Dec. 12, 1944.

R. F. MALLINA

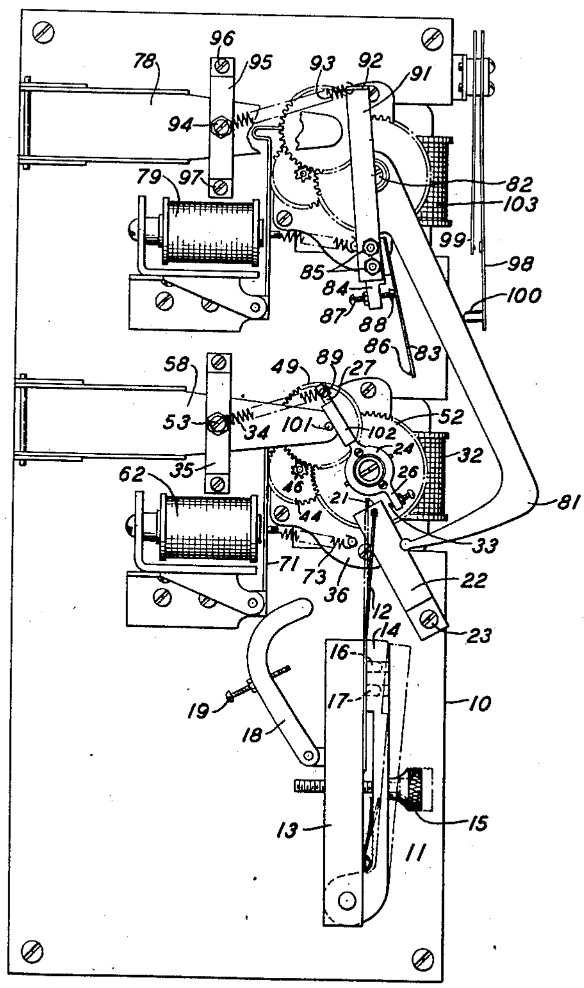
2,364,989

MATERIAL FORMING APPARATUS

Filed Nov. 26, 1941

4 Sheets-Sheet 1

FIG. 1



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4 Sheets-Sheet 2

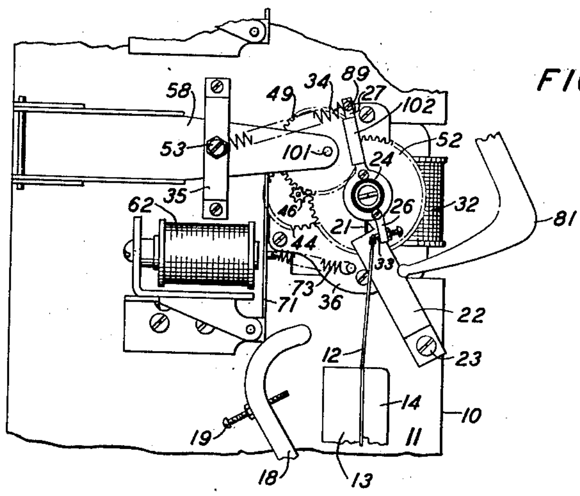

FIG. 2

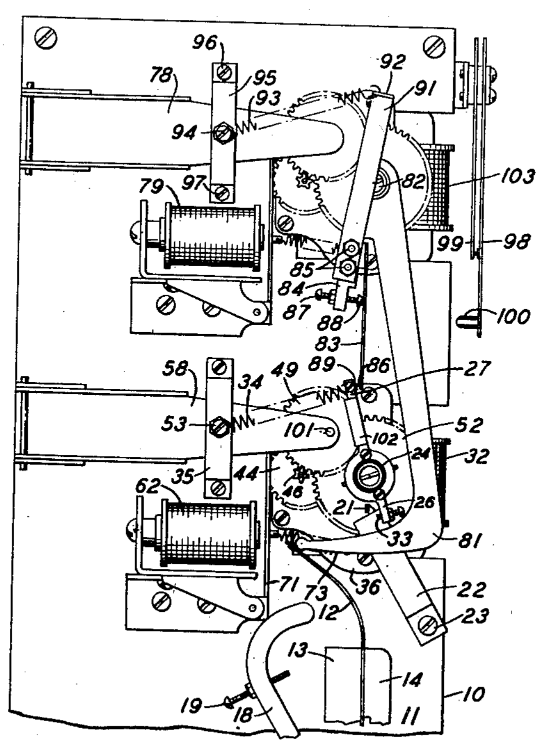

FIG. 3

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MATERIAL FORMING APPARATUS

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FIG. 4

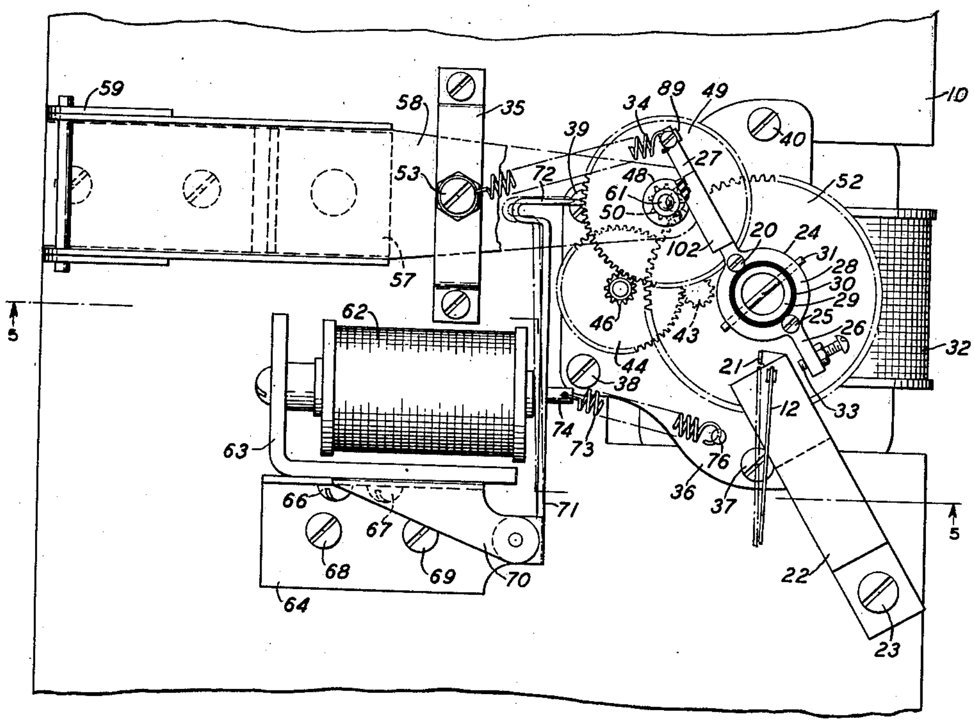

FIG. 5

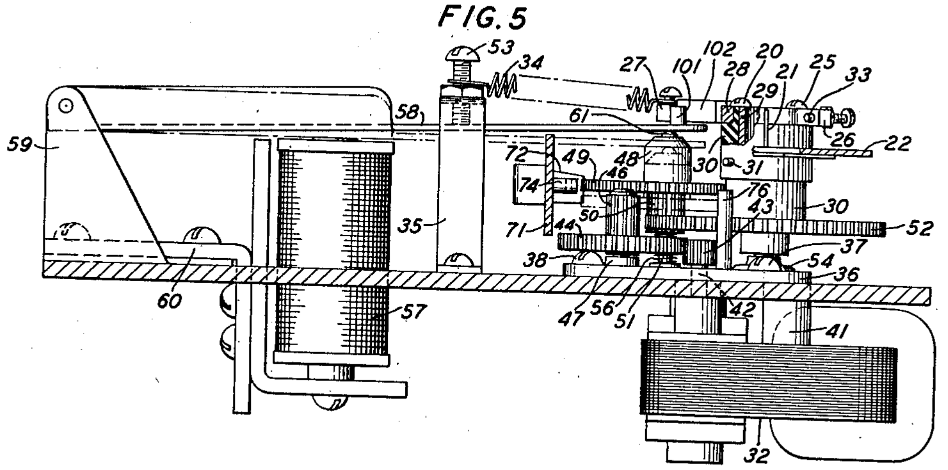

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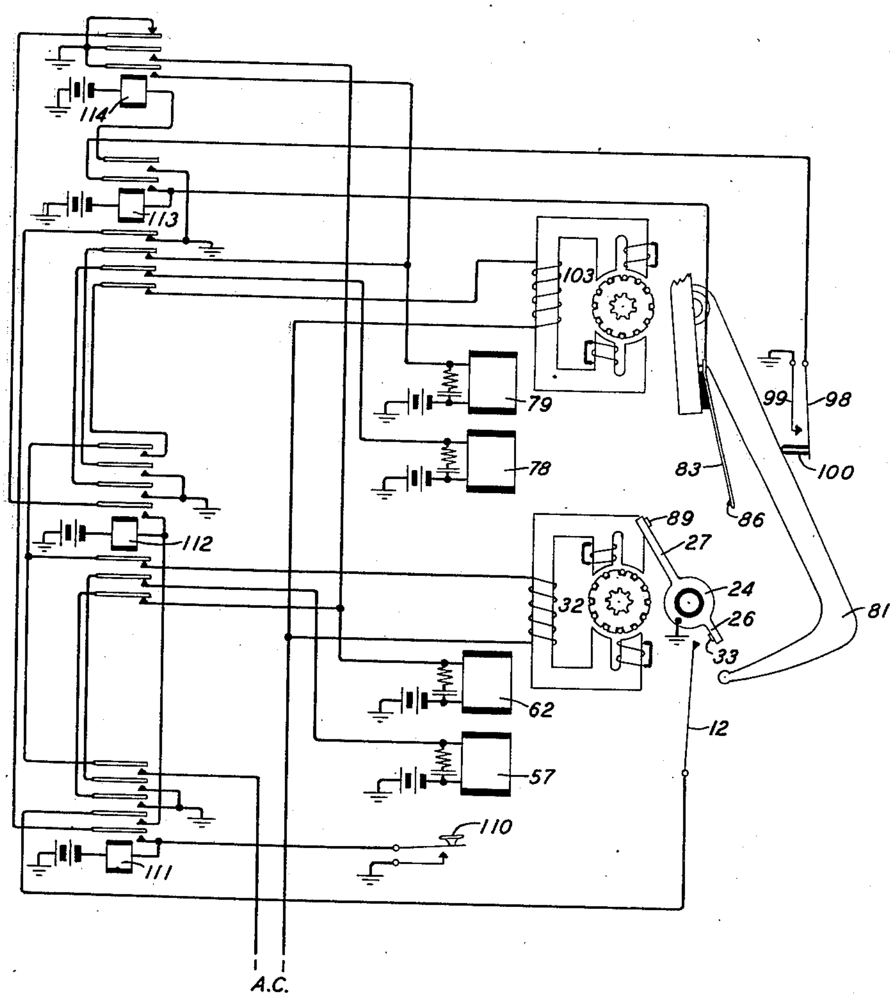
FIG. 6



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Patented Dec. 12, 1944 2,364,989

UNITED STATES PATENT OFFICE

2,364,989

MATERIAL FORMING APPARATUS

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Application November 26, 1941, Serial No. 420,503

11 Claims. (Cl. 153—15)

This invention relates to improvements in material forming apparatus and particularly to improvements in apparatus for reforming bent contact springs.

