DEVICE FOR BENDING CONTACT SPRINGS

Filed Nov. 15, 1952 3 Sheets-Sheet 1

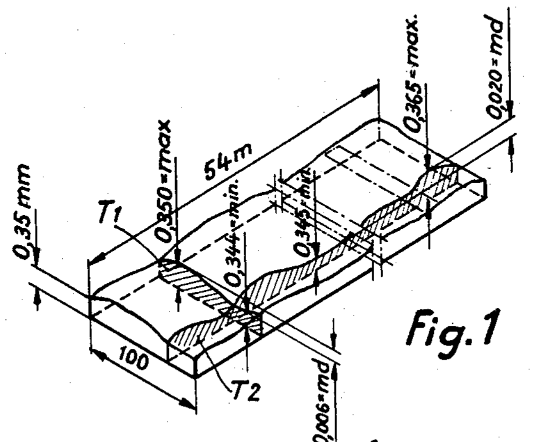


Fig. 1

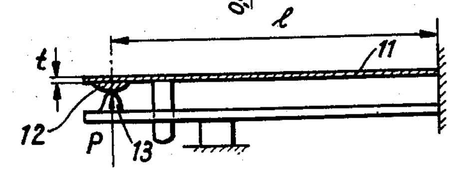


Fig. 2

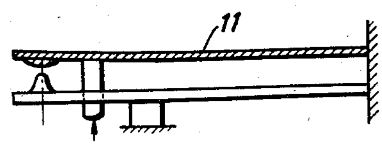


Fig. 3

Fig. 4

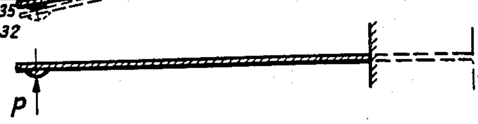


Fig. 5

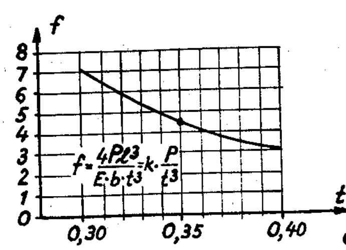


Fig. 6

INVENTORS
GUSTAV VILHELM TUNBERG
ANDERS OSSIAN JÖRGENSEN
ALEXANDER PARSCHIN
ERNST ERIK TEODOR EDMAN
BY [signature]
ATTORNEY

DEVICE FOR BENDING CONTACT SPRINGS

Filed Nov. 15, 1952 3 Sheets-Sheet 2

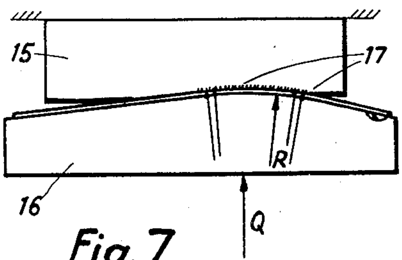


Fig. 7

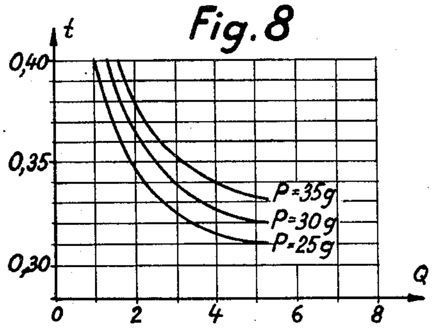


Fig. 8

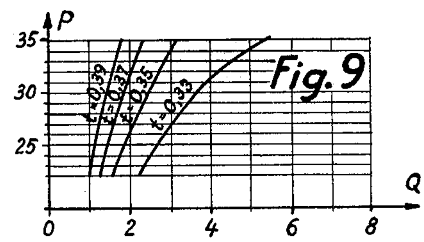


Fig. 9

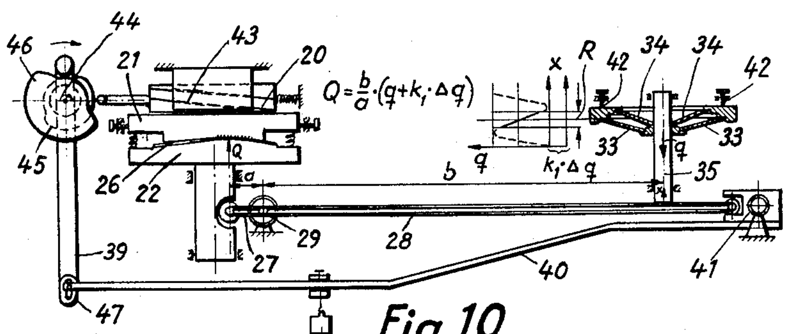


Fig. 10

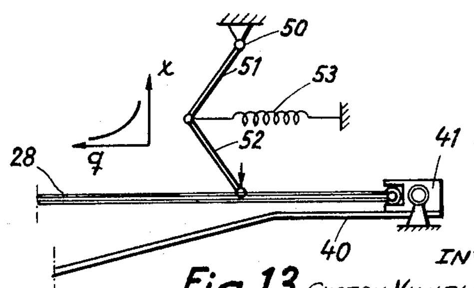


Fig. 13

INVENTORS
GUSTAV VILHELM TUNBERG
ANDERS OSSIAN JÖRGENSEN
ALEXANDER PARSCHIN
ERNST ERIK TEODOR EDMAN

BY Fredrik E. Hane
ATTORNEY

DEVICE FOR BENDING CONTACT SPRINGS

Filed Nov. 15, 1952

FIG.11

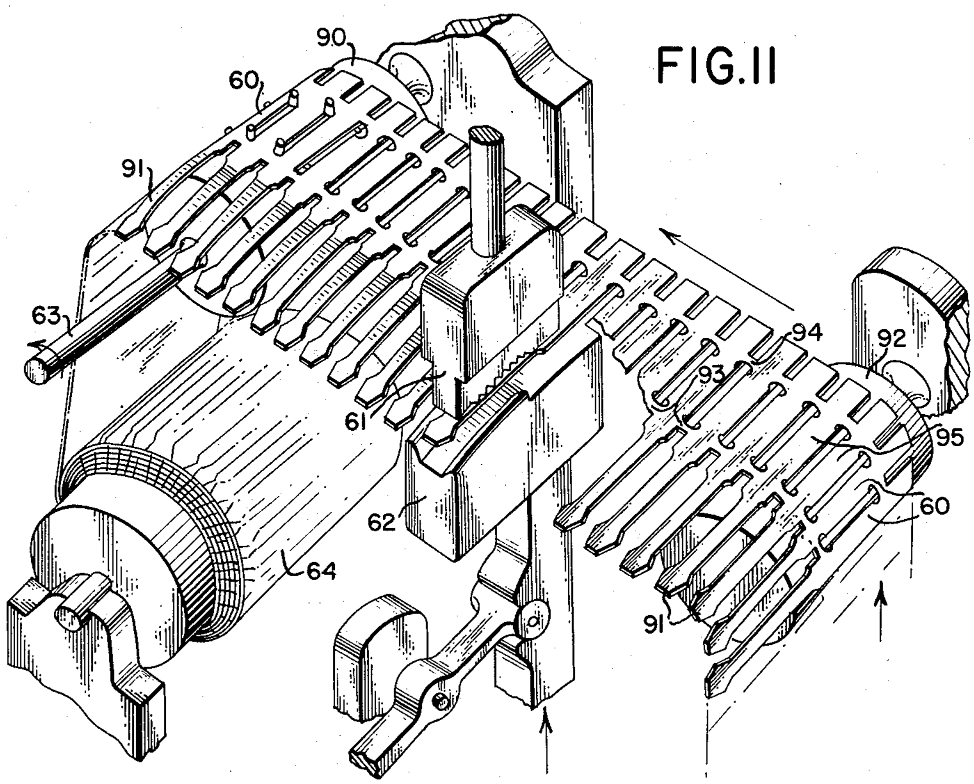
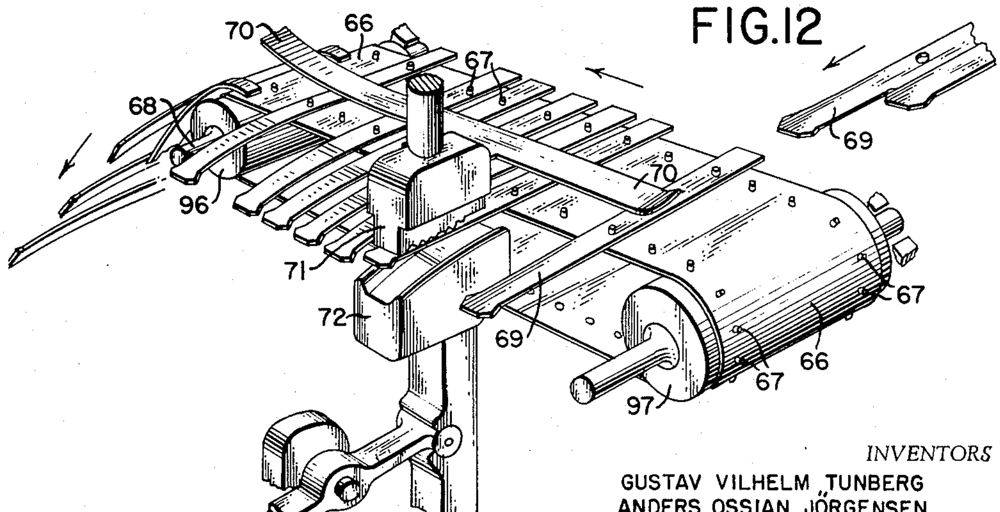


FIG.12



INVENTORS
GUSTAV VILHELM TUNBERG
ANDERS OSSIAN JÖRGENSEN
ALEXANDER PARSCHIN and
ERNST ERIK TEODOR EDMAN
BY [signature]
ATTORNEY

2,781,817

DEVICE FOR BENDING CONTACT SPRINGS

Gustav Vilhelm Tunberg, Hagersten, Anders Ossian Jörgensen, Traneberg, Alexander Parschin, Stockholm, and Ernst Erik Teodor Edman, Hagersten, Sweden, assignors to Telefonaktiebolaget L M Ericsson, Stockholm, Sweden, a Swedish company

Application November 15, 1952, Serial No. 320,764

Claims priority, application Sweden November 28, 1951

12 Claims. (Cl. 153—48)

The present invention relates to a device for bending springs, especially contact springs for such electromagnetic relays, as are used within telephony. Different devices for bending contact springs have earlier been suggested, but none of them has given quite satisfactory results, an after-adjustment of the springs having proved necessary. The object of the present invention is to avoid said drawback, the device being designed to effect the bending in dependence on the spring material. This is achieved by the device in the following manner: the contact springs are bent through a press-operation with a pressure matched to the material properties and thickness of the separate springs in such a manner, that the contact springs have the same tension after bending when straightened out to a certain position, the working position.

The invention will be more closely described with reference to the accompanying drawings. Fig. 1 shows measured variations in the thickness of a blank of German silver, from which the contact springs are cut out. Figs. 2 and 3 show a contact spring in unoperated and operated position, respectively. Fig. 4 shows the extent of the required bending for three different spring-thicknesses in order to give the same tension P in the position according to Fig. 5. Fig. 6 is a diagram of the bending f as a function of the spring thickness t. Fig. 7 shows a bending tool. Figs. 8 and 9 are diagrams of the spring thickness t and of the tension P, respectively, as a function of the pressure Q. Fig. 10 is a principle-illustration of a machine or device for bending springs according to the invention. Figs. 11 and 12 are perspective views showing the feeding of a continuous carrier and of loose contact springs, respectively, into the machine in Fig. 10. Fig. 13 illustrates a detail of a modified embodiment of the device shown in Fig. 10.

Such a blank of German silver, out of which contact springs are cut, is, in the example shown in Fig. 1, drawn in different scales for the three dimensions: length, width and height. The length is 54 m., the width 100 mm. and the height, i. e. the thickness, about 0.35 mm. In a section T1 across the width, the smallest thickness is 0.344 mm., and the greatest thickness is 0.350 mm., as appears from the figure. Accordingly, the maximal difference md is here 0.006 mm. In a section T2 across the length the corresponding measures of the thickness are 0.345 and 0.365 mm. respectively, the maximal difference md being 0.020 mm. If the contact springs from such a blank are bent in the same manner, the different springs will, owing to the variations in thickness, have a varying tension P in working position, for example when, in unoperated position, they rest against another contact **13** by means of their contact **12**, as does the bent spring **11** in Fig. 2.

For the anchored contact spring shown in Fig. 2 or Fig. 5 having a free length l, a thickness t, a width b and an elasticity modulus E, the following relation between the bending f at the place of contact and the spring-pressure P is valid:

$$f=\frac{4.l^3}{E.b.t.^3}\cdot P$$

For springs with the same length and width, or small allowances of length and width relatively to the thickness allowance, and made of usual spring material, for which the elasticity modulus E may be supposed to be constant, the formula may be simplified to

$$f=k\cdot\frac{P}{t^3}$$

Fig. 4 shows in continuous lines the bending f of a spring, the thickness of which is 0.35 mm. Had the thickness of the spring instead been 0.40 or respectively 0.32 mm., it would have been necessary, to obtain the same tension P when straightening the spring according to Fig. 5, to make a smaller bending f for the thicker, and respectively a greater bending f for the thinner spring, as can be read from the given formula and is indicated with dotted lines in Fig. 4. This is directly apparent on the curve illustrating the relation between the bending f in mm. and the spring thickness t in mm. for a constant tension P, shown in Fig. 6.

So called point bending may be used when bending the springs. The springs are thereby pressed in a bending tool, Fig. 7, between two tool halves **15**, **16**, the pressing surfaces of which are provided with varying or constant radius of curvature R along a greater or smaller part of the effective length of the spring. The pressing surfaces of the bending tool are usually shaped so that the spring is nearly straight when in working position, Fig. 2. In certain known bending methods the bending is concentrated to one or several points of the spring. Such a spring can however not be straight when in working position. This is a drawback, since a greater distance between the springs in a group is then required. One or both pressing surfaces of the bending tool according to Fig. 7 are provided with a number of suitably distributed jags **17** or ridges or embossed points which during the pressing operating penetrate into the spring material, leaving small hollows. After the pressing-process has taken place, the spring has a curvature which, for springs made of the same material, depends on the thickness of the spring and on the pressure. Equally thick springs are being given a greater curvature at greater pressure. At the same pressure, for example when the pressing process takes place in a hydraulic press, the thick springs are being given a greater curvature than the thin ones. At use of an excenter press with constant play the pressure will be greater on the thick springs than on the thin ones, and the difference in curvature f, Fig. 4, and in tension P, Fig. 5, will be all the greater. To obtain the same tension P for springs with different thicknesses, a smaller pressure is required for the thick springs than for the thin ones, as appears from the diagrams in Figs. 8 and 9, which have been obtained when checking springs with different thicknesses.

Fig. 8 illustrates the spring thickness t in mm. as a function of the pressure Q in tons for three spring tensions $P=35$, 30 and 25 respectively. It appears immediately, that a thin spring requires a greater pressure than a thick spring. Thus, for example, a spring having the desired tension 25 gr. must be exposed to a pressure surpassing 5 tons if it is 0.31 mm. thick, whereas not quite 2 tons are required if it is 0.35 mm. thick. Fig. 9 shows the spring tension P in grams as a function of the pressure Q in tons for four different spring thicknesses t. If the radius of curvature R of the pressing surfaces of the bending tool according to Fig. 7 is changed, the position and the shape (characteristics) of the curves are also changed, see Fig. 8. By for example reducing the radius R, a greater tension is obtained at unchanged pressure and spring pressure.

In the device or machine for carrying out the bending shown in Fig. 10 the pressure Q between the tool halves **21**, **22** is automatically regulated so, that springs with different thicknesses are given the same tension P, for example 30 grams. Thus, the pressure Q can be obtained by means of known devices per se. In the example shown in Fig. 10, the pressure Q is regulated by means of conical annular dished springs **33**, **34**, which operate a centrally located shaft **35** having a pressure q. It is well known, as evidenced by the United States patents to Fawkes, No. 2,308,475 and Hay, No. 2,162,719, granted January 12, 1943 and June 30, 1939, respectively, that conical annular dished springs of the type shown can be designed so that the pressure q varies with the distance x of the shaft **35** from a lower position corresponding to the rest position in such a manner that the resistance to an axial bend pressure with increased X-value first increases and thereafter decreases and finally increases again. This is illustrated in the diagram shown in Fig. 10, where the pressure q of the shaft **35** is drawn as a function of the movement or distance x of the shaft from its lower position. The useful pressure range is the decreasing or negative pressure characteristic shown as full line. The upper half **21** of the used bending tool rests against a fixed stop **20**. The lower half **21** is movable. When a pressure is impressed on the lower half **22** the distance between the halves **21**, **22** becomes dependent on the thickness of the contact spring **26**, which on this occasion is placed between them. The pressure Q on the bending tool is applied by means of a double-armed lever **27**, **28** movable round a support **29**, the short arm **27**, which has a length a, operating the tool half **22**. The pressure q of the conical springs is transmitted by means of the shaft **35** to the long lever **28** at a distance b from the support **29**. Due thereto, the springs can be dimensioned for a smaller pressure q and a greater movement x, than would be possible if they were to act directly on the pressing tool. Owing to the lever ratio, the formula

$$Q=\frac{b}{a}\cdot q$$

is valid, provided the pressure q is the only one to act upon the lever **28**.

The pressing device is now set in such a manner, that for all the occurring spring thicknesses it works with x-values, which fall within an adjustment-area R on the curve of the diagram corresponding to the pressure q. Since a thick spring between the pressing halves **21**, **22** corresponds to a greater x-value and consequently to a smaller pressure q within the area R than a thin spring does, it will accordingly be exposed to a smaller pressure Q than a thin spring would. The pressure Q on the springs fed into the pressing tool will thus vary with the thickness of the springs, and be smaller for thick springs and greater for thin ones.

Besides the pressure by conical annular dished springs it is possible to apply on the pressing tool half **22** a pressure which does not vary with the thickness of the springs. This is achieved by means of a weight Δq, on a lever **40** used for connection and disengagement of the pressure Q, said lever **40** actuating the free end of the lever **28**. In Fig. 10, the arrowed x axis to the left signifies the conditions without the weight Δq and the arrowed x axis to the right with the weight. The additional pressure of the weight causes a pressure on the pressing half **22**, which can be written

$$=\frac{b}{a}\cdot k_1\cdot\Delta_q$$

The characteristic of the last mentioned adjusting means causing a pressure

$$Q=\frac{b}{a}\cdot(q+k_1\cdot\Delta_q)$$

may be changed in many different manners, as for example:

(1) The additional weight Δ_q may on one hand be pushed along its lever and on the other hand be changed with regard to its magnitude, the additional pressure $k_1.\Delta_q$ thereby being changed.

(2) The spring housing may be displaced along the lever **28**, the gear ratio b/a thereby being changed. Simultaneously with b/a increasing or decreasing, the value of q for a certain change of the spring thickness t increases or decreases.

(3) The cup-spring housing may be raised or lowered by means of screws **42**, the working range of the springs thereby being displaced within the adjustment-area R of the spring characteristic.

(4) The dimensions and number of the springs may be changed and therewith also the pressure.

(5) Progressive springing may be obtained (not shown on the drawing). This is achieved by varying the number of working springs with the preceding pressing. The springs are thereby arranged so that part of them are not actuated until after a certain movement, either owing to their being without tension when they begin to work, or owing to their having a certain tension when they start working. In the latter case a jump in the spring characteristics will ensue. If a great number of springs are arranged to start working at different points, a relatively smooth curvature of the resulting characteristic can be obtained.

Owing to these possibilities of change, it is possible to choose a characteristic of the regulating means suitable for each conceivable contact spring material and consequently causing such a pressure on each separate contact spring, that the tension of the springs is the right one or does not differ from the right tension more than is determined by the allowance limits of the tension.

Besides the device shown in Fig. 10 other methods may also be used to produce a greater pressure Q for thin springs than for thick ones. In a detail of a changed embodiment shown in Fig. 13, the cup-springs system **33**, **34**, **35** is, compared to the device in Fig. 10, replaced by a link and spring system **50**, **51**, **52**, **53**. A link **51** is at one of its ends turnably cradled in a fixed point **50** and at its other end turnably connected with a link **52**, which at its other end actuates the lever **28**. The junction point of the links is actuated by a normal draw spring **53** with linear characteristics.

The power characteristic of the system, the pressure q as a function of the distance x, which is shown in the diagram in Fig. 13, is a hyperbola curve. For increased x-value the pressure q decreases.

The other details of the device are identical with those shown in Fig. 10, and are therefore not drawn in Fig. 13. It is naturally possible to have the link system operate the pressing tool directly without lever, whereby however a greater power q and a smaller movement x are required.

To feed the springs into the tool it is required, on one hand that the pressure of the lower tool half be reduced, and on the other hand that the upper tool half be lifted in order to leave space for the displacement of the springs. The reduction of the pressure takes place in the following manner: the lever **40** is lifted, being under the influence of the movement of a vertical arm **39** turned upwards round its point of bearing **41**, when the free end of the lever **28** is also lifted upwards and therewith the shaft **35**. The vertical arm **39** of the operating means, which operates the lever **40**, is provided with an oblong groove **47**, by means of which the outer lever is disengaged at its left end in working position. The upper tool half **21** is lifted by the stop **20** being moved to the left in Fig. 10 and simultaneously raised due to the diagonal guiding groove **43**. Both these movements, that of the arm **39** and that of the stop **20**, can be controlled by means of an operating shaft **44** and of cam discs **45**, **46**, or in any other known manner. To said operating shaft may also be connected the feeding means for the springs. The feeding can be achieved very simply if the springs are cut so that they hang together in blanks with two bridges or, tongues **93**, **94** (Fig. 11) in the part **95** designed for anchoring, but are free at their front or contact ends **91**, thus keeping their individuality. The spring blank may either be allowed to pass directly from the stamping machine to the bending machine, or else be wound up after stamping in a box, which is then moved to the bending machine. The springs should suitably have been provided with contacts before bending.

Fig. 11 shows such a feeding device. The blank **60** forming the partly joined springs **91**, **95** is moved over a roller **92** from the right to the left on the drawing in the direction of the arrows and comes either directly from the stamping machine or from a magazine. The front or contact ends **91** of the springs are moved through the bending tool **61**, **62** and over a roller **90** on a driving shaft **63**, driven by the same motor which drives the operating means for the tool according to Fig. 10. The operating movement of the bending machine may also be effected by means of the press which stamps out the spring blank. The blank is thereafter wound on a magazine drum **64**. In order that the bending tool may be seen better, parts of three springs are removed in the drawing.

The bending of the springs proceeds in the following way. The blank **60**, Fig. 11, is moved forward, whereby one spring at a time with its end **91** centers between the two halves **61**, **62** of the bending machine. As this forward movement is regulated from the same motor, which controls the movement of the bending machine, the two halves **61**, **62** are pressed against each other at the moment a spring is placed between them. This is obtained by the regulating device shown in Fig. 10 and with a higher pressure for a thin spring than for a thick one. The two halves **61**, **62** are separated as described in connection with Fig. 10 and the next following spring is placed between them.

If for some reason the springs cannot be in form of a continuous blank, it is possible, without difficulty, to feed loose springs to the bending machine, for example by providing an endless control blank driven by the operating shaft. The springs can be arranged into the control blank manually or automatically. Fig. 12 shows a feeding device for loose springs. An endless conveyor **66** with guiding pins **67** for the springs is guided by rollers **96** and **97** and is driven by a shaft **68** supporting roller **96**. Shaft **68** is driven by the motor also driving the tool according to Fig. 10. The upper half of the blank is driven from the right to the left on the drawing. The springs **69** are applied onto the right part of the blank and led under a springy bar **70**, in order to prevent them from loosening from the blank. Thereafter, the springs pass the bending tool **71**, **72**, the tool itself determining the position of the spring at bending. The springs are ejected from the conveyor at its left side. Other embodiments of the spring control may naturally be thought of. Thus the conveyor may for example be made to guide the front and rear ends of the springs, a recess for the bending tool being provided in the conveyor.

A condition for the spring to obtain the right bending is, that is is plane before bending, at least outside the bending range. At loose springs (i. e. which do not form a continuous blank) and especially with springs divided into two tongues at their front end, the front part is usually not plane. In order to eliminate a fault of this kind it is suitable to planish the spring wholly or partially for example by point straightening. The planishing may take place immediately before the bending in a series tool in connection with the point bending. The bending of the spring should be carried out so as just to extend to the part of the spring intended for anchoring. That part of the spring, which is planished, must exceed the

bending range. The pressing surfaces of the two tool halves should furthermore continuously move apart from each other outside the press-range, so that no bending of the spring at the edge of the press-range takes place.

There exist other methods than point bending which may be used advantageously for bending. One method consists of feeding the springs between two rolls having a suitable curvature and smooth or serrated surfaces. By regulating the pressure between the rolls the bending can be fitted so that the springs have a constant tension in working position. A higher roll-pressure is also required at rolling for a thin spring than for a thick one. Therefore, the adjustment may be achieved in the same manner as has been shown with regard to point bending in accordance with the example described with reference to the drawing.

When the shown bending machine is working, it is suitable to check now and then whether the pressure on the bent springs is the right one or lies within the tolerance limits. This can be effected manually or at an automatically working control station, which is then provided with pressure measuring means and either a servo-regulating means or an alarm device. If the spring pressure lies outside the tolerance limit the bending machine must be adjusted. This operation may be effected manually after alarm has been given from the control station, or automatically by means of servo-regulation or any of the methods for changing the characteristic of the regulating means indicated in the points 1—5 above.

We claim:

1. A device for curving blank material in form of strips of various thicknesses for use as contact springs in electromagnetic devices, comprising curving means including two coacting pressure members movable relative to each other for exerting a curving pressure upon a strip placed therebetween, and pressure regulating means for varying the pressure exerted by said pressure members so as to decrease said pressure with increasing thickness of the strip material, said pressure regulating means including elastically deformable means having a pressure characteristic negative with increasing pressure, means responsive to the thickness of the strip material and coacting with said deformable means for applying a pressure to the latter increasing with increasing thickness of the strip material, and transmission means controlled by said deformable means and coacting with said pressure members to vary the pressure therebetween as a function of the pressure upon said deformable means.

2. A device according to claim 1, wherein one of said pressure members is stationarily and the other movably mounted, the coacting surfaces of said pressure members being curved in accordance with the desired curving of the strip material.

3. A device according to claim 2, wherein the said coacting surfaces are formed with protrusions adapted to penetrate into the material of a strip placed between the two pressure members.

4. A device according to claim 1, wherein one of said pressure members is stationary and the other movable, and wherein said transmission means comprise lever means connecting said movable pressure member with said pressure regulating means for transmitting the pressure varying effect of the latter to the movable pressure members.

5. A device according to claim 4, wherein the said elastically deformable means comprise at least one springy dished ring, mounting means peripherally supporting said ring, said lever means effecting a deflection of said ring corresponding to the spacing between the pressure members, the resulting loading of the ring causing said variation of the pressure exerted by said pressure members upon strip material placed therebetween such that the pressure exerted by said pressure members decreases with increasing thickness of the strip material.

6. A device according to claim 5, wherein the said

lever means comprise a two-arm lever pivotal about a fulcrum, one arm of said lever engaging said movable pressure member, and wherein a rod disposed coaxially with said ring transmits a deflection of the latter to the other lever arm and a pivotal movement of said arm to the ring.

7. A device according to claim 6 and further comprising constant load means coupled with said lever so as to add a constant increment of pressure to the pressure transmitted by the lever to the movable pressure member by the effect of said springy ring.

8. A device according to claim 7, wherein the said constant load means comprise a weight means and lever means coupled with the said other lever arm of said pivotal lever.

9. A device according to claim 8, wherein the said weight means is shiftably supported by said lever means for varying the magnitude of said transmitted increment of pressure.

10. A device according to claim 1, wherein said elastically deformable means comprise spring means including a plurality of superimposed springy dished rings, mounting means peripherally supporting said rings, the said superimposed discs being successively deflected for correspondingly varying the total loading of the spring means.

11. A device according to claim 1, wherein one of

said pressure members is stationary and the other movable, and wherein the said self-setting control means comprise a pivotally mounted two-arm lever engaging with one arm the movable pressure member, linkage means including two pivotally connected elements, one of said elements being pivoted with its free end to a stationary point and the other being linked with its free end to the other arm of said lever for varying the relative position of the linkage elements upon pivoting of said lever, and loaded yieldable means having one end fixedly mounted and the other connected to the pivot point linking the two elements of said linkage means for loading the linkage elements with a load controlled by the pivotal position of said lever.

12. A device according to claim 11, wherein the said yieldable means comprise a coil spring having a linear characteristic.

References Cited in the file of this patent

UNITED STATES PATENTS

805,508	Stambaugh	Sept. 26, 1905
1,750,471	Hoover	Mar. 11, 1930
2,162,719	Hay	June 20, 1939
2,308,475	Fawkes	Jan. 12, 1943
2,490,320	Pashby	Dec. 6, 1949