United States Patent [19]

Kopczynski

[11] **3,875,978**

[45] **Apr. 8, 1975**

[54] **STRAIGHTENING MACHINE FOR ELONGATED WORKPIECES**

[76] Inventor: **John F. Kopczynski,** 1671 Sweeney St., North Tonawanda, N.Y. 14120

[22] Filed: **Mar. 22, 1974**

[21] Appl. No.: **453,792**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 286,547, Sept. 6, 1972, Pat. No. 3,799,216.

[52] **U.S. Cl.** **140/147;** 72/DIG. 10

[51] **Int. Cl.** **B21f 1/02**

[58] **Field of Search** 140/147; 72/DIG. 10

[56] **References Cited**

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3,739,819 6/1973 Swanson 140/147

Primary Examiner—Lowell A. Larson

Attorney, Agent, or Firm—Joseph P. Gastel

[57] **ABSTRACT**

A machine for simultaneously straightening leads extending in opposite directions from the central portion of a member such as a diode, including a base, a plurality of substantially parallel roll sets mounted on said base for defining a first space for receiving the leads for simultaneously rolling said leads therebetween, each of said roll sets consisting of first and second coaxial series of rolls with a second space between the first and second series with the rolls of each series being mounted in a cantilevered manner, a conveyor in the form of a feed wheel having pivotally mounted arms for receiving a workpiece proximate the central portion thereof at a pick-up station and carrying the member to said first space and for holding said member at said first space while the leads are straightened and thereafter carrying the member to a station where it is removed from the feed wheel, the mounting of the roll sets in a cantilevered manner permitting the feed wheel and related feed apparatus to be located in the second spaces between the axially aligned cantilevered roll sets. The feed wheel can be driven in an intermittent stepwise manner, as by a Geneva gear mechanism, or, alternatively, the feed wheel can be driven by a gearing arrangement at a substantially continuous rate of speed because the arm carrying the workpiece is mounted to yield while the workpiece is being momentarily stopped at the work station.

34 Claims, 26 Drawing Figures

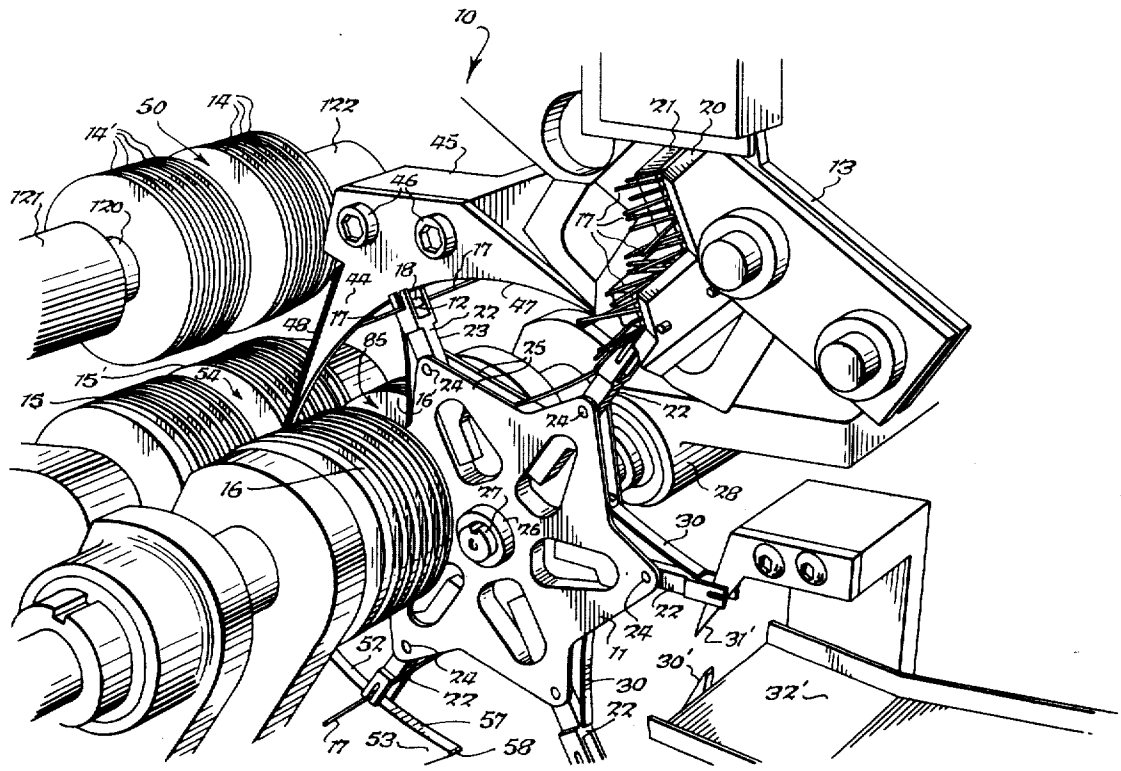


Fig. 1A.

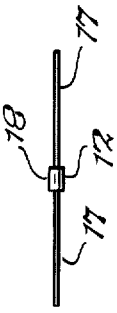

18
17
12
17
17

Fig. 1.

10
13
20
21
17
28
30
22
24
31'
30'
32'
25
27
26
24
16'
18
44
85
48
54
16
15'
15
50
14
14'
12a
12a'
45
46
57
58
53
52

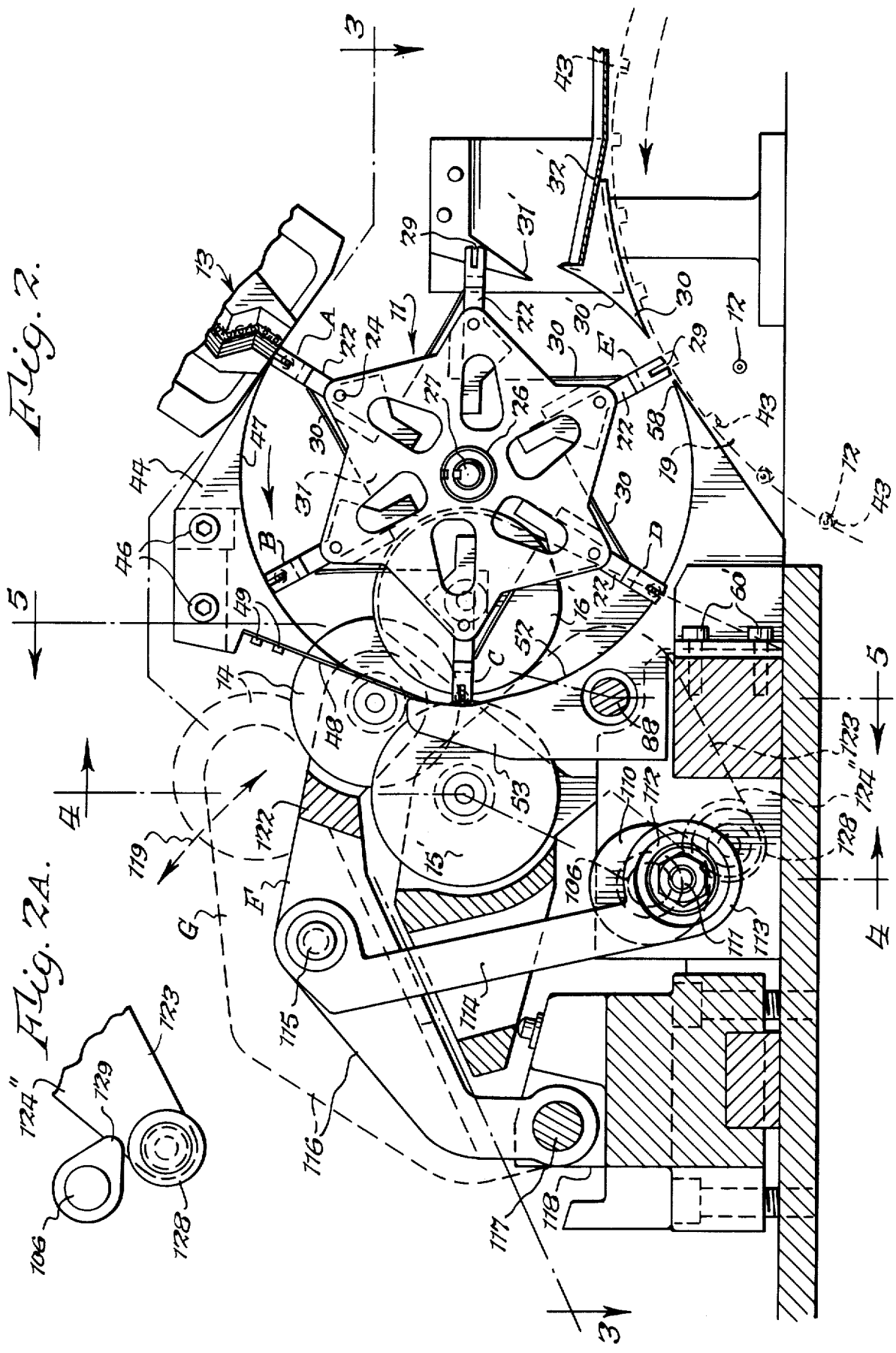


Fig. 2.