The object of this invention is to provide an arrangement for efficiently and expeditiously straightening bent electrical contact springs.

In accordance with the general features of the invention there is provided in one embodiment thereof a machine for measuring a contact spring, clamped at its base, for straightness and then bending it to a degree that, when restored to normal, will assume its proper position of alignment. Such contact springs are employed extensively in the telephone art, particularly in telephone exchanges, where electrical connections are established through the use of relays, jacks, switches, etc., that contain a plurality of springs grouped into a pileup. To insure good electrical contact among the springs of a jack pileup, a certain minimum lateral pressure has been found essential. In relays, for example, the contact must rest against the back-stop with a certain tension and if this tension is outside the required margin, the spring must be bent until the tension is correct. This is a costly item in telephone maintenance practice and if it were possible to make all springs of uniform thickness, uniform hardness, and perfect alignment, no adjustment would be necessary. Thickness and hardness can be kept within close limits during the manufacturing effort but straightness is a more difficult requirement. However, the maintenance effort is reduced substantially by straightening the bent contact springs automatically with the machine described herein.

In one embodiment of the invention the spring straightening machine comprises a pair of motor actuated levers, one of which determines the amount of spring disalignment and the other of which bends the spring in the proper direction a predetermined distance beyond its elastic limit, so that when the spring returns to its free position it is in alignment.

While the machine disclosed herein describes the straightening of a single contact spring, the invention is not to be understood as limited thereto, as the machine can be quite easily adapted for straightening a plurality of contact springs simultaneously.

