Aug. 1, 1950 R. D. HELLER 2,517,309

WIRE STRAIGHTENER

Filed May 16, 1947 3 Sheets-Sheet 1

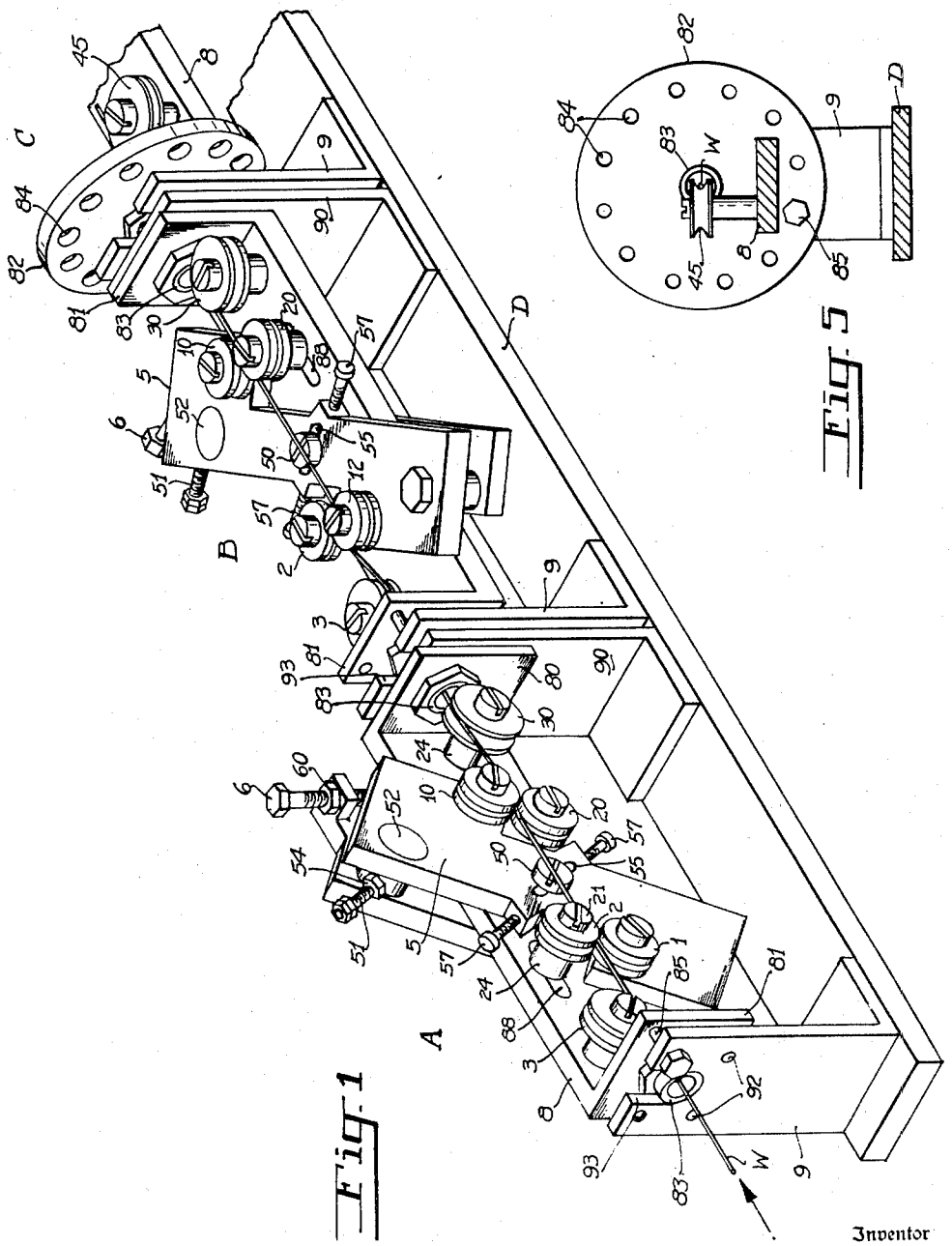

Fig. 1

Fig. 5

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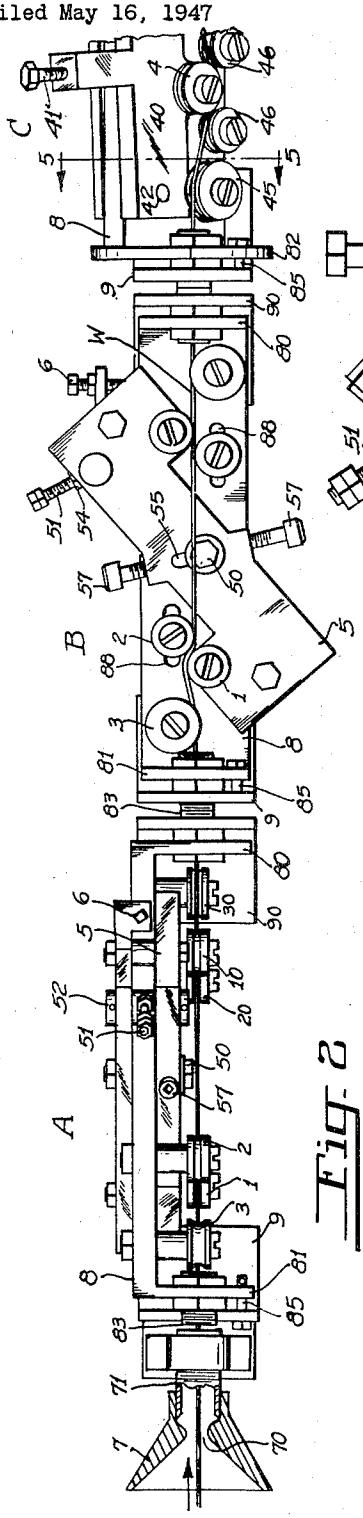