Fig. 2A.

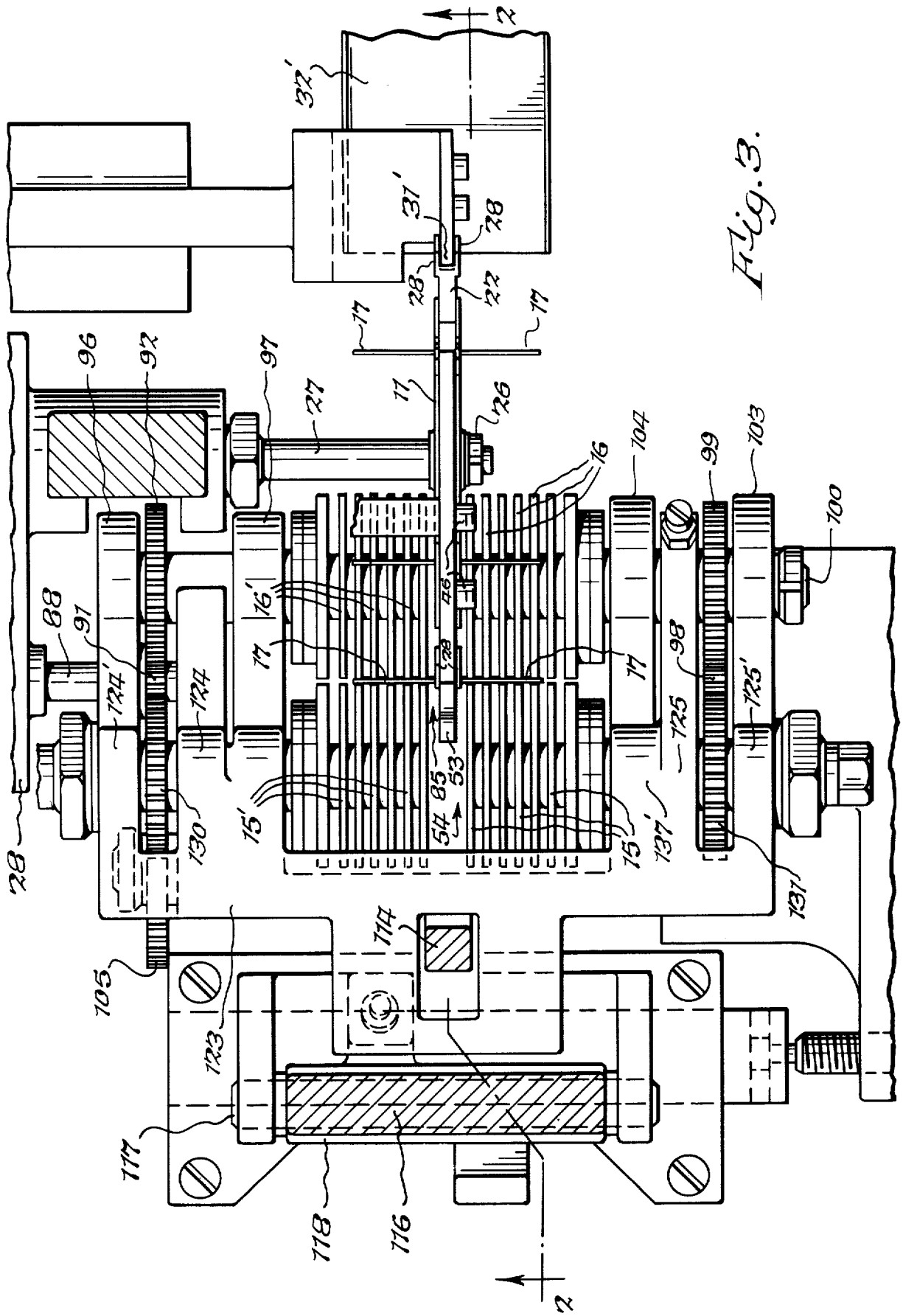
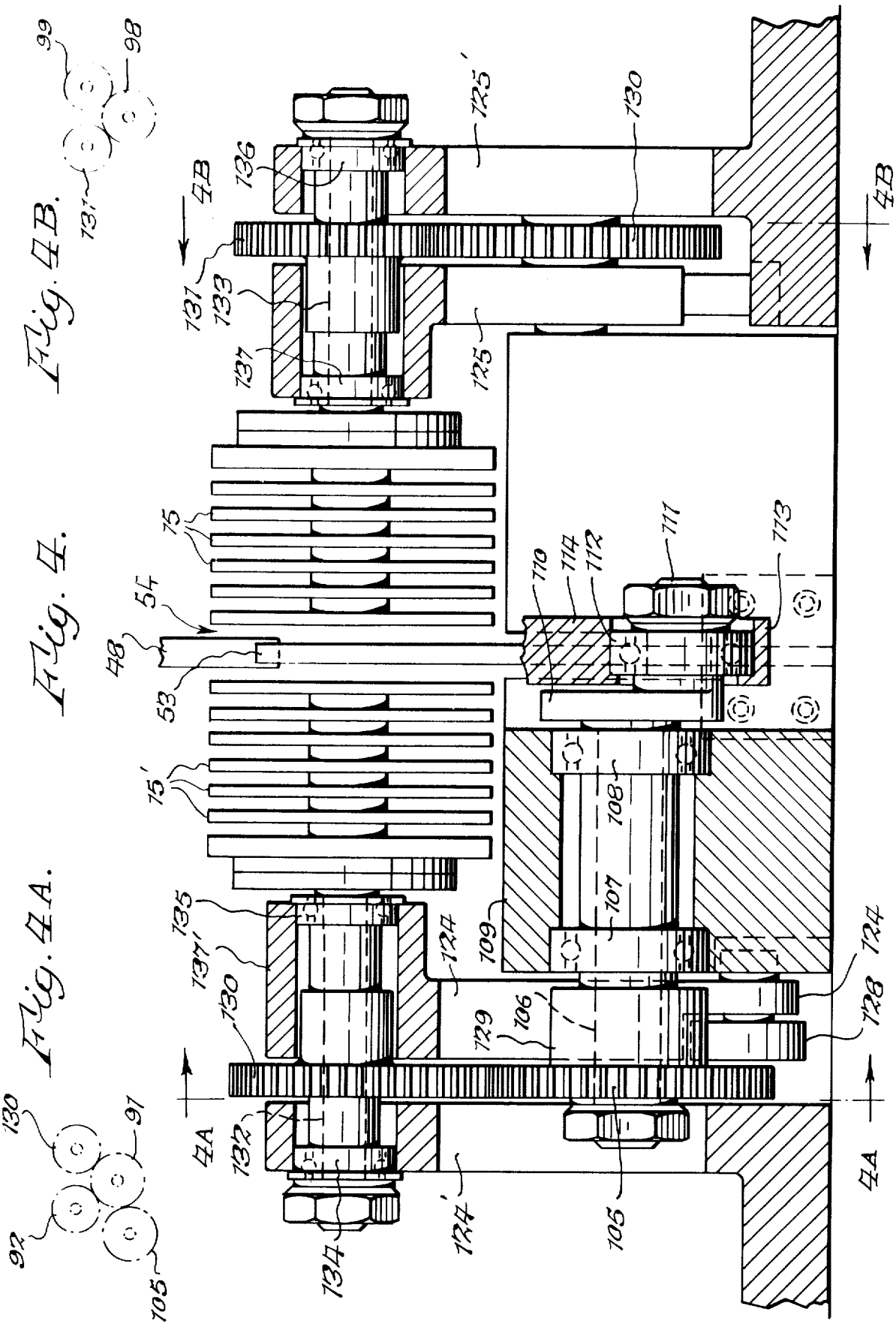

2
37'
31'
28
27
17
96
92
97
26
16
104
99
103
100
88
91
124'
124
16'
46
98
125
125'
28
130
15'
54
85
53
137'
137
114
105
123
117
118
116
2

Fig. 3.


