Also mounted on frame **10** is an upstanding portion **12** which supports a screwdriver receptacle **13** which is attached by a flexible connector **15** to one end of the shaft **14** of motor **11**.

The screwdriver receptacle **13** is mounted adjacent an adjusting machine screw **16** (which of course may be any suitable threaded member and not necessarily and specifically a machine screw as such) of one embodiment of a machine adjustable relay **17**. A portion of relay **17** is shown which includes a coil **18** and core piece **19** magnetically cooperating with an armature **20**. Card **21** is movable in a downward direction upon the energization of coil **18** and the resultant downward movement of armature **20**. Hence, relay **17** operated allows upper contact spring **22***a*, which is biased in a downward direction, to approach lower contact spring **22***b*. The machine screw **16** is threadedly retained in a fixed card **23** having therein a series of threaded apertures **24**. It will be noted that if machine screw **16** is turned in a clockwise direction (when looking at the head of the screw) its opposite end portion or camming surface **25** will increasingly bear on spring **22***b* due to the peculiar configuration of the spring. This has the effect of overcoming the bias of spring **22***b* in an upward direction and therefore forces it downwardly to increase the separation between the cooperating surfaces of springs **22***a* and **22***b*. This occurs because movable card **21** holds spring **22***a* a fixed distance away from the core **19** so long as the relay is unoperated. On the other hand, when screw **16** is turned in a counterclockwise direction its camming surface **25** releases the lower spring **22***b* thereby allowing it to move upwardly due to its biasing.

Fixedly attached to the other end of the motor shaft **14**, opposite the flexible connector **15**, is a bevel gear **28**. This other end of shaft **14** is rotatably supported by an upstanding portion **29** which is fixedly attached to frame **10**. Also mounted on frame **10** is a support bracket **30** for a second bevel gear **31**, which meshes with bevel

gear 28 and which is rotatably mounted on shaft 32 at right angles to motor shaft 14. Also mounted on shaft 32 is a pinion 33. Pinion 33 is fixedly attached to bevel gear 31 and is capable of meshing with gauging gear 34.

Gauging gear 34 is mounted on shaft 36 at the lower end of hanger 35. Gauging gear 34 is a large spur gear having the same diametral pitch and pressure angle as that of pinion 33 and also having an arcuate aperture 37 therein. Cooperating with the gauging gear 34 is a selecting bar 38 which is mounted on common shaft 36. The selecting bar 38 is mounted behind gauging gear 34 and extends beyond the radius thereof, and has an L-bend 39 (Fig. 2) at its outer end as well as an extension 40 capable of engaging breaker points 41 if selecting bar 38 is rotated far enough in a specified or counterclockwise direction. The selecting bar 38 has a threaded aperture therein which is in line with the arcuate aperture 37 in gauging gear 34. A locking screw 42 extending through the arcuate aperture 37 is threaded into the selecting bar 38. The L-bend 39 of the selecting bar 38 supports a dial pointer 43 which cooperates with a scale adjacent the arcuate aperture 37 on gauging gear 34.

This scale is marked off in mils and the divisions have been correlated with the degrees of rotation in a specified direction of gauging gear 34 from a normal position (hereinafter defined) to indicate separation between contacts associated with springs 22*a* and 22*b*. Selecting bar 38 may be locked in fixed relation to gauging gear 34 by lock screw 42 after dial pointer 43 is set on a desired contact separation in mils. Hence, with the selecting bar 38 locked to the gauging gear 34, said gauging gear in its normal position, the arcuate distance between the extension 40 and the breaker points 41 equivalent to the contact separation desired.

The gauging gear 34 is biased to maintain this normal position by an "unwound" clock spring 44 encircling shaft 36. One end of the spring is fixedly retained at point 45 on hanger 35 and the other end is retained at point 46 on gauging gear 34. Thus, if gauging gear 34 is turned in a specified or counterclockwise direction by an external turning force, the coil spring 44 stores energy to return it to its normal position when the force is removed.