Referring now to the accompanying drawings:

Fig. 1 is a top plan view of the spring straightening machine and a deformed contact spring;

Fig. 2 is a top plan view of the quantitative lever assembly for determining the amount of spring deformation and illustrates engagement of this lever with the deformed contact spring;

Fig. 3 is a top plan view of the bending lever and quantitative lever assemblies during the spring deflecting operation;

Fig. 4 is a detailed plan view of the quantitative lever mechanism;

Fig. 5 is a sectional view of the mechanism shown in Fig. 4 drawn along line 5—5; and

Fig. 6 shows a schematic diagram of the electrical circuit for operating the machine.

Referring now to Fig. 1, there is shown a panel 10 for mounting the various apparatus comprising the spring straightening machine. Upon the panel is insulatedly secured in any well-known manner, a vise 11 for clamping a deformed contact spring 12 into position. The vise 11 comprises a base 13 upon which is rotatably mounted a clamping arm 14, which is opened and closed by means of a thumb screw 15. Projections 16, 17 are provided on the upper side of base 13 for positioning the contact spring 12, said projections registering through holes in the clamping arm 14. A manually operated deforming lever 18 is also rotatably mounted on the underside of base 11 to deflect spring 12 initially upward a predetermined amount depending upon the position of adjusting screw 19. This deforming lever 18 is used primarily to facilitate automatic operation of the machine during those instances where the spring has been clamped in the vise with its deflection downward rather than upward.

Spring alignment is indicated by means of a center marker 21, which is secured in any suitable manner, for instance, by welding, to a bracket 22 secured to panel 10 by screw 23. A perfectly straight spring will line up with the center marker 21, as illustrated by the dot-dash lines. In Fig. 1 the spring is shown deflected above the center marker 21 and therefore does not require any further deflection by lever 18.

The amount of spring disalignment is measured by a lever 24, described as a quantitative lever herein for purposes of description. This lever (see Figs. 4 and 5) has two rigid metallic arms 26, 27 and an integral hub 28 rotatably and insulatedly secured to a metallic bushing 29 through an insulated sleeve 30 and pin 31. Lever 24 is fastened to sleeve 30 by screws 20, 25. Rotation of lever 24 is produced through a train of gears actuated by an electric motor 32, which operates until adjustable contact 33 on lever arm 26 engages spring 12, after which motor 32 is deenergized and lever 24 locked in said position.

Lever **24**, as hereinafter explained, is later returned to its normal position through the influence of tensioning spring **34**. Spring **34** is attached at one end to arm **27** and at the other end to bracket **35**, which is fastened to panel **10**.

The apparatus for the above lever and motor mechanism is supported by an individual mounting plate **36**, which is attached to panel **10** by screws **37, 38, 39, 40**. The motor **32** is appended in spaced relationship to the underside of mounting plate **36** in any suitable manner, as for example, by the usual sleeved studs **41**, and the power thereof is transmitted through a driving shaft **42** and pinion **43** fixedly placed thereon. Gear **44** by meshing with pinion **43** further transmits the power to pinion **46** rigidly coupled to gear **44**, the combination rotating about shaft **47**. A clutch comprising a hub **48** rigidly coupled to a gear **49** and pinion **50** combination and rotatably mounted upon a shaft **51** arranges for the transmission of power to the quantitative lever **24** by the engagement of gear **49** with pinion **46**. Clutch pinion **50** in turn meshes with lever gear **52** which, being rigidly coupled to sleeve **30** and being rotatably mounted on shaft **54**, causes rotation of lever **24**. Shafts **47, 51**, and **54** are affixed to mounting plate **36** in any well-known manner. Normally the clutch is disengaged from the motive power because of compressive spring **56**, which positions clutch gear **49** above pinion **46** and therefore out of engagement therewith. A downward force upon clutch bushing **48** lowers gear **49** into engagement with pinion **46** and thereupon produces rotation of quantitative lever **24** at a suitably slow speed by reason of the gear reduction arrangement.

Electric operation of the clutch is obtained through energization of a magnet **57**, which attracts an armature **58** rotatably mounted on a clevis **59**. The clevis **59** and mounting bracket **60** for magnet **57** are both affixed to panel **10** in a well-known manner. The travel of clutch armature **58** is regulated by an adjustable screw **53**, which also serves as a support for one end of spring **34**. The attraction of armature **58** forces clutch bushing **48** in a downward direction to couple the gear trains with consequent rotation of lever **24**, as above described. To reduce friction between clutch armature **58** and clutch bushing **48** a ball bearing **61** is seated in the top of clutch bushing **48**.

In order to prevent motor **32** from coasting upon deenergization thereof a magnetic brake mechanism is provided. This mechanism comprises a brake magnet **62** supported by bracket **63** fastened to a second bracket **64** by screws **66, 67**. Bracket **64** is fastened to panel **10** by screws **68, 69** and is provided with a clevis assembly **70** to support rotatable brake armature **71** at one end thereof. At the other end of brake armature **71** is integrally formed a U shaped finger **72** to normally engage clutch gear **49** through the action of tensioning spring **73** attached at one end to a stud **74** intermediately located on armature **71** and at the other end to a stud **76** fastened to mounting plate **36**. Upon energization of brake magnet **62** brake armature **71** is attracted thereto with the result that the brake finger **72** is withdrawn from engagement with clutch gear **49** (shown in dot-dash lines Fig. 4) and the gear train is free to rotate.

The bending lever mechanism, which deflects deformed spring **12** a distance predetermined by the relative position of quantitative lever **24**, will now be described. It comprises (see Fig. 1) a magnetic clutch **78**, magnetic brake **79**, and electric motor gear train similar to that described for the quantitative lever mechanism and a detailed description is therefore not considered necessary. However, the bending lever will be described as it is slightly different in design from that of the quantitative lever. The bending lever comprises a rigid bending arm **81** rotatably secured to a metallic bushing **82**, which in turn is coupled to its associated gear train in a manner similar to that of the quantitative lever **24**. It is to be noted, however, that the bending arm **81** is not insulated from the gear train. The other arm **83** of the bending lever is insulatedly mounted on an extension **84** of the bending arm **81** and fastened thereto in any suitable manner, as for example, by a screw and nut arrangement **85**. This arm **83** may be of contact spring material and is furnished with a contact **86** at the free end thereof. An adjusting screw **87** with insulated tip **88** thereon is also provided on extension **84** of the bending arm **81** for regulating the relative position of contact **86** with respect to contact **89** on quantitative lever arm **27**. Attached to extension **84** also by screw and nut combination **85** is a flat L shaped bar **91**, which is arranged at the L projection **92** for attachment of one end of a tensioning spring **93**, the other end of which is attached to clutch armature adjusting screw **94** supported by bracket **95** in a manner similar to that shown in Fig. 5 for supporting screw **53**. Bracket **95** is similar in design to bracket **35** and is affixed to panel **10** by screws **96, 97**. Tensioning spring **93** is provided for returning the bending lever mechanism to its normal position upon completion of the bending operation. In its normal position of rest bending arm **81** separates off-normal springs **98, 99** from each other by exerting pressure against an insulated stop pin **100**, which is fastened to spring **98** and which is permitted to freely pass through an opening (not shown) in spring **99**. During the bending operation of arm **81** pressure against pin **100** is released and the springs **98, 99** contact each other. The function of the off-normal springs **98, 99** will be explained fully during the description of the circuit operation. The automatic control equipment, namely, relays, start key, etc., for the machine are not shown mounted on panel **10** but this equipment is of conventional type and their functions will be described hereinafter in the circuit operation.

The general operation of the machine is as follows:

The spring **12** (Fig. 1) to be straightened is placed upon the base **13** of vise **11** with its two mounting holes (not shown) registering over projections **16, 17** and is clamped securely by arm **14** through the threading action of thumb screw **15** into base **13**. Assuming that the spring deflection is downward, generally it will be upward, deforming lever **18** is pressed upward against spring **12**, as far as the lever can travel, that is, until the tip of adjusting screw **19** bears against the underside of base **13**. Lever **18** is then released and spring **12** assumes a deformation similar to that shown in Fig. 1.

To predetermine the amount of spring flexure required to bring spring **12** to its position of alignment with center marker **21**, quantitative lever **24** is rotated until contact **33** thereof engages the contact of spring **12**, as shown in Fig. 2. However, lever **24** in its position of rest (see Fig. 1) normally has its left arm **27** bearing against pin stop **101** rigidly secured to the free end of clutch armature 58. Arm 27 is insulated from pin stop 101 by insulating element 102 secured thereto in any well-known manner. The rotation of lever 24 is accomplished by the energization of clutch magnet 57, brake magnet 62, and motor 32, as explained hereinafter. Brake magnet 62 upon energization thereof attracts armature 71 (Figs. 4 and 5) which disengages finger 72 from clutch gear 49 and thereupon permits the gear train to rotate freely Energization of clutch magnet 57 causes clutch armature 58 to force clutch bushing 48 and clutch gear 49 downward so that gear 49 meshes with driving pinion 46. In the meantime motor 32 has also been energized with the result that upon the meshing of clutch gear 49 with driving pinion 46 the motive power is transferred through the train of gears to lever 24. Upon engagement of contact 33 with that of spring 12, brake magnet 62, clutch magnet 57, and motor 32 become deenergized. Brake armature 71 is retracted to its normal position by spring 73 whereupon finger 72 engages clutch gear 49 to lock lever arm 26 in contact with spring 12. The release of clutch magnet 57 permits compressive spring 56 to force clutch gear 49 upward and out of engagement with driving pinion 46. As shown in Fig. 5, clutch finger 72 can lock gear 49 in either its normal (upper) or operated (lower) position.

The amount of spring deformation having having been determined by the relative position of quantitative lever 24, particularly contact 89, the bending lever is then rotated clockwise to flex contact spring 12 with its bending arm 81 until the spring has been deflected its predetermined distance, as shown in Fig. 3. Rotation of the bending lever is produced in a similar manner to that of the quantitative lever. The magnetic clutch 78, magnetic brake 79, and electric motor 103 are all energized, as in the quantitative lever arrangement, to rotate the bending lever through its gear train. As bending arm 81 rotates, the tip thereof bends spring 12 until contact 86 of adjustable arm 83 engages contact 89 of lever arm 27, whereupon the bending action ceases. Contact between adjustable arm 83 and arm 27 deenergizes the circuits for magnetic brake 79, magnetic clutch 78, and electric motor 103, as explained hereinafter, and thus locks the bending lever in its flexing condition, as shown in Fig. 3.

Having deformed the contact spring to a definite degree, the final step is to restore both levers to their normal positions and to release the contact spring. This is performed by energizing both brake magnets 62 and 79, which in attaching their armatures release the respective clutch gear trains in a manner already described. Quantitative lever 24 is returned to its normal position through the influence of retractile spring 34 while at the same time the bending lever is restored by spring 93. Upon return of the levers to their normal positions both brake magnets release, and lock their respective levers in position. The operation is completed upon the release of contact spring 12 from bending arm 81, spring 12 returning to a position in alignment with center marker 21, as indicated by the dot-dash lines of Fig. 1.

Experiments made on typical relay springs indicate the only temporary deformations are obtained by bending springs up to their elastic limits, the springs eventually returning to their original conditions. The elastic limits for the springs under test were found to be at angular deflections of approximately 25°. It is recognized, of course, that for springs of different cross-sectional area the elastic limit thereof will vary. Beyond the elastic limit the bending movement causes a permanent deformation and the relation between the deflection of the spring and the resulting permanent deformation appears to be approximately linear. In other words, if a spring tip is $\frac{1}{32}''$ out of line and the spring has to be bent $\frac{1}{2}''$ beyond its elastic limit to assume its correct position of alignment, a bending amplitude of 1'' beyond its elastic limit would appear necessary to straighten a spring whose tip is $\frac{1}{16}''$ out of line. While this linearity is not obtainable for the entire bending range, nevertheless for the ranges which occur in practice, the above bending relationship is, for practical purposes, linear.

The circuit operation of this machine, as disclosed in Fig. 6, will now be described. Operation is started by actuating start key 110, which completes an obvious circuit for start relay 111. Start relay 111 accordingly energizes and closes a locking circuit for itself from battery through winding and lower front contact thereof and thence through back contact of relay 113 to ground.

Relay 111 at its three uppermost front contacts also completes energizing circuits for the quantitative lever clutch magnet 57, brake maget 62, and motor 32, respectively; while at its intermediate front contact prepares an operating circuit for relay 112. The circuit for clutch magnet 57 can be traced from battery through winding thereof, bottom intermediate back contact of relay 112, and upper intermediate front contact of relay 111 to ground. Similarly, the circuit for brake magnet 62 is traced from battery through winding thereof, bottom contact of relay 112, and upper intermediate front contact of relay 111 to ground. Motor 32 is energized in a circuit from one leg of an alternating current source through winding of motor 32, upper bottom back contact of relay 112, and uppermost front contact of relay 111 to the other leg of the alternating current source.

Clutch magnet 57, upon energizing, engages clutch gear 49 with driving pinion 46 (Fig. 5) while magnet 62 withdraws the brake finger 72 from engagement with the clutch gear 49, as previously described. Motor 32, upon energizing, rotates quantitative lever 24 clockwise through the gear train coupled by the above-described clutch mechanism. When contact 33 of lever arm 26 touches the contact of spring 12, a circuit is closed for the operation of relay 112, from ground at lever arm 26 through contact 33, contact of spring 12, intermediate front contact of relay 111, and thence through winding of relay 112 to battery. In operating, relay 112 connects a self-locking circuit, from battery through winding and lower front contact thereof, and thence to ground at uppermost back contact of relay 114. Actuation of relay 112 at its three bottom back contacts releases clutch magnet 57 and brake magnet 62, and also opens the circuit for motor 32. As a consequence, motor 32 stops with lever arm 26 in contact with spring 12; brake magnet 62 locks contact lever arm 26 in this position; and clutch 57 disengages the lever mechanism from the driving motor 32.

Relay 112 at its two upper intermediate front contacts connects ground to the bending lever clutch and brake magnets 78 and 79, respectively, through the two intermediate bottom back contacts of relay 113; and at its uppermost front contact completes a circuit for motor 103 through the lowermost back contact of relay 113. As in the quantitative lever mechanism, clutch magnet 78, brake magnet 79, and motor 103 operate to rotate bending lever arm 81 clockwise thereby deflecting spring 12. Lever arm 83 also rotates therewith until engagement is made between contacts 86 and 89 whereupon ground is connected to relay 113 with consequent energization thereof. In its normal position of rest bending lever arm 81 maintains off-normal springs 98 and 99 separated from each other, but as soon as the lever arm 81 leaves its normal position, springs 98 and 99 close to connect an obvious holding circuit for relay 113 by way of the inner upper front contact thereof. In operating, relay 113 at its three bottom back contacts respectively releases clutch magnet 78, opens the circuit of motor 103 to stop the bending lever, and releases the brake magnet 79, which locks the bending lever; at its inner bottom contact opens a holding circuit for start relay 111; and at its top front contacts connects energizing ground to relay 114.

Start relay 111 thereupon releases and opens an operating circuit for relay 112. Relay 114 energizes and at its top back contact opens a holding circuit for relay 112, which releases; and at its two front contacts connects energizing ground to brake magnets 62 and 79, respectively. Both brake magnets operate and thereupon release the quantitative and bending levers to their original positions of rest. Bending lever arm 81, upon returning to its normal position separates the off-normal switch springs 98 and 99 whereby the holding circuit for relay 113 is opened. Relay 113 releases, since its operating circuit was also opened upon separation of contacts 86 and 89, and immediately thereafter releases relay 114. Upon release of the above-mentioned levers, contact spring 12 returns to its position of alignment, and the machine is ready for another spring straightening operation.

While this invention has been shown and described as embodying certain features merely for the purpose of illustration, it will be understood that it can be used in many other and widely varied fields without departing from the spirit of the invention and scope of the appended claims.

What is claimed is:

1. A straightening machine comprising a support, means on said support for holding a deformed flexible member, an alignment indicator on said support, said member having a free end for alignment with said indicator, a rotatable quantitative lever measuring the amount of deformation in said member, said lever comprising an adjustable contact arm contacting the free end of said member and a second contact arm in continuation of said first-mentioned arm, a rotatable bending lever deforming said member oppositely the amount predetermined by said quantitative lever, said bending lever comprising a crank bending said member and a resilient arm contacting said second contact arm to stop the travel of said crank, and electrical control means automatically operating said levers, whereby upon release of said levers said spring is aligned with said indicator.

2. In a spring straightening machine, a support for a bent contact spring, a rotatable quantitative lever for measuring distortion in said spring, a rotatable bending lever in combination with said quantitative lever to remove said distortion, electromechanical means rotating said levers, a start circuit initiating automatic operation of said electromechanical means, and an electrical control circuit including an off-normal switch regulating the travel and restoral of said levers.

3. In a straightening machine, a support for a deformed relay contact spring, quantitative means determining the deformation thereof, corrective means in combination with said quantitative means for straightening said spring, means including a start circuit for initiating operation of said quantitative means, means including a cut-over circuit for starting movement of the corrective means, means including locking circuits for holding said quantitative and corrective means in their operated positions, and means including a release circuit for restoring both of said quantitative and corrective means to their normal positions.

4. In a straightening machine, a support for a resilient member having a deformation therein, a quantitative lever mechanism measuring said deformation, a bending lever mechanism in combination with said quantitative mechanism for correcting said deformation, said second lever mechanism bending said spring oppositely to said deformation an amount proportional to the deformation measured by said quantitative lever mechanism, whereby as a result said deformation is removed and said spring is straightened, means including a start circuit for initiating movement of said quantitative mechanism, a switching circuit closed by contact of said quantitative mechanism with said member for operating said bending mechanism, locking circuits including an off-normal switch holding said mechanisms in their operated positions, and a release circuit returning both mechanisms to their normal positions.

5. In combination, a spring straightening machine comprising a support therefor, a vise on said support for clamping a deformed relay contact spring, a quantitative lever measuring the deformation in said spring, a bending lever in combination with said quantitative lever to deflect said spring oppositely to its deformation an amount proportional to said measured deformation, individual alternating current motor circuits actuating said levers, individual electromagnetic brake and clutch circuits for said levers, and a direct current control circuit comprising a start circuit energizing the motor, brake, and clutch circuits of said quantitative lever, a switching circuit deenergizing the motor, brake, and clutch circuits of the quantitative lever and energizing the motor, brake, and clutch circuits of the bending lever, and a release circuit including an off-normal switch deenergizing the motor, brake, and clutch circuits of the bending lever and returning said levers to their normal positions.

6. In a spring straightening machine, the combination with a support for holding a deformed spring, of a bending lever, means for actuating said lever, a contact arm insulatedly attached to said lever, measuring means for determining the amount of deformation in the spring, means for actuating said measuring means, said measuring means including a control arm arranged to engage said contact arm, and means operated by electric current arranged to pass through said contact arm and said control arm for limiting

the amount to which said deformed spring is bent by said bending arm.

7. A spring straightening machine comprising, in combination, a support for a deformed spring, means for determining the amount of deformation in said spring, said means including a control arm, a spring straightening device comprising a bending lever and a contact arm, means energized by electric current arranged to pass through said spring and said control arm for initiating operation of said bending lever, and means energized by electric current arranged to pass through said contact arm and said control arm for completing operation of said bending lever, thereby regulating the effective operation of the spring straightening device.

8. A spring straightening machine comprising, in combination, a support for a deformed spring, a quantitative lever, means for actuating said quantitative lever, said lever comprising a measuring arm for determining the amount of deformation in said spring and a control arm, a straightening lever, means for actuating said straightening lever, said straightening lever comprising a bending arm for removing said deformation and an insulated contact arm, said contact arm adaptable for engagement with said control arm, and means including an electric circuit closed upon engagement of said contact arm with said control arm for limiting the extent to which said spring is bent by said bending arm.

9. A spring straightening machine comprising, in combination, a support for a bent spring, a quantitative lever for determining the amount of deformation in said spring, means for actuating said lever, means comprising an electric start circuit and key for initiating operation of said lever, said lever comprising a measuring arm adaptable for engagement with said spring and a control arm, a straightening lever, means for actuating said straightening lever, said straightening lever comprising a bending arm for removing the bend in said spring and an adjustable arm adaptable for engagement with said control arm, means including an electric cut-over circuit closed upon engagement of said measuring arm with said spring for initiating operation of said straightening lever, and means including an electric circuit closed upon engagement of said control arm with said adjustable arm for stopping the operation of the straightening lever.

10. In an article forming apparatus, a support for holding a deformed spring, a device for measuring the amount of deformation in said spring, means for correcting said deformation as determined by the measuring device, said means comprising a bending arm for bending said spring, a member secured to and carried by the bending arm, a control arm on the measuring device for engaging the member on the bending arm to determine the extent to which said bending arm should be operated to bend the spring, and control means automatically operating said measuring device and correcting means sequentially.

11. In a straightening machine, a support for a deformed relay contact spring, quantitative means determining the deformation thereof, corrective means in combination with said quantitative means for straightening said spring, means for initiating operation of said quantitative means, means for starting movement of the corrective means, means for holding said quantitative and corrective means in their operated positions, and means for restoring both of said quantitative and corrective means to their normal positions.

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