Fig. 4B.
Fig. 4.
Fig. 4A.
99
98
131'
136
4B
131
133
137
125'
130
125
75
54
48
53
75'
110
114
112
111
113
108
107
109
135
137'
130
124
129
106
105
124'
134
132
4A
130
91
92
105

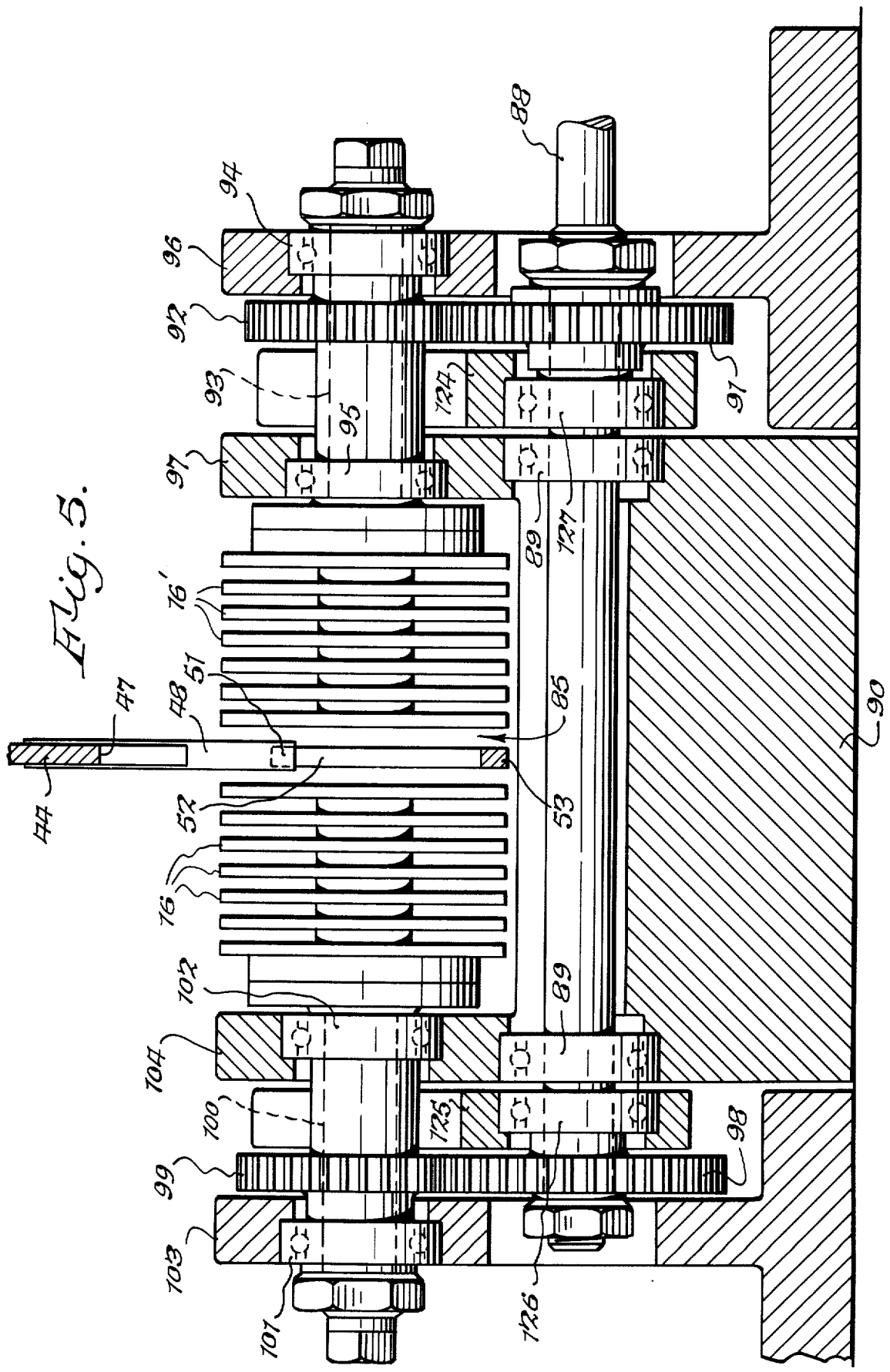

88
94
96
92
93
95
97
91
124
89
127
76'
51
48
47
44
85
53
57
76
102
104
100
125
99
103
101
126
98
90

Fig. 5.

Fig. 8.
Fig. 10.
Fig. 9.
Fig. 6.
Fig. 7.

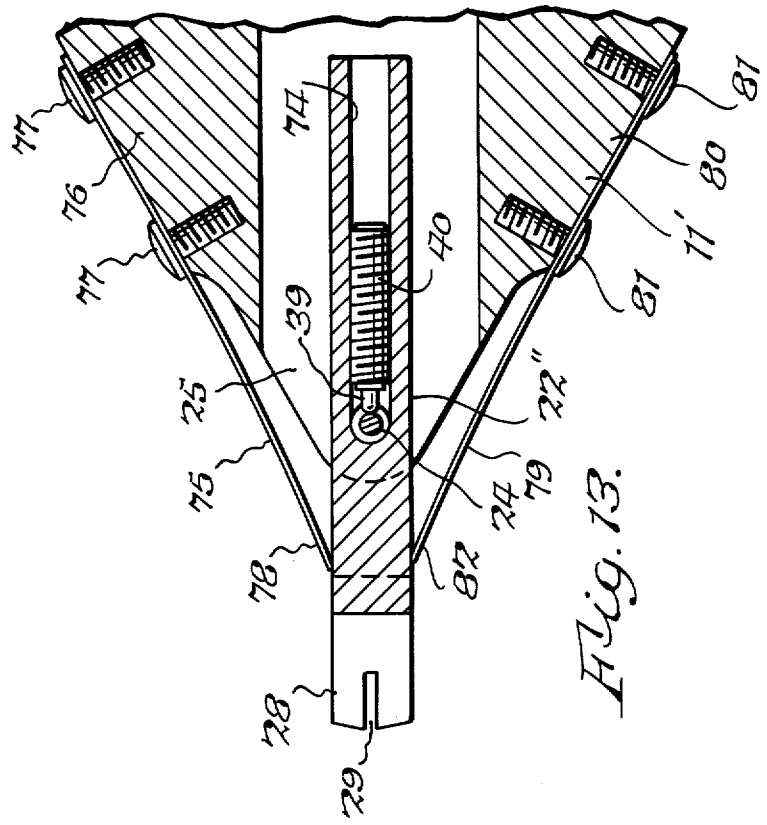


Fig. 13.