The hanger 35 is pivotally mounted on shaft 47 which is supported by frame 10. Spring 48 is fixedly retained at one end by pin 49 attached to frame 10 and at its other end by hanger 35. It biases the hanger 35 to prevent gauging gear 34 from meshing with pinion 33 in the absence of some positive external force on the hanger 35. A projection 50 on hanger 35 and engageable by the armature 51 of a relay 52 provides the means for applying this positive external force whenever relay 52 is operated.

The relay 52, in addition to armature 51, comprises a coil 53, core 54, and return path and armature support 55. Armature 51 bears against projection 50 on hanger 35 and is pivoted at point 56 on armature support 55.

Armature 51, operated, not only applies a positive force to hanger 35 to move gauging gear 34 into engagement with pinion 33, but displaces contact stud 57 thereby allowing the swingers *a* and *b* associated with relay 52 to engage their respective make contacts (to the right of the swingers). Of course, upon swinger *a* engaging its make contact, the connection between the swinger *a* and its back contact (to the left of the swinger) is broken.

Motor 11 has a first and a second winding whose separate terminals are 63 and 64, respectively, and whose common terminal is 65. The energization of only the first winding (by placing a shunt across terminals 63 and 65 through back contact and swinger *a* of relay 52) causes the shaft 14 to rotate screwdriver receptacle 13 in a counterclockwise direction, which in turn causes machine screw 16 to move to the right to permit spring 22*b* to approach spring 22*a*; whereas, the energization of only the second winding (by placing a shunt across terminals 64 and 65 through front contact and swinger *a* of relay 52) causes the motor 11 to rotate in a clockwise direction thereby making camming surface 25 of machine screw 16 displace contact spring 22*b* in a direction away from contact spring 22*a*.

The circuit for automatically operating the adjusting machine heretofore described structurally comprises, additionally, a start key 66, relays 67 and 68 with associated swingers *a* and *b*, respectively, a source of alternating-current power 69, a source of direct-current power 70 and an indicating light 26. In considering the operation of this circuit the sequence of events is as follows:

Upon the temporary closure of start key 66, ground is supplied through the start key to one side of relays 67 and 68, thereby completing their respective operating circuits including direct-current battery 70. Relay 68, upon operating, establishes a lock-up path through its swinger *b* and breaker points 41 to ground. Relay 67, operated, establishes a lock-up path through its swinger *b* and swinger *a* of relay 68 to ground and also applies alternating current from source 69 to motor 11 through its swinger *a*.

Motor 11, energized, turns shaft 14 in a counterclockwise direction because terminals 63 and 65 are bridged by way of the break contact associated with swinger *a* of relay 52, the relay being in a released condition. Motor 11 rotates flexible connector 15 and screwdriver receptacle 13 until machine screw 16 has been withdrawn to the right to such a degree that contact springs 22*a* and 22*b* contact each other.

Upon engagement of the contact surfaces of springs 22*a* and 22*b*, ground is supplied through these contact springs to one side of coil 53 of relay 52, thereby completing a circuit for relay 52 including battery 70. Relay 52, in operating, transfers the shunt from the counterclockwise terminals 63 and 65 on motor 11 to the clockwise terminals 64 and 65 by way of swinger *a* and its front contact and, at the same time, establishes a locking path for itself through swinger *b* and its front contact and breaker points 41 to ground. Also, when relay 52 operates, the upper projection of armature 51 engages pin 50 on hanger 35 and displaces hanger 35 to the left until its associated gauging gear 34 meshes with pinion 33. As a result, when motor 11 begins to turn in a clockwise direction, adjusting screw 16 not only increasingly separates contact springs 22*a* and 22*b* from one another, but gauging gear 34 rotates in a specified or counterclockwise direction from its normal biased position with respect to the hanger 35. Gauging gear 34 continues to rotate until the outermost end 40 of measuring bar 38, which has been preset to a desired contact separation, separates breaker points 41.