Fig. 2

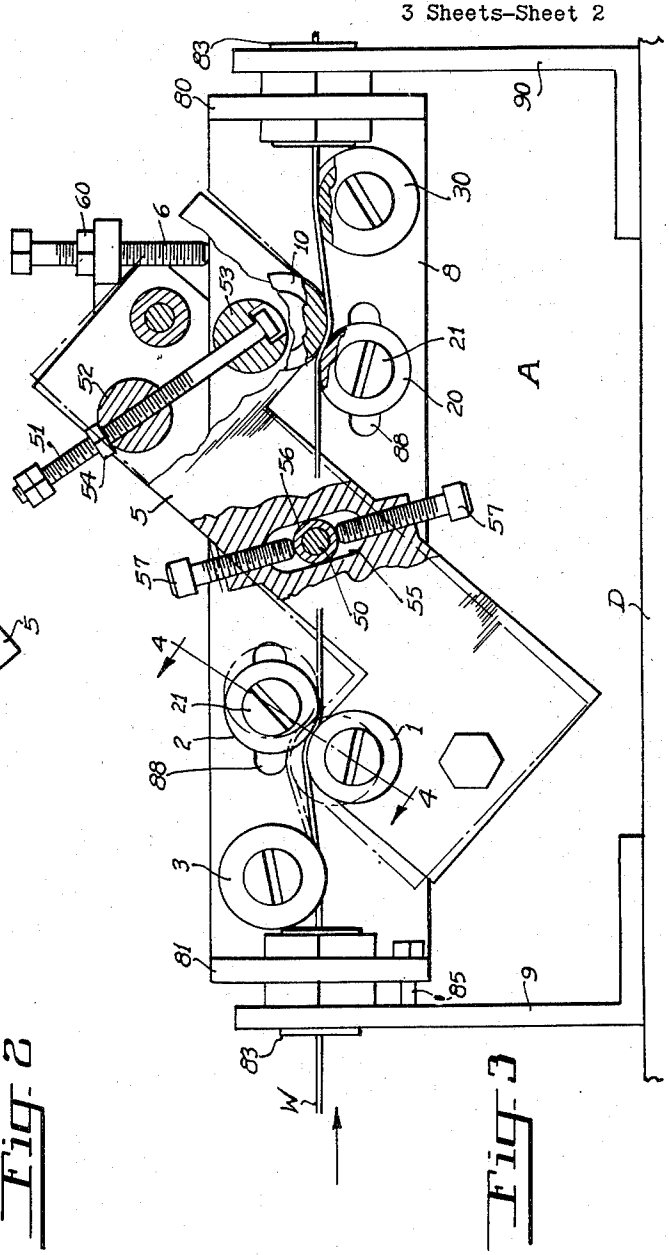

Fig. 3

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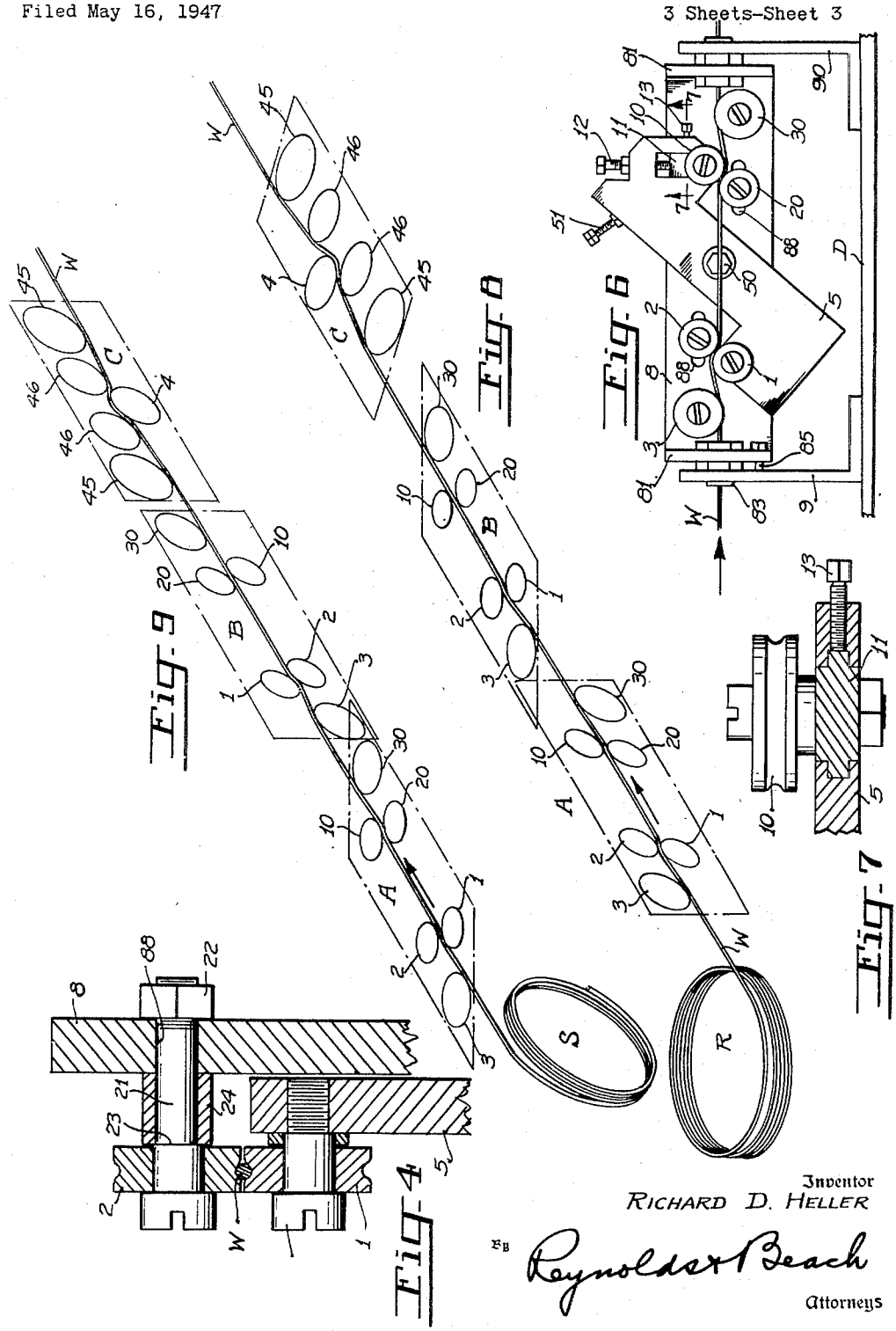