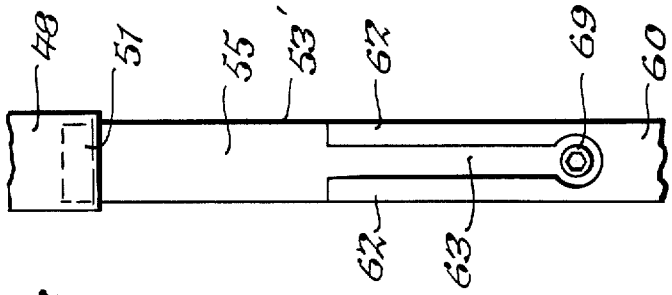


Fig. 12.

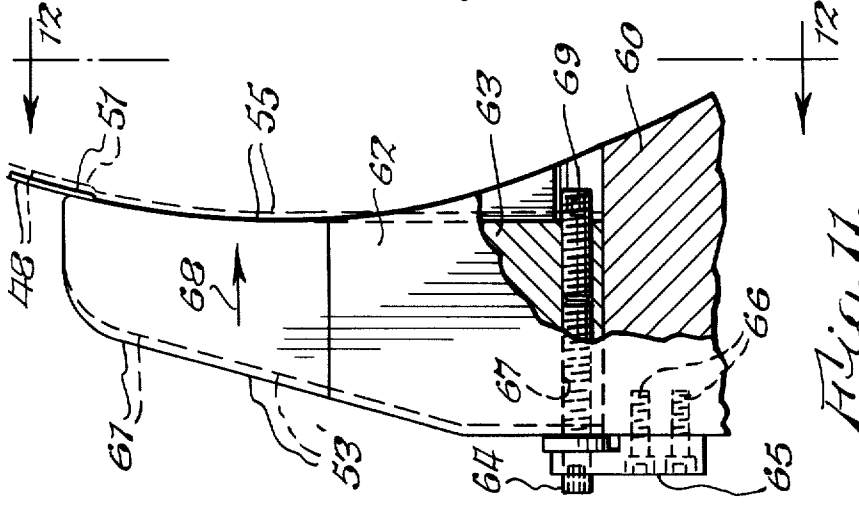


Fig. 11.

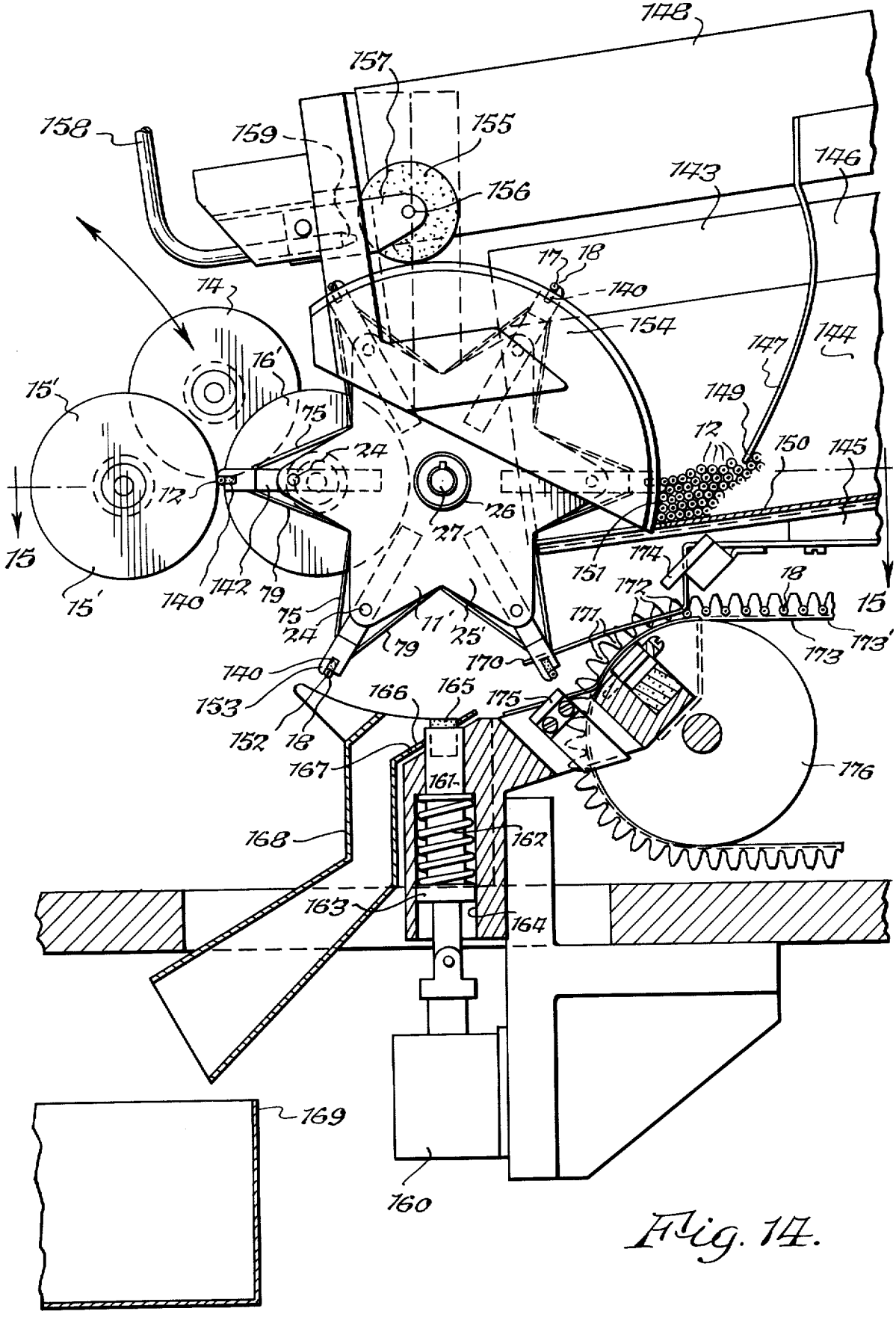

148
157
158
159
155
156
143
146
17
18
140
154
74
16'
147
144
15'
75
149
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150
145
24
26
27
15
15'
140
142
79
75
24
11'
25'
151
174
172
18
15
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173'
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Fig. 14.

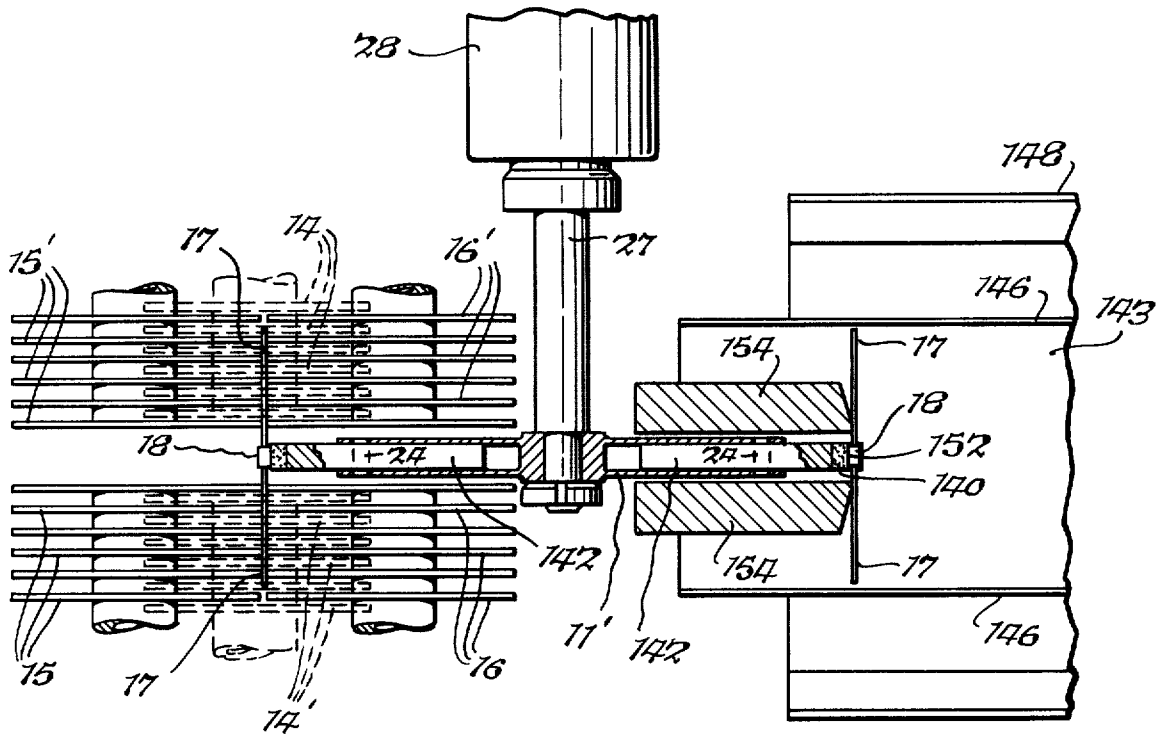

28
148
27
146
143
15'
17
14
16'
154
17
18
18
152
1+2A
2A+1
140
142
154
17
11'
142
146
15
17
16
14'

Fig. 15.