When breaker points 41 are separated, holding ground is immediately removed from relays 52, 67 and 68. Removal of holding ground from relay 52 allows spring 48 to return hanger 35 to its equilibrium position which, by disengaging pinion 33 and gauging gear 34, allows gauging gear 34 to resume its normal position with respect to hanger 35 under the action of coiled spring 44. The removal of holding ground from relay 68 allows it to release. Relay 68, released, interrupts the holding ground of relay 67 which in turn releases. Therefore, as a result of the interruption of breaker points 41, relays 52, 67 and 68 release returning the adjusting machine to normal until such time as start key 66 is again depressed.

It is, of course, apparent that the heretofore described adjusting machine can be used to advantage in adjusting any relay which utilizes the camming action of a machine screw to obtain a selected contact separation. The machine is in no way restricted to adjusting relays similar in construction to the one disclosed in the preferred embodiment, it being merely illustrative.

Further, it is to be understood that the above-described apparatus and arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In a machine for adjusting a pair of contacts, a device movable in one manner to cause said contacts to move towards each other and movable in another manner to cause said contacts to move away from each other, means for causing said device to move in said one manner, detecting means to detect the amount of movement of said device, means responsive to a closure of said contacts to cause said device to move in said other manner, and means responsive to a preselected amount of movement in said other manner, as detected by said detecting means, to stop said other movement.

2. In a machine for adjusting a pair of contacts, a device movable in one direction to cause said contacts to move towards each other and movable in another direction to cause said contacts to move away from each other, means for causing said device to move in said one direction, detecting means to detect the amount of movement of said device, means responsive to a closure of said contacts to cause said device to move in said other direction, and means responsive to a preselected amount of movement in said other direction, as detected by said detecting means, to stop said other movement.

3. In a machine for adjusting a pair of contacts, a device movable in one direction to cause said contacts to move towards each other and movable in an opposite direction to cause said contacts to move away from each other, means for causing said device to move in said one direction, detecting means associable with said device to detect the amount of movement of said device, means responsive to a closure of said contacts to cause said device to move in said opposite direction and to associate said detecting means therewith, and means responsive to a preselected amount of movement in said opposite direction, as detected by said detecting means, to stop said opposite movement.

4. In a machine for adjusting a pair of contacts, a rotatable device, means operable by said device to cause said contacts to move towards each other when said device rotates in one direction and to cause said contacts to move away from each other when said device rotates in the opposite direction, means for causing said device to rotate in said one direction, detecting means to detect the amount of rotation of said device, means responsive to the closure of said contacts to cause said device to rotate in said opposite direction, and means responsive to a preselected amount of opposite rotation of said device, as detected by said detecting means, to stop said opposite rotation.

5. In a machine for adjusting a pair of contacts, a rotatable device, means operable by said device to cause said contacts to gradually move towards each other when said device rotates in one direction and to gradually move away from each other when said device rotates in the opposite direction, means for causing said device to rotate in said one direction, detecting means connectable to said device to detect the amount of rotation of said device, means responsive to the closure of said contacts to cause said device to rotate in said opposite direction and to connect said detecting means thereto, and means responsive to a preselected amount of opposite rotation of said device, as detected by said detecting means, to stop said opposite rotation.

6. In a machine for adjusting a pair of contacts, a rotatable device; means operable by said device to cause said contacts to gradually move towards each other when said device rotates in one direction and to cause said contacts to gradually move away from each other when said device rotates in the opposite direction; means for causing said device to rotate in said one direction; detecting means associable with said device to detect the amount of rotation of said device; means responsive to a closure of said contacts to cause said device to rotate in said opposite direction and to associate said detecting means therewith; and means comprising a bar cooperating with said detecting means and a set of contact points disposed adjacent said detecting means and operable by said bar to stop said opposite rotation when said detecting means has detected a number of degrees of said opposite rotation corresponding to a desired contact separation.

7. In a machine for adjusting a pair of contacts; a rotatable device; means operable by said device to cause said contacts to move towards each other when said device rotates in one direction and to cause said contacts to move away from each other when said device rotates in the opposite direction; means for causing said device to rotate in said one direction; detecting means comprising a movable supporting member, a gauging device rotatably mounted on said member and capable of engaging said rotatable device, and spring restraining means to hold said member and said gauging device away from said rotatable device; said detecting means engaging said rotatable device when said member is moved to detect the amount of rotation of said rotatable device; means responsive to a closure of said contacts to cause said rotatable device to rotate in said opposite direction and to move said member whereby said gauging device engages said rotatable device; and means responsive to a preselected amount of opposite rotation of said rotatable device, as detected by said gauging device, to stop said opposite rotation.

8. In a machine for adjusting a pair of contacts; a rotatable device; means operable by said device to cause said contacts to move towards each other when said device rotates in one direction and to cause said contacts to move away from each other when said device rotates in the opposite direction; means for causing said rotatable device to rotate in said one direction; detecting means comprising a movable supporting member, a gauging device rotatably mounted on said member and capable of engaging said rotatable device, and spring restraining means to hold said member and said gauging device away from said rotatable device; said detecting means engaging said device when said member is moved to detect the amount of rotation of said rotatable device; means responsive to a closure of said contacts to cause said rotatable device to rotate in said opposite direction and to move said member whereby said gauging device engages said rotatable device; and means comprising a bar cooperating with said gauging device and a set of contact points disposed adjacent said gauging device and operable by said bar to stop said opposite rotation when said gauging device has detected a number of degrees of said opposite rotation corresponding to a desired contact separation.

9. In a machine for adjusting a pair of contacts; a rotatable device; means operable by said device to cause said contacts to move towards each other when said device rotates in one direction and to cause said contacts to move away from each other when said device rotates in the opposite direction; means for causing said device to rotate in said one direction; detecting means comprising a pivotally mounted member, a gauging gear capable of engaging said rotatable device and rotatably supported on said member, said gauging gear restrained in a normal position with respect to said member by first resilient means, and second resilient restraining means to bias said member and said gauging gear away from said rotatable device; said gauging gear connectable to said rotatable device upon the arcuate movement of said member about its pivot point to detect the amount of rotation of said rotatable device; an electromechanical device operable to overcome the bias of said second resilient means and to arcuately move said member about its pivot point in

order that said gauging gear may engage said rotatable device; means responsive to a closure of said contacts to cause said device to rotate in said opposite direction and to operate said electromechanical device; and means comprising a bar cooperating with said gauging gear and a set of contact points disposed adjacent the periphery of said gauging gear and operable by said bar to stop said opposite rotation when said gauging gear has detected a number of degrees of said opposite rotation corresponding to a desired contact separation.

10. In a machine for adjusting a pair of contacts; a rotatable device; means operable by said device to cause said contacts to move towards each other when said device rotates in one direction and to cause said contacts to move away from each other when said device rotates in the opposite direction; means for causing said device to rotate in said one direction; detecting means comprising a pivotally mounted member, a gauging gear capable of engaging said rotatable device and rotatably supported on said member, said gauging gear restrained in a normal position with respect to said member by first resilient means, and second resilient restraining means to bias said member and said gauging gear away from said rotatable device; said gauging gear connectable to said rotatable device upon the arcuate movement of said member about its pivot point to detect the amount of rotation of said rotatable device; an electromechanical device operable to overcome the bias of said second resilient means and to arcuately move said member about its pivot point in order that said gauging gear may engage said rotatable device; means responsive to a closure of said contacts to cause said device to rotate in said opposite direction and to operate said electromechanical device; means comprising a measuring bar rotatably mounted on said member, which bar cooperates with said gauging gear and is lockable thereto in a preselected position, and a set of contact points disposed beyond the periphery of said gauging gear and operable by the free end of said bar to stop said opposite rotation when said gauging gear and said bar, locked together, are rotated by said rotatable device; and cooperative means integrating the relationship between said bar and said gauging gear in said gear's normal position with the arcuate distance between said bar and said contact points when said bar is locked to said gauging gear, and with a desired contact separation.

11. In a contact adjusting machine to be used in conjunction with a relay wherein contact separation is obtained by the camming action of a threaded member, the relay having a pair of contacts; a source of power; a reversible motor having energizable first and second windings; means engaging the threaded member and operable by said motor rotating in one direction upon the energization of said first winding to cause said contacts to move towards each other and rotating in the opposite direction upon the energization of said second winding to cause said contacts to move away from each other; means for connecting said source of power to said first winding; detecting means to detect the amount of rotation of said motor; means responsive to a closure of said contacts to cause said motor to rotate in said opposite direction; and means responsive to a preselected amount of opposite rotation of said motor, as detected by said detecting means, to stop said opposite rotation.

12. In a contact adjusting machine to be used in conjunction with a relay wherein contact separation is obtained by the camming action of a threaded member; a pair of contacts; a source of power; a reversible motor having energizable first and second windings; means engaging the threaded member and operable by said motor rotating in one direction upon the energization of said first winding to cause said contacts to move toward each other and rotating in the opposite direction upon the energization of said second winding to cause said contacts to move away from each other; means for connecting said source of power to said first winding; detecting means associable with said motor to detect the amount of rotation of said motor; means responsive to a closure of said contacts to cause said motor to rotate in said opposite direction and to associate said detecting means therewith; means comprising a measuring bar cooperating with said detecting means and lockable thereto in a preselected position, and a set of contact points disposed adjacent said detecting means and operable by one end of said bar to stop said opposite rotation when said detecting means and said bar, locked together, move under the control of said motor; and cooperative means integrating the relationship between said bar and said detecting means with the distance between said bar and said contact points, when said bar is locked to said detecting means, and with a desired contact separation.

13. In a contact adjusting machine to be used in conjunction with a relay wherein contact separation is obtained by the camming action of a threaded member, the relay having a pair of contacts; a source of power; a reversible motor having energizable first and second windings; means engaging the threaded member and operable by said motor rotating in one direction upon the energization of said first winding to cause said contacts to move toward each other and rotating in the opposite direction upon the energization of said second winding to cause said contacts to move away from each other; means for connecting said source of power to said first winding; detecting means comprising a movable supporting member, a gauging device rotatably mounted on said member and capable of engaging said motor, and spring restraining means to hold said member and said gauging device away from said motor; said gauging device connectable to said motor when said member is moved to detect the amount of rotation of said motor; means responsive to a closure of said contacts to cause said motor to rotate in said opposite direction and to move said member whereby said gauging device is connected to said motor; and means responsive to a preselected amount of opposite rotation of said motor, as detected by said gauging device, to stop said opposite rotation.

14. In a contact adjusting machine to be used in conjunction with a relay wherein contact separation is obtained by the camming action of a threaded member, the relay having a pair of contacts; a source of power; a reversible motor having energizable first and second windings; means engaging the threaded member and operable by said motor rotating in one direction upon the energization of said first winding to cause said contacts to move toward each other and rotating in the opposite direction upon the energization of said second winding to cause said contacts to move away from each other; means for connecting said source of power to said first winding; detecting means comprising a movable supporting member, a gauging device rotatably mounted on said member and capable of engaging said motor, and spring restraining means to hold said member and said gauging device away from said motor; said gauging device connectable to said motor when said member is moved to detect the amount of rotation of said motor; means responsive to a closure of said contacts to cause said motor to rotate in said opposite direction and to move said member whereby said gauging device is connected to said motor; and means comprising a bar cooperating with said gauging device and a set of contact points disposed adjacent the periphery of said gauging device and operable by said bar to stop said opposite rotation when said gauging device has detected a number of degrees of said opposite rotation corresponding to a desired contact separation.

15. In a contact adjusting machine to be used in conjunction with a relay wherein contact separation is obtained by the camming action of a threaded member, the relay having a pair of contacts; a source of power; a reversible motor having energizable first and second wind-

ings; means engaging the threaded member and operable by said motor rotating in one direction upon the energization of said first winding to cause said contacts to move toward each other and rotating in the opposite direction upon the energization of said second winding to cause said contacts to move away from each other; means for connecting said source of power to said first winding; detecting means comprising a pivotally mounted member, a gauging gear rotatably supported on said member and capable of engaging said motor, said gauging gear restrained in a normal position with respect to said member by first resilient means, and second resilient restraining means to bias said member and said gauging gear away from said motor; said gauging gear connectable to said motor upon the arcuate movement of said member about its pivot point to detect the amount of rotation of said motor; an electromechanical device operable to overcome the bias of said second resilient means and to arcuately move said member about its pivot point in order that said gauging gear may engage said motor; means responsive to the closure of said contacts to cause said motor to rotate in said opposite direction and to operate said electromechanical device; and means comprising a measuring bar cooperating with said gauging gear and lockable thereto in a preselected position and a set of contact points disposed beyond the periphery of said gauging gear and operable by one end of said bar to stop said opposite rotation when said gauging gear and said bar, locked together, rotate under the control of said motor; and cooperative means integrating the relationship between said bar and said gauging gear with the arcuate distance between said one end of said bar and said contact points when said bar is locked on said gauging gear, and with a desired contact separation.

16. In a machine for adjusting the separation between the contact surfaces of the pairs of contact springs associated with a relay wherein at least one of the springs of a cooperating pair is adjusted with respect to the other by the camming action of a screw rotatably mounted in a preselected position with respect to said one spring comprising, in combination; a source of alternating-current power; a constant speed, low revolution-per-minute motor having oppositely wound singularly energizable first and second windings and a through shaft; said first winding energizable to cause said shaft of said motor to rotate in one direction and said second winding energizable to cause said shaft to rotate in the opposite direction; a flexible shaft screwdriver connectable to the head of said screw and fixedly attached to one end of said shaft of said motor whereby said screw when rotated in said one direction moves said one spring closer to its cooperating spring to reduce the separation between said springs and whereby said screw when rotated in said opposite direction increases said spring separation; switching means operable to connect said source of power to said first winding; detecting means comprising a movable supporting member, a gauging device rotatably mounted on said member and capable of engaging said motor, and spring restraining means to hold said member and said gauging device away from said motor; said gauging device connectable to the other end of said shaft of said motor when said member is moved to detect the amount of rotation of said motor; means responsive to the closure of said contacts to cause said motor to rotate in said opposite direction and to move said member whereby said gauging device is connected to said motor; and means comprising a bar cooperating with said gauging device and a set of contact points disposed adjacent the periphery of said gauging device and operable by said bar to stop said opposite rotation when said gauging device has detected a number of degrees of said opposite rotation corresponding to a desired contact separation.

17. In a machine for adjusting the separation between the contact surfaces of the pairs of contact springs associated with a relay wherein at least one of the springs of a cooperating pair is adjusted with respect to the other by the camming action of a screw rotatably mounted in a preselected position with respect to said one spring comprising, in combination; a source of alternating-current power; a constant speed, low revolution-per-minute motor having oppositely wound singularly energizable first and second windings and a through shaft; said first winding energizable to cause said shaft of said motor to rotate in one direction and said second winding energizable to cause said shaft to rotate in the opposite direction; a flexible shaft screwdriver connectable to the head of said screw and fixedly attached to one end of said shaft of said motor whereby said screw when rotated in said one direction moves said one spring closer to its cooperating spring to reduce the separation between said springs and whereby said screw when rotated in said opposite direction increases said spring separation; switching means operable to connect said source of power to said first winding; detecting means comprising a pivotally mounted member, a gauging gear rotatably supported on said member and capable of engaging said motor, said gauging gear restrained in a normal position with respect to said member by first resilient means, and second resilient restraining means to bias said member and said gauging gear away from said motor; said gauging gear connectable to said motor upon the arcuate movement of said member about its pivot point to detect the amount of rotation of said motor; an electromechanical device operable to overcome the bias of said second resilient means and to arcuately move said member about the pivot point in order that said gauging gear may engage said motor; means responsive to the closure of said contacts to transfer said source of power from said first winding to said second winding and to operate said electromechanical device; and means comprising a measuring bar cooperating with said gauging gear and lockable thereto in a preselected position and a set of contact points disposed beyond the periphery of said gauging gear and operable by one end of said bar to remove said source of power from said second winding thereby to stop said opposite rotation when said gauging gear and said bar, locked together, rotate under the control of said motor; and cooperative means integrating the relationship between said bar and said gauging gear with the arcuate distance between said one end of said bar and said contact points when said bar is locked on said gauging gear, and with a desired contact separation.

18. In a machine for adjusting the separation between the contact surfaces of the pairs of contact springs associated with a relay wherein at least one of the springs of a cooperating pair is adjusted with respect to the other by the camming action of a screw rotatably mounted in a preselected position with respect to said one spring comprising, in combination; a frame; a source of alternating-current power; a constant speed, low revolution-per-minute electric motor fixedly attached to said frame and having oppositely wound singularly energizable first and second windings and a through shaft; said first winding energizable to cause said shaft of said motor to rotate in one direction and said second winding energizable to cause said shaft to rotate in the opposite direction; a flexible shaft screwdriver connectable to the head of said screw and fixedly attached to one end of said shaft whereby said screw when rotated in said one direction moves said one spring closer to its cooperating spring to reduce the separation between said springs and whereby said screw when rotated in said opposite direction increases said spring separation; first switching means manually operable to connect said source to said first winding; a first bevel gear fixedly retained on the other end of said shaft of said motor; a second bevel gear rotatably mounted on said frame at right angles to said shaft of said motor and engaging said first bevel gear; a pinion mounted on the shaft of said second bevel gear and integrally connected to said second bevel gear; a hanger

having an extension thereon and pivotally mounted at one end on said frame; a gauging gear rotatably mounted at the other end of said hanger on a shaft at right angles to said shaft of said motor and capable of meshing with said pinion upon the arcuate movement of said other end of said hanger about its pivot point; said gauging gear having an arcuate aperture therein and restrained from rotating in a specified direction from a normal position with respect to said hanger by a coil spring; said coil spring encircling the shaft of said gauging gear and fixedly attached at one end to said gauging gear and at the other end to said hanger; spring restraining means attached between said hanger and said frame to hold said hanger and said gauging gear away from said pinion; an electromagnetic device having an armature operable to engage said extension on said hanger and to overcome said spring restraining means thereby to pull said hanger in a direction to cause said gauging gear to engage said pinion; second switching means responsive to the engagement of said cooperating pairs of springs to operate said electromagnetic device and to switch said source of power from said first winding to said second winding of said motor; and contact separation measuring means comprising a rotation measuring bar, said bar rotatably mounted

at one end on the shaft of said gauging gear and extending at its other end beyond the outer radius of said gauging gear and having a threaded aperture therein to receive a lock screw projected through said arcuate aperture on said gauging gear, said lock screw manually operable to lock said bar to said gauging gear, a set of normally closed breaker points fixedly mounted on said frame beyond the outer radius of said gauging gear and engageable by said other end of said measuring bar when said gauging gear and said bar, locked together, rotate in said specified direction under the influence of said pinion to stop the rotation of said motor in said opposite direction, and a scale adjacent said arcuate aperture on said gauging gear calibrated to translate angular degrees of rotation in said specified direction between a preselected locked position of said measuring bar on said gauging gear when in its said normal position and said breaker points, which translation corresponds to a desired contact separation.

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