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UNITED STATES PATENT OFFICE

2,517,309

WIRE STRAIGHTENER

Richard D. Heller, Tujunga, Calif.

Application May 16, 1947, Serial No. 748,391

7 Claims. (Cl. 140—148)

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The present invention concerns a wire straightener of somewhat the same nature as the subject matter of my prior and copending application, Serial No. 695,497, filed September 7, 1946, and is intended for a similar purpose. Whereas that application was concerned primarily with the straightening of wires of high carbon or stainless steel, of high tensile strength and of larger gauge or diameter, by gentle, cumulative deflections away from and back to the strand's path, with an intervening abrupt reverse deflection, and was not so much concerned with softer wires, nor with hard wires of smaller size, the present invention is primarily, but not exclusively, concerned with the straightening of wires of softer material, and can accomplish the straightening by more frequent and more abrupt deflections without injury to such wire. While on the point, however, it should be made clear that though the desire to achieve the end indicated led to the present invention, nevertheless this invention is also well adapted to the straightening of hard wires of the larger diameters, say from .033" upward, and it is particularly well adapted to the straightening of wires in sizes ranging downward from that diameter, whether of hard material and high tensile strength, or of softer material and lower tensile strength. Accordingly, the present invention differs somewhat from the invention of somewhat restricted usefulness of my application Serial No. 695,497 in that the present invention is of substantially universal application to all sizes and all hardnesses of wire and is, therefore, particularly well adapted to the straightening of soft wire in all sizes.

From the above may be ascertained one of the objects of the present invention, namely, the provision of a machine of substantially universal application in the straightening of wire, and one which is capable of such flexibility and range of adjustment as will adapt it for use upon wires of various hardness and of various size, without danger of undue weakening of or injury to the wire, particularly in the larger sizes and greater hardness.

It is also an object of this invention to provide a wire straightener which is so flexibly adjustable that it satisfactorily removes substantially all types of curvature likely to be encountered in unreeling wire strands, and precisely straightens the wire, yet with a minimum of mechanism, and with a minimum of bending and counterbending of the wire, such as may adversely affect the strength or hardness of the strand.

The present invention attacks a problem not

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discussed in my prior application, namely, the removal of the helical set which sometimes is present in coiled wire in addition to the normal coil set, the removal of the latter being the sole object of most wire straighteners. This problem of helical set is encountered principally in dealing with soft wires. Wires, when reeled or coiled, are ordinarily annealed slightly in order to retain them in coil form, that is, to give them the coil set, so that they will not tend unduly to unwind or straighten out when restraint is removed from them. Occasionally the wire is so coiled that when annealed it acquires a helical set, in addition to the coil set, this helical set tending to expand the coil in the direction of its axis. Unless this helical set is neutralized, the wire is not straight, however much its coil set may be neutralized, and this at times becomes troublesome in the subsequent use of the wire. Unless the wire is bent so repeatedly and rapidly as to anneal it and thereby overcome all possible bending, with resultant weakening, or alternatively is bent specifically in opposition to its coil set, the latter will not be overcome. One of the objects of the present invention is to provide a wire straightener which, as a matter of routine, will neutralize this helical set, but which, if the wire being uncoiled does not possess a helical set, will not materially affect the nature and strength of the wire, nor its ultimate straightness.

It is a still further object to provide a wire straightener of minimum length and requiring a minimum of power to advance the strand through it. To such ends the straightener of this invention is one in which there is primarily (though not necessarily in the sequence of their operations upon the strand) a bank of straightening wire guides or rollers to neutralize the helical set, a similar bank somewhat differently adjusted and arranged to neutralize the coil set, and a final bank adjustable preferably through 360° about the axis of the strand, arranged in such manner as precisely to neutralize any residual curvature which the strand may have as it emerges from the last of the first two banks.

It is also an object of this invention to effect the straightening of a wire strand with a small number of rollers or wire guides, and in particular to effect the flexing or bending of the wire to such extent as may be necessary by passing it in a novel manner and according to a novel method between two paired rollers, and by so doing, instead of employing three or a larger number of rollers, to minimize and control with accuracy the flexure which otherwise tends unduly to

weaken the wire, particularly in the case of wire of hard steel or similar material. Otherwise stated, it is desirable to effect straightening in any given plane primarily, and perhaps solely, by the use of two rollers about which the strand passes, these rollers being arranged, relatively to one another and to preceding and following guide rollers or other forms of guide, that the strand is deflected from its normal path by, and is bent sharply about, only one of these two rollers, and the second such roller merely holds the strand to and bends it about the first roller, and itself lies in such relation to the strand's path that it will not deflect nor counterbend the strand materially. The provision of the above, which is believed to be novel in principle, is an important object of this invention.

Also, by lessening the number of bends and counterbends necessary to effect the desired straightening, rotation of the strand about its own axis, during straightening, is prevented, and thereby become attainable further objects, namely, more exact control of the plane of straightening as related to the plane of any set in the wire, and precision correction for any residual set, in any plane rotated 360° about the strand's axis, after normal corrective measures in two generally perpendicular planes to remove or neutralize helical set and coil set.

The provision of a wire straightener to the ends indicated which is rugged, reliable, easily threaded, and accurately returnable to any given adjustment, and capable of long and accurate use, is a further object of the invention.

Other objects, and particularly those which pertain to the mechanical details and arrangement of the various parts, will be understood as this specification progresses.

The present invention comprises the novel wire straightener apparatus, and the novel method of straightening wires, which is shown in the accompanying drawings, which will be more fully described in this specification, and which is defined in the claims which terminate this specification.

In the accompanying drawings the invention is shown embodied in mechanical forms such as are well calculated to achieve the ends indicated, but it will be remembered that the principles of the invention, as defined in the claims, may be embodied in other and varied forms without departing from the spirit of the invention.

Figure 1 is an isometric view of the first two banks and a portion of the final bank, showing parts in operative relationship to a wire strand which is being straightened.

Figure 2 is a plan view of the same machine similarly set up.

Figure 3 is a side elevation partly broken away of one such bank, somewhat enlarged.

Figure 4 is a detail section taken substantially along the line 4—4 of Figure 3, illustrating the manner in which the paired rolls cooperate in gripping a wire strand.

Figure 5 is a transverse section substantially along the line 5—5 of Figure 2, illustrating the third or final straightening bank.

Figure 6 is a view similar to Figure 3 illustrating a slightly modified arrangement for adjustment, and Figure 7 is an enlarged sectional view substantially along the line 7—7 of Figure 6.

Figure 8 is an isometric diagram showing the manner of arrangement of the banks for removing the sets of curvature from a coil which has its general plane horizontal while being uncoiled, as from a swift, and Figure 9 is a similar isometric diagram showing the preferred manner of arrangement of the banks when the coil is uncoiled while its general plane is vertical, as from a reel.

When a wire has a helical set, the coils tend to extend along the axis of the coil, as is suggested in Figures 8 and 9. This is due to a very slight curvature transverse to the coil set, but unless this helical set is eliminated, that is to say, if the straightening operation concerns itself only with the coil set, the helical set, not being necessarily neutralized, will still tend to remain in the strand and will be troublesome when the wire is put into use. Since the preferred principle of straightening a wire strand, particularly in soft or low carbon steel, is to bend the wire directly oppositely to its set to remove the same, rather than to knead or flex it indiscriminately, it is desirable and important that this helical set be attacked directly rather than obliquely or indirectly. Accordingly, in the present mechanism and method, a bank of rollers is provided which will effect a straightening operation in the plane wherein lies the helical set, that is, transversely of the general plane of the coil. Similarly, since the coil set should be directly attacked by counterbending directly oppositely to the coil set, a second bank of straightening rollers is provided, which operates in the general plane of the coil to neutralize the coil set.

It is desirable, particularly with hard or high-carbon steel wire, that counterbending be kept to a minimum, both in abruptness and in number of counterbends, for such bending, particularly if repeated in rapid succession, tends to lessen the wire's tensile strength unduly. It is also desirable to maintain the length of the wire straightener as short as possible, for each bend and counterbend may rotate the strand about its own axis, until the straightening operations produce actually a corkscrew effect. In order to accomplish both these ends, such counterbending as is accomplished is done with the least abruptness consistent with the desired results, and only a few times, preferably not more than twice in each bank. The abruptness of the counterbending to counteract the helical set need be but very slight, and yet however slight it may be, if it is accurately oriented, it is almost certain that it will be amply sufficient to overcome the very minute curvature which gives rise to the helical set of the coil. Accordingly, such counterbending as is accomplished for the purpose of counteracting helical set, though small in amount, and repeated but once, and therefore but little likely to weaken the wire, is considered to be ample to overcome any probable helical set, and is preferably employed whether or not the wire has a helical set. It does not materially affect the strength of the wire, nor tend materially to rotate the strand about its own axis, and yet the minimum of counterbending is sufficient to neutralize helical set and to leave the strand straight when the counterbending is substantially equal at the two points where it occurs. Residual components of the helical set need not be taken into consideration after such overriding counterbending at the two points involved.

In the counterbending to overcome the coil set, however, the bending reversely to the coil set is almost necessarily greater than any reversal of that counterbend back to straightness, and the bank which accomplishes the neutralization of the coil set has its parts so arranged, preferably again at not more than two points, to accomplish

a greater degree of bending counter to the coil set, and then a minimum or lesser amount of reverse bending, calculated in amount with relation to the degree of initial counterbend as to leave the strand precisely straight. Furthermore, since it is desirable that the two banks already referred to be substantially identical in mechanical construction, it will be recognized that each must be flexibly adjustable in order that any one of them may accomplish the varying degrees of bending required by these somewhat variant ends.

Since it would scarcely be possible under all circumstances, and with all sizes and types of wire, to accomplish precisely the right amount of bending in precisely the correct planes to remove all curvature from the wire in the two banks, having desirably a total of not more than four operative points of bending, yet since it is desirable that the length of the wire straightener be kept to a minimum, it is preferable to employ a third or final bank adjustable about the strand as an axis, which will engage the strand after its passage through the first two banks, in such manner as to remove any residual bend, in whatever plane such residual bend may lie.

It is not material to the operations already discussed whether the counteracting of the helical set, if any, or the counteracting of the coil set, occurs first. Either may be accomplished first, and hence it is largely a matter of choice and convenience that in the invention as herein shown and described the neutralization of the helical set is first accomplished, followed by the neutralization of the coil set.

The general principles of the invention just described will be more clearly understandable after studying the description of the mechanism, which follows.

For convenience and rigidity the entire device may be mounted upon a base D whereon are secured the standards 9 and 90 of each of the banks. The several banks are designated generally by the letters A, B, and C. Each bank includes a bracket 8 of generally U-shape, the ends 80, 81 or 82 whereof lie adjacent and between the standards 9 and 90 of the bank, and these brackets are provided with bushings 83, received in slots 93 in the upper edges of the respective standards, whereby each bracket may rotate about its bushings 83 as a center. All these bushings are aligned throughout the machine, and the wire strand W extends through them to define the general axis of the machine. The only difference between the standards 9 and 90 is that the standards 9 are provided with one or more threaded apertures 92 for the reception of an adjusting bolt 85 or the like, whereby the brackets 8 may be secured in several angularly rotated positions about the axis defined by the wire strand W. Normally the brackets of the banks A and B are adjustable only by 90° intervals and are maintained each relative to the other at angles of 90°. The bracket of the bank C, however, should be adjustable by small angular increments throughout the entire range of 360°, wherefore its end flange 82 is provided with a plurality of holes 84 for the reception of its bolt 85.

Carried upon the brackets 8 of each of the banks A and B is a lever 5, somewhat Z-shaped in elevation, and which, while formed of two separated parts so that it may straddle the brackets 8, is in effect but a single lever. This lever is fulcrumed between its ends, as indicated

generally by the bolt 50, and it extends somewhat transversely to and across the wire strand, so that its one end lies generally above the wire strand, in the case of the bank A in Figure 1, and its other end lies below the strand. This lever, thus fulcrumed, may be tilted by such means as the adjusting screw 51 threaded within a nut 52 (see Figure 3), which is oscillatably mounted in the lever 5, the end of the nut being swiveled in a transverse post 53 which is oscillatable in the bracket 8. A lock nut 54 serves to retain parts in any given position of adjustment.

The wire strand guides are preferably in the form of rollers of such diameter, particularly with respect to the size of wire being straightened, as will afford a bend of abruptness which is the minimum necessary in order to achieve the required bending of the wire, having regard to the latter's diameter and hardness. They are arranged in part upon the bracket 8 and in part upon the lever 5. A roll 3, mounted upon the bracket 8, is first encountered by the strand, this preferably being a deeply grooved roller the function of which is primarily and almost solely as a guide to retain the strand in alignment with the following rollers. The strand next encounters a roller 1 which is mounted upon an end of the lever 5, and then a roller 2 which is mounted upon the bracket 8. These two rollers 1 and 2 constitute a pair, and are shallow grooved and so close together that they nearly touch one another, but tend to grip the strand between them, and to force it to follow about the grooves' peripheries. Ordinarily the rollers 1 and 2 would be so arranged relative to one another, by certain adjustments already mentioned or hereafter to be mentioned, that the roller 1 extends across the path of the strand to deflect it, while the function of the paired roller 2 is primarily to hold the strand closely to the deflecting roller 1, and to deflect it to the minimum in the opposite direction. The strand then encounters a bracket-mounted roller 20 similar to the roller 2, and a lever-mounted roller 10 paired with the roller 20, and which corresponds generally to the roller 1. The final roller in the bank is the guide roller 30, deep-grooved and corresponding generally to the roller 3. It insures that the strand on leaving the bank is disposed generally in the rotative axis of the brackets.

With respect to the rollers 1 and 2 the roller 20 constitutes a strand guide, widely spaced from the paired rollers, and especially from the holding roller 2. Conversely, with respect to the rollers 20 and 10 the roller 2 constitutes a strand guide, widely spaced from the paired rollers 20 and 10. The rollers 3 and 20 may be considered widely spaced strand guides, intermediate which are located the paired bending rollers 1 and 2, which are close to one another. The normal path of the strand would be from roller 3 to roller 20, but the roller 1 deflects the strand more or less abruptly from that path (depending upon the transverse adjustment of the roller 1), while the roller 2 holds the strand to the roller 1, about an appreciable angular extent, sufficient to give the desired bend to the wire, counter to any set it may have. The strand then leaves the roller 2, about which it extends a lesser angular distance than about the roller 1—for the roller 2 lies in or close to the undeflected strand path—and hence which has little tendency to counteract the bend given by the roller 1. This is a new departure in wire straighteners, wherein heretofore the deflecting roller was midway be-

tween and spaced from two other rollers, the latter of which so nearly counteracted the bend of the "bending roller" that repeated further bending, to a progressively lesser degree, was required to effect the desired result, and the wire's strength suffered by such rapidly repeated abrupt reversals, and the strand tended thereby to rotate about its own axis. My copending application, Serial No. 668,789, filed May 10, 1946, and issued February 22, 1949 as Patent No. 2,462,396 is an example of the type just referred to. By effecting a single bend, with minimum following counter-bending, the wire's strength is preserved, and accuracy of the plane of bending is maintained. This result follows from the use of only two paired rollers, one holding the strand wrapped about the other, disposed intermediate widely spaced strand guides.

The banks A and B are alike in mechanical construction, but differ somewhat in the relative adjustment of the parts. The bank C, however, is preferably substantially identical in construction to the individual banks disclosed in my copending application Serial No. 695,497, referred to above. This final bank C includes preferably a large guide roller 45, a smaller roller 46 both mounted upon the brackets 8, a bending roller 4 adjustably mounted with respect to the rollers 45 and 46 by reason of its mounting upon a lever 40 adjustable by means such as are as indicated at 41 about the pivot 42, or adjustable to the same end by any other suitable means. The set of five rollers in the final bank C is completed by duplicates of the rollers 46 and 45 already mentioned, as is more fully shown in the copending application referred to.

It will be noted that in addition to the tilting adjustment of the lever 5 about its fulcrum at 50, accomplished by means of the adjusting screw 51, the fulcrum 50 is in effect shiftable with respect to the lever, through actually the lever is shiftable with respect to the fulcrum. To this end the lever is provided with a more or less transversely disposed slot 55, wherein is received the fulcrum bolt 50 and its surrounding sleeve 56, and the shifting of the lever 5 is accomplished by means of the opposed adjusting screws 57.

In addition to these adjustments a further adjustment is provided, lengthwise the strand's path, for the rollers 2 and 20. The bolt 21 whereon each is journaled is received within a slot 88 which extends lengthwise of the bracket 8, parallel to the strand's path, where it is maintained in any given adjusted position lengthwise of the slot by the clamping nut 22 reacting between the rear side of the bracket 8 and a shoulder 23 on the bolt 21 through the spacer 24 (see Figure 4).

It is the intention that the rollers 1 and 2, 10 and 20, be readily removable and replaceable by rollers having varying depths of grooves and possibly having different relative diameters in order differently to affect wires of different size, and requiring different degrees of abruptness of bending. The slot 88 would be particularly advantageous in adjusting the paired rollers 1 and 2, 10 and 20, respectively, when rollers of different diameter are substituted for those already in place. However, normally the adjustment by means of the slot 88 is for the purpose of accommodating the position of the roller 2 or 20 with respect to the respectively paired rollers 1 or 10, in such position of adjustment of the lever-mounted rollers 1 and 10 as is accomplished by rocking of the lever 5 about its fulcrum 50. The object in each case is to cause the paired rollers

1 and 2 or 10 and 20 to approach one another so closely that the wire strand has just room to pass between them, and to accomplish, as it is passing about them, a bending of the strand about one or the other or both such rollers of a pair.

It is evident that by the adjustment of the fulcrum 50 with respect to the lever 5, or vice versa, it is possible to cause one of the lever-mounted rollers, for instance the roller 1, to project farther than the other lever-mounted roller 10 beyond the normal axis of the strand, that is, to cause the strand a greater deflection than is caused as it passes over the other such roller 10. Such an uneven adjustment is shown in dot-dash lines in Figure 3, and this may be caused by adjustment of the screws 57 to shift the lever 5, as it were, upwardly, as viewed in that figure, with respect to its fulcrum 50. When any such adjustment has been made, corresponding lengthwise adjustment of the paired bracket-mounted rollers is necessary in order to preserve the nearly-contacting relationship between the paired rollers 1 and 2 or 10 and 20. Moreover, when such tilting adjustment is made, by means of the adjusting screw 51, such tilting causes adjustment of the two lever-mounted rollers by corresponding ratios, to maintain their ratio of deflection, though the degree of deflection of each thereof may change.

In similar fashion to the adjustment of the rollers in the banks A and B, the bending roller 4 in the bank C may be adjusted by rocking the lever 40 about its fulcrum 42 by means of the adjusting screw 41, in the manner and to substantially the same end as is explained in the copending application Serial No. 695,497.

Before proceeding to the description of the method and the manner of operation of the mechanism, it may be pointed out that a stop or gauge means is shown in connection with the levers 5, which takes the form of a gauge screw 6 threaded in an end of the lever 5 in position to contact the bracket 8 which mounts this lever. A lock nut 60 will hold this gauge screw in any given adjusted position. Once the proper adjustment for a given size and quality of wire is accomplished, the gauge screw 6 is adjusted to touch the bracket 8 and is locked in this position. Now when a given batch of wire has been run through, it is necessary to thread the next batch or coil through the machine, and to this end it is necessary to back off the lever-mounted rollers 1 and 10 from their paired rollers 2 and 20. In other words, the delicate adjustment of the machine is interfered with. However, once the new strand is threaded through it, assuming the new strand to be of the same size and quality as was previously operated upon, it is desirable to bring parts back to precisely the same position of adjustment. This is done by so adjusting the lever 5 that the gauge finger 6 again contacts the bracket 8, whereupon it is safe to assume that the adjustment of the parts is substantially the same as before.

Referring now to Figures 8 and 9, it may be assumed in Figure 8 that the strand is being uncoiled from a coil which is disposed with its axis vertical and its general plane horizontal. Such a coil is shown at R in Figure 8, and it will be noted that the topmost coil tends to separate axially from the remainder of the coil. In other words, this coil has a helical set. Since, as a matter of choice, it is preferred to deal first with this helical set, the first bank A is disposed in such man-

ner that the plane common to its several wire-guiding rollers is transverse to the general plane of the coil R, that is, the plane of the rollers is substantially vertical. If parts are not so disposed, they can be quickly shifted to this position by disengaging the screw 85 and reengaging it in one of the holes 92. The strand is threaded beneath the roller 3, over the roller 1, under the roller 2, over the roller 20, under the roller 10, and over the roller 30.

In the second bank, by choice, the coil set is neutralized, and hence the plane common to its several wire-guiding rollers should be parallel to the general plane of the coil R, consequently the bracket 8 in the bank B is set horizontally, and again the strand is threaded in the manner already described through the several rollers of this second bank.

Issuing from the second bank, the strand is threaded over the rollers 45 and 46 of the third bank, under the wire-bending roller 4 of this third bank, and then over the rollers 46 and 45, whence it is discharged from the wire-straightening machine.

Now preliminarily to any straightening operation the lever 5 of the bank A is adjusted to bring its rollers 1 and 10 into such position that they project substantially equally, but from opposite sides, across the path of the strand, and this projection is by but a slight amount.

The rollers 2 and 20 are now adjusted, each with respect to its paired roller 1 and 10, so that the paired rollers grip the wire as it passes between them, and provide approximately equal counterbending at each of these two pairs of rollers. The rollers 3 and 30, which are appreciably more deeply grooved, serve primarily as guides and do not participate in the bending function.

The lever 5 of the bank B is adjusted, meanwhile, to shift its fulcrum point in such manner that one or the other of the lever mounted rollers 1 or 10 projects to an appreciable distance across the path of the strand, more than does the other such roller. In the drawings it is the roller 1 which thus projects farther than the roller 10. Indeed, the roller 10 may project but slightly, if at all, across the path of the strand. The roller 1, then, becomes the primary bending roller to counterbend the strand in the direction opposite its coil set. Normally the counterbend is sufficient to bend the strand somewhat past a straight condition, and in such case the roller 10 with its companion roller 20 is so adjusted as to bend back the strand slightly in the direction of the original coil set, and to leave the strand approximately straight. It is not outside the scope of the invention, however, to accomplish such bending solely and entirely by means of the rollers 1 and 2, so that the wire is left substantially straight as it passes therefrom, in which case the rollers 10 and 20 would be so adjusted as to have no appreciable bending function, and would serve merely as supplemental guides.

With banks A and B adjusted approximately correctly, a test run is made. Through the bank A, however, slightly the wire may be bent and counterbent, it is therein stressed far more than any stressing which gave it its helical set, so much so, in fact, that the helical set becomes negligible and is overcome and canceled out by the bending and counterbending at the rolls 1 and 2, 10 and 20, respectively. Henceforward the helical set can be disregarded. Now the strand passes into the bank B and the coil set is taken out of it, either by precisely equivalent counterbending at

the rollers 1 and 2 or by a somewhat excessive counterbending at these rollers followed by reverse bending at the rollers 10 and 20. The aim is to complete the straightening of the wire by the time it emerges from the bank B. However, it will ordinarily be found that the wire is not precisely straight as it emerges from the bank B. Rather than attempt, by delicate adjustment of the parts in banks A and B, to correct for this small amount of error, it is preferable to correct for it in the bank C by rotating the bracket 8 of this bank into such position about the strand as an axis that the relatively mild bending which it is given in this bank C by the roller 4 is just exactly sufficient in amount and in direction to cancel out and remove the residual curvature. By rotation of the bracket 8 in the bank C, the direction or plane of the final straightening can be regulated, and by adjustment of the transverse position of the roller 4 by means of the adjusting screw 41, the amount of such bending can be determined. It may be seen in Figure 8, which was chosen as the first example, how the plane of the rollers in bank C is nearly parallel to the plane of the rollers in bank B, yet is somewhat rotated with respect to the plane of the rollers in each of the banks A and B.

If the coil S is placed with its axis horizontal and the general plane of the coil vertical, then the brackets 8 of the banks A and B should ordinarily be rotated through 90°, or their rollers could be so adjusted that the coil set is dealt with in the bank A and the helical set in the bank B. Figure 9 shows the parts in the same position of adjustment within each bank as in Figure 8, but with the brackets in the banks A and B each rotated through 90° to deal with a coil, the axis of which is at 90° to the axis of the coil R in Figure 8. Here the bank C is more or less in parallelism with the bank B.

It is desired to repeat for emphasis that the bending is accomplished, as may be seen best by reference to Figure 3, by deflecting the wire more or less abruptly and forceably about a roller such as 1, by confining the effect of the paired roller 2 holding the wire to and about the roll 1. There is also some bending as the wire straightens out in passing from the roll 2. These two paired rolls, as may be seen best in Figure 4, do not contact one another, and because such contact is undesirable, it may be necessary, as has already been indicated, to change the rollers from time to time as wire strands of different diameter or gauge are to be straightened. In each bank, then, the wire is given some bending about one of the rolls 1 and perhaps as much reverse bending, or a different degree of reverse bending, about the rolls 20 and 10, but all the bending is accomplished as it passes between these two pairs of rolls. The degree of bending is nicely adjustable by regulating the adjustment of the fulcrum 50 and the longitudinal adjustment of the rollers 2 and 20. Because the bending is not repeated but is concentrated at a few points, the annealing effect upon the wire is a minimum, and consequently it loses a minimum in strength by the straightening operation, or, in the case of soft wire, the working and toughening effect is a minimum. The strand is held against rotation about its own axis while the straightening is being accomplished by reason of the gripping and relatively abrupt bending about the rollers 1 and 2, 10 and 20 of the banks A and B. Because there is a minimum of weakening of the wire, such a method and such mechanism are well adapted to the straightening

of hard wire, such as wire of high-carbon steel, where minimum loss of strength is highly desirable, yet it is equally well adapted to the straightening of low-carbon steel wire, which is softer, since such wire tends to retain any corrective set given to it without repeated bending back and forth. Moreover, the entire straightener becomes much more open and accessible than previous straighteners, and it is much simpler to thread the strand through it. The device and method are as well adapted to wires of small diameter as to wires of large diameter, by proper choice of roller sizes and groove depths.

Because softer wires sometimes have a tendency to kink as they are being drawn into and through the machine, I have found it desirable at times to provide a lead-in funnel 7 with a restricted throat 70 leading to a bushing 71 by which the wire is delivered in alignment with the first guide roller 30. The funnel 7 tends to iron out any kinks or abrupt twists or bends in the wire and to prevent the wire from jumping off the guide rollers in the bank A.

The adjustment of the position of the fulcrum 50 is only one means of accomplishing differential positioning as between the two lever-mounted rollers. The same effect can be accomplished by adjusting one or both such rollers directly with respect to its mounting lever 5, and such an arrangement is shown in Figures 6 and 7. In this instance it is the roller 10 which is mounted in a sliding block or carriage 11 guided at 59 in the lever 5, and adjustable by means of the adjusting screw 12 swiveled in the block or carriage 11. A set screw 13 additionally holds parts in any given adjusted position. The roller 1 might be similarly adjustable, but it is believed that the manner of its adjustment would be obvious if such adjustment were deemed desirable, and it is not believed to be necessary that more than one such roller be adjustable.

I claim as my invention:

1. In a wire straightener, a bracket disposed lengthwise of the path of a strand which is being straightened, a lever fulcrumed between its ends upon said bracket, and crossing such path, a roller upon each end of said lever disposed to contact and deflect the strand, each oppositely to the other, a roller paired with each of said lever-mounted rollers, disposed at the opposite side of the strand from and in the near vicinity of its paired roller, and mounted upon said bracket to dispose its periphery in the vicinity of the strand's path, means to rock said lever, thereby to vary simultaneously and correspondingly the extent of projection of the two lever-mounted rollers across the path of the strand, and means to adjust the fulcrum of the lever transversely of the strand's path, to vary the relative projection of the respective lever-mounted rollers, at each position of adjustment of the lever about its fulcrum.

2. In a wire straightener as in claim 1, means to adjust one such lever-mounted roller relative to the lever and transversely of the strand, to vary the relative projection of the respective lever-mounted rollers at each position of adjustment of the lever about its fulcrum.

3. In a wire straightener as in claim 1, means to adjust the position of each bracket-mounted roller lengthwise of the strand's path and relative to its paired lever-mounted roller.

4. A wire straightener as in claim 1, including also means mounting said bracket for adjustment angularly about the path of the strand into a plurality of adjusted positions.

5. In a wire straightener as in claim 1, adjustable feeler means engageable between the lever and the bracket to determine the adjusted position of the lever about its fulcrum, and serving as a gauge to reestablish such position of adjustment after departure therefrom.

6. A wire straightener as in claim 1, including further a duplicate bracket, lever, rollers, and lever adjusting means, said second bracket being aligned with the first bracket, means to adjust said second bracket independently of the first, to dispose the second set of rollers in a plane disposed angularly relative to the plane of the first set, and means independent of the adjustment of the fulcrum of the first lever, to adjust the fulcrum of said duplicate lever, in the plane of its rollers and transversely of the strand's path, to project one lever-mounted roller farther past the strand's path than its companion lever-mounted roller, and to project the two rollers mounted upon the duplicate lever substantially equally and oppositely past the strand's path, in all adjusted positions of the respective levers about their fulcra.

7. A wire straightener as in claim 6, further including means to adjust each bracket-mounted roller lengthwise of the strand's path, to vary its spacing from the paired lever-mounted roller.

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