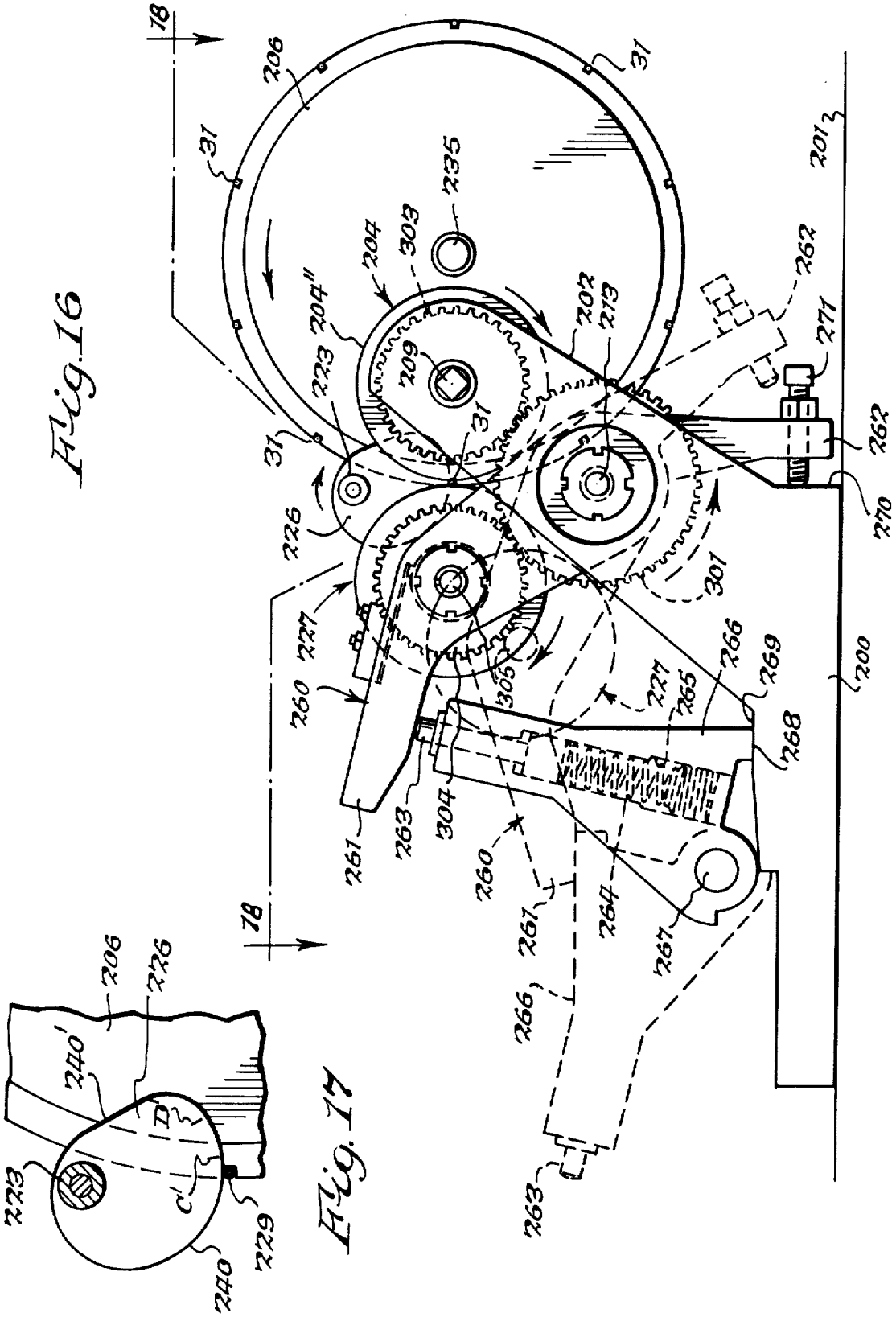

78
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31
235
201
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303
204"
209
207
213
262
271
223
226
227
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Fig. 16

206
226
240'
228
229
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Fig. 17

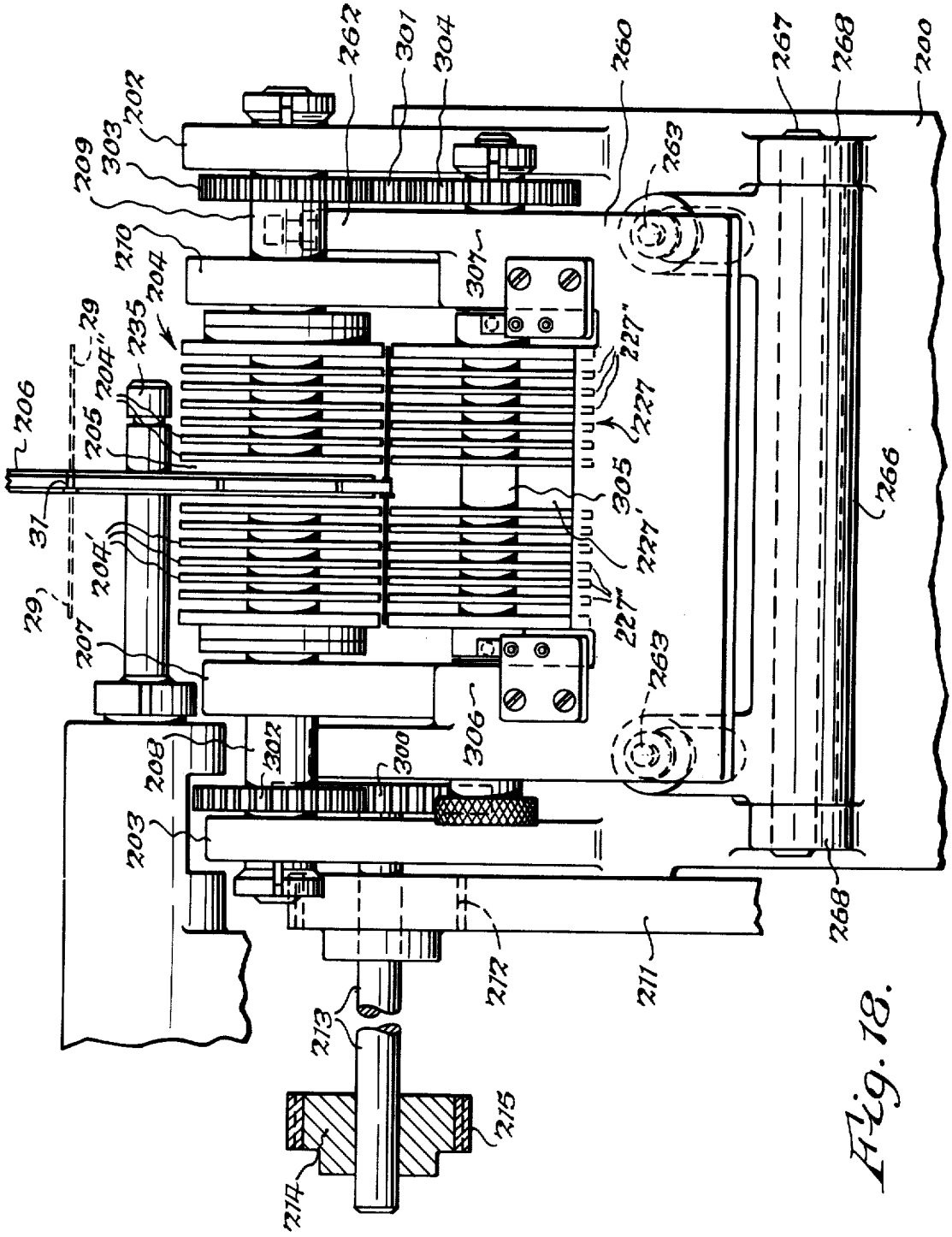

262
301
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268
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202
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263
270
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37
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244'
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227"
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Fig. 18.

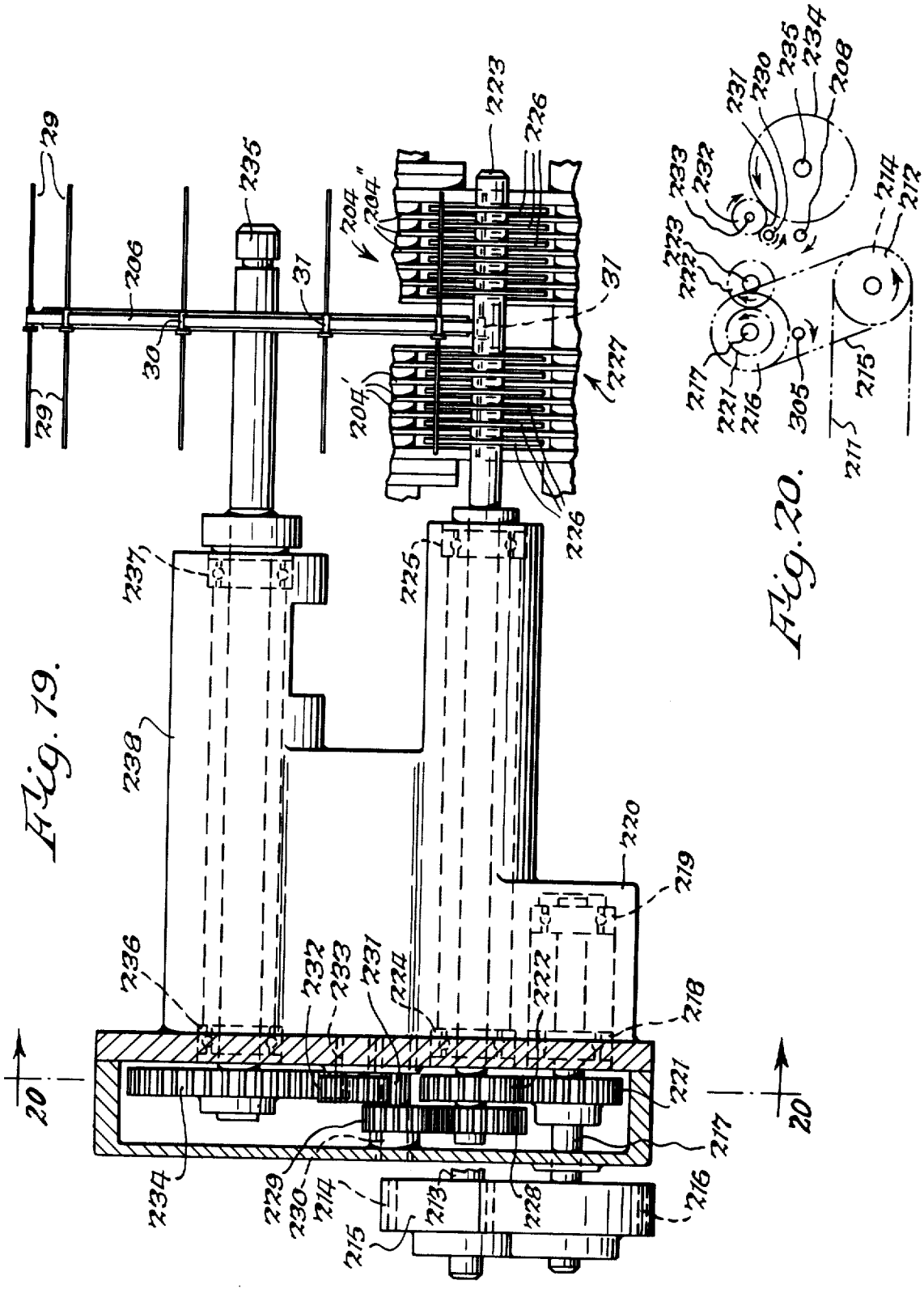

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Fig. 19.

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Fig. 20.

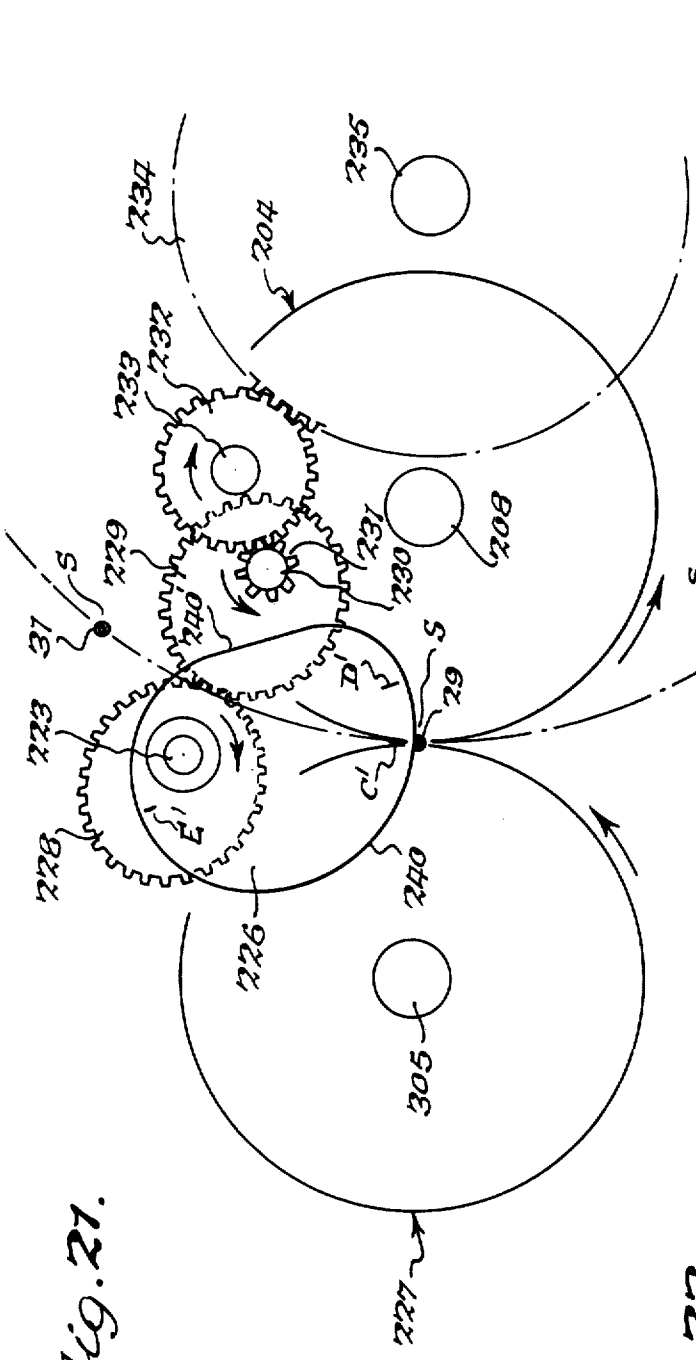

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235
240
241
305
S
S'
29
31
37
C'
E'
F'

Fig. 21.

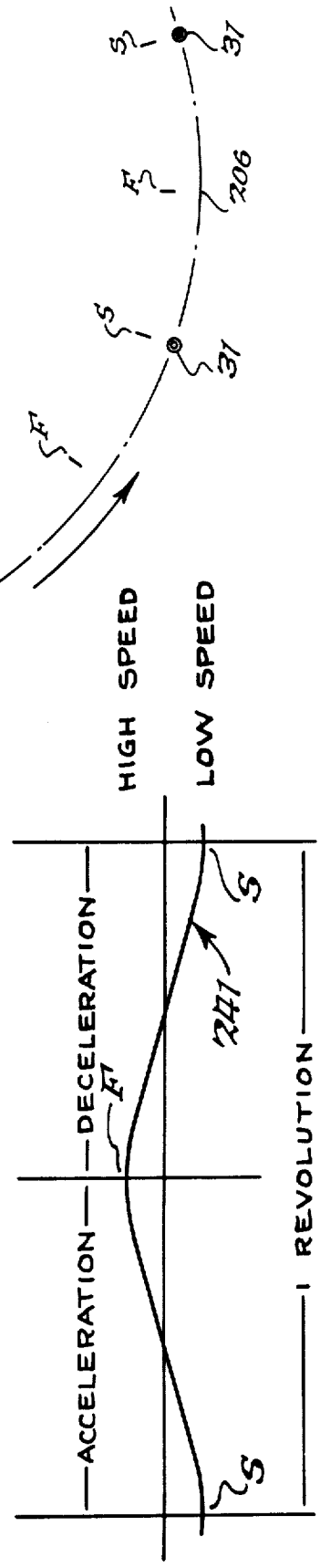

HIGH SPEED
LOW SPEED
ACCELERATION
DECELERATION
1 REVOLUTION
S
S
241
F'

Fig. 22.

STRAIGHTENING MACHINE FOR ELONGATED WORKPIECES

The present application is a continuation-in-part of application Ser. No. 286,547, filed Sept. 6, 1972 now U.S. Pat. No. 3,799,216.

The present invention relates to an improved machine and feed mechanism for straightening elongated wire-like workpieces and more particularly to a machine and feed mechanism for straightening the leads of electronic components such as diodes by bending the leads between rolls.

By way of background, machines have been known in the past for straightening the leads of a workpiece such as a diode or the like by means of a series of opposed rolls. A machine of this type is shown in copending application of John F. Kopczynski Ser. No. 286,547, filed Sept. 6, 1972, now U.S. Pat. No. 3,799,216. In the prior machine the workpiece was held by a magnetic wheel from the time that it was picked up at a pick-up station to the time that it was delivered to a delivery station, including the time that it was at a work station between the bending rolls. However, in the prior machine the engagement between the workpiece and the feed mechanism was strictly by a magnetic attraction. Therefore, care had to be taken that the feed mechanism was carefully synchronized with the action of the rolling machine so that there was no loss of engagement between the feed mechanism and the workpiece during the rolling action. Furthermore, the feed to the rolling machine had to be of a generally intermittent nature, that is, it had to have a stop and go action so that the workpiece could dwell between the work rollers for a required time. It is with an improved rolling machine and feed mechanism therefor which is an improvement over the foregoing type of rolling machine that the present invention is concerned.

It is accordingly one important object of the present invention to provide an improved feed mechanism for a machine for rolling the leads of an electronic component, the feed mechanism being capable of moving relative to the workpiece while the workpiece is in engagement by the rolls during a bending operation, without a loss of engagement between the workpiece and the feed mechanism.

Another object of the present invention is to provide an improved feed mechanism for feeding a workpiece having wire leads to a rolling machine, the feed mechanism being so constructed so as to hold the workpiece against detachment therefrom from the time that the workpiece is picked up at a pick-up station until it is delivered at a delivery station.

A further object of the present invention is to provide a feed mechanism in conjunction with a rolling machine having a plurality of cantilever mounted workpiece bending rolls with spaces between axially aligned sets of rolls so that workpiece feeding means can be positioned in such spaces to thereby insure positive handling of the workpieces by the feed mechanism.

Yet another object of the present invention is to provide an improved bending machine and feed mechanism combination in which the workpieces are handled in such a manner so that the feed mechanism can move at a constant uniform rate notwithstanding that the workpieces must dwell at the work station for a short period of time in order to be acted on properly.

Another object of the present invention is to provide an improved rolling machine for elongated members which utilizes a guiding cam arrangement to guide a workpiece through a work station between spaced rolls, thereby simplifying the rolling machine structure.

Yet another object of the present invention is to provide an improved feed arrangement for feeding workpieces from a magnetic hopper to a rolling machine where leads extending from the workpieces are straightened. Other objects and attendant advantages of the present invention will readily be perceived hereafter.

In accordance with one aspect of the present invention the improved machine for simultaneously straightening the leads extending from opposite sides of the central portion of a workpiece comprises a base, first, second and third substantially parallel roll sets mounted on said base to define a first space in which said leads are placed when they are engaged by said roll sets, each of said roll sets comprising first and second coaxial roll means with a second space therebetween, and means for mounting said first and second rolls of said first and second roll sets in a cantilevered manner.

In accordance with another aspect of the present invention the machine for simultaneously straightening the leads extending from opposite sides of the central portion of a workpiece comprises a base, a plurality of substantially parallel roll means mounted on said base for defining a space for receiving said leads for simultaneously rolling said leads therebetween, feed means for conveying said workpiece to and from said space and maintaining substantial engagement with said workpiece while conveying said workpiece and while said workpiece is in said space, said feed means comprising arm supporting means, outwardly extending arm means on said arm supporting means for carrying said workpiece, and means movably mounting said arm means on said arm supporting means to permit said arm means to adjust to the position of said workpiece carried thereby while said workpiece is in said space. The drive means for driving said arm supporting means can move said arm supporting means either in a continuous manner or an intermittent manner.

In accordance with another aspect of the present invention the machine for straightening an elongated wire-like workpiece comprises a base, first and second substantially parallel sets of roll means mounted on said base and defining a work station therebetween for said workpiece, said first set of roll means comprising a plurality of coaxial spaced first rolls with first spaces therebetween, said second set of roll means comprising a plurality of coaxial spaced second rolls with second spaces therebetween, cam means, and cam mounting means mounting said cam means relative to said first and second rolls to cause said cam means to periodically enter said first and second spaces to move a workpiece through said work station.

In accordance with still another aspect, the present invention is directed to a feed mechanism for feeding elongated magnetic workpieces to a rolling machine comprising a hopper, spaced magnetic sides on said hopper for causing said magnetic workpieces to line up therebetween, a feed wheel, pick-up means on the outer portions of said feed wheel for picking up single workpieces, a rolling machine, and intermittent or continuous drive means for causing said feed wheel to advance to carry said workpieces from said hopper to said

rolling machine, said pick-up means including means for maintaining contact with said workpieces while said workpiece is acted on by said rolling machine. The various aspects of the present invention will be more fully understood when the following portions of the specification are read in conjunction with the accompanying drawings wherein:

FIG. 1 is a fragmentary perspective view of the improved machine of the present invention including the feed mechanism and the rolling or straightening machine;

FIG. 1A is a side elevational view of the electronic component having leads which are straightened by the machine of the present invention;

FIG. 2 is a fragmentary cross sectional view of the machine of the present invention taken substantially along line 2—2 of FIG. 3;

FIG. 2A is a fragmentary end elevational view of a cam arrangement used for cyclically varying the position of certain of the rolls during the rolling operation;

FIG. 3 is a fragmentary cross sectional view taken substantially along line 3—3 of FIG. 2 with certain parts omitted in the interest of clarity;

FIG. 4 is a fragmentary cross sectional view taken substantially along line 4—4 of FIG. 2;

FIGS. 4A and 4B are schematic views taken substantially along lines 4A—4A and 4B—4B, respectively, of FIG. 4 showing the relationship of various drive gears of the rolling machine;

FIG. 5 is a fragmentary cross sectional view taken substantially along line 5—5 of FIG. 2;

FIG. 6 is an enlarged fragmentary cross sectional view taken substantially along line 6—6 of FIG. 7 and showing further details of construction of the arm of the feed wheel;

FIG. 7 is a fragmentary cross sectional view taken substantially along line 7—7 of FIG. 6;

FIG. 8 is a fragmentary cross sectional view similar to FIG. 6 but showing the manner in which the arm of the feed wheel may deflect during the rolling operation;

FIG. 9 is a fragmentary cross sectional view showing an alternate type of mounting arm for the feed wheel with the arm being oriented in a vertically upward position for receiving a workpiece from the feed mechanism for transporting to the rolling machine;

FIG. 10 is a view similar to FIG. 9 but showing the arm in a downwardly extending position for depositing the workpiece at a delivery station;

FIG. 11 is a fragmentary side elevational view, partially in cross section, showing a modified guide for the rolling machine, the modification residing in the adjusting feature thereof;

FIG. 12 is an end elevational view of the modified guide of FIG. 11 taken substantially along line 12—12 of FIG. 11;

FIG. 13 is a fragmentary cross sectional view similar to FIG. 6 but showing a feed wheel arm which is spring-biased in both directions;

FIG. 14 is a fragmentary side elevational view partially in cross section showing a modified arrangement of the feed wheel arms having magnetic holding means at their outer ends and side panels associated with the arm for aiding in maintaining the workpieces properly aigned;

FIG. 15 is a fragmentary cross sectional view taken substantially along line 15—15 of FIG. 14;

FIG. 16 is a side elevational view of an alternate embodiment of the present invention showing a feed arrangement in conjunction with a straightening machine for causing the workpieces to be fed in a continuous manner with a varying speed to the rolling machine, rather than the intermittent manner of FIGS. 1–5 and also showing a rolling machine utilizing cams instead of one of the sets of rolls;

FIG. 17 is an enlarged fragmentary side elevational view of a portion of the feed mechanism of FIG. 16 and showing in enlarged detail the relationship between the feed cam structure and the workpiece carried by the feed wheel;

FIG. 18 is a plan view of the machine of FIG. 16 taken substantially along line 18—18 of FIG. 16 with certain parts omitted in the interest of clarity;

FIG. 19 is an enlarged fragmentary cross sectional view similar to FIG. 18 but showing the gearing arrangement for providing the continuous drive;

FIG. 20 is a schematic view showing the relationship between the various drives of the machine taken in the direction of line 20—20 of FIG. 19;

FIG. 21 is another schematic view showing the relationship between the drives to the various portions of the machine and the feed mechanism and the rolls; and

FIG. 22 is a graph depicting the varying speed with which the workpiece is carried continuously at various portions of its travel.

The improved machine 10 of the present invention includes a base or frame mounting spoked feed wheel 11 and a rolling machine. Feed wheel 11 receives workpieces 12 from a hopper 13 and carries these workpieces to a work station between the substantially parallel roll sets 14—14', 15—15' and 16—16' of the rolling machine where the leads 17 on opposite sides of workpiece body portion 18 are straightened simultaneously. Wheel 11 thereafter discharges each workpiece 12 on a drum 19 (FIG. 2).

The feed hopper 13 is of a construction to receive workpieces 12 from a suitable bin (not shown) and maintain them in substantial alignment between plates 20 and 21 as shown in FIG. 1. At the lower ends of plates 20 and 21 a suitable catch mechanism (not shown) is provided to release workpieces 12 one at a time into the outer ends of arms 22 which are momentarily brought into alignment with the slot between plates 20 and 21 during intermittent movement of wheel 11.

Each arm 22 includes a central portion 23 (FIG. 6) which is pivotally mounted on pin 24 mounted between parallel side plates 25 of feed wheel 11, plates 25 in turn being mounted on hub 26 which is keyed to shaft 27 driven by Geneva gear drive 28. Each arm 22 includes a bifurcated end portion 27 having spaced arms 28 which have slots 29 therein. As can be seen from FIG. 7, the portions of leads 17 immediately adjacent to body portion 18 of the workpiece are received in slots 29 and are carried to the work area of the rolling machine. It is to be especially noted that slot 29 is elongated so that workpiece 12 may float to any required position axially of arm 22 as required so that it will occupy an optimum position at the work station between roll sets 14—14', 15—15' and 16—16' during the rolling operation, as can be seen from FIG. 2. At this point it is to be noted that when the leads 17 are being rolled, the roll sets 14—14', 15—15' and 16—16' are in the position shown in FIG. 6, and, as noted above, the

workpiece 12 can shift in the direction axially of arm 22 as required for optimum rolling action. In addition, each arm 22 can pivot about its respective pin 24 so as to provide a substantially vertical floating movement of the workpiece in FIG. 6, as required, to permit the workpiece to adjust itself in an optimum manner relative to the work area between the rolls.

The adjustment of each arm 22 in a counterclockwise direction about its associated pin 24 is against the bias of leaf spring 30 which is secured to block portion 31 of wheel 11 by screws 32. In this respect, it is the end portion 33 of spring 30 which bears against side 34 of arm 22 and biases side 34' of arm portion 35 against shoulder 36 of block 31. At this point it is to be noted that the wheel 11 moves rapidly toward the work station and therefore the fact that practically equal parts of each arm 22 are located on opposite sides of pin 24 will provide a balancing effect which tends to obviate the tendency for the arms 22 to pivot relative to pin 24 during the rotation of wheel 11. Each pin 24 includes opposite enlarged portions 37 and a central cutaway portion 38 which is engaged by spring-biased detent 39 mounted in the end of screw member 40 which is threaded into tapped bore 41 in enlarged portion 42 of arm 22. Therefore, in the event it is ever desired to replace arm 22, it is merely necessary to drive pin 24 out of the position shown in FIG. 7 against the bias of detent 39, and to replace pin 24 it is merely necessary to insert a new pin when the bore 41 in arm 22 is in alignment with the pin receiving bores in side plates 25 of wheel 11.

After arm 22 receives a workpiece from the hopper 13 at position (FIG. 2), it moves to an intermediate position B, then to a work station at position C wherein the workpiece is acted on by roll sets 14—14', 15—15' and 16—16' and thereafter the arm moves to a position D and thence to a position E wherein the workpiece is deposited into a depression 43 in receiving wheel 19. A Geneva gear mechanism 28 causes the foregoing movement between the various stations to be intermittent. A guide 44 (FIG. 1) is secured to frame 45 of the feeder 13 by means of screws 46. Guide 44 includes an arcuate surface 47 which generally follows the path traversed by the outer ends of arms 22. As can be seen from FIG. 1, surface 47 lies between the outer ends of the arms so as to positively trap body portion 18 of the workpiece in the position shown in FIG. 1. A leaf spring 48 is attached to guide 44 by screws 49 (FIG. 2) and extends inwardly into the space 50 (FIG. 1) between roll sets 14—14' which are mounted in cantilevered fashion on opposite sides of space 50. The lower end 51 of leaf spring 48 bears against the upper end of arcuate surface 52 of block 53 which is secured to the frame of the rolling machine. Arcuate surface 52 starts slightly before work station C and ends slightly before position E of arm 22 (FIG. 2). It can be seen from FIG. 4 that roll sets 15—15' are cantilever mounted with a space 54 therebetween. At this point it is to be noted that curved surface 52 (FIG. 6) includes a first curved portion 55 which lies beyond the ends 56 of arms 22 and a second curved portion 57 which extends inwardly of the ends of arms 22. This relationship can be seen in FIGS. 2 and 6. As can be seen from FIGS. 6 and 7, body portion 18 of the workpiece bears against curved portion 55 during the lead straightening action. Because surface 55 is the distance of the radius of body portion 18 away from the axis of leads 17, when surface 55 bears against body portion 18, the leads 17 will be oriented properly for straightening. It is to be noted from FIG. 6, however, that the ends 56 of arms 28 lie beyond leads 17 while body portion 18 bears against surface 55, and this relationship prevents loss of contact between workpiece 12 and arm 22. When arm 22 carries workpiece 12 across surface 57, as at position D, the ends 56 of arms 22 will lie beyond surface 57 to positively trap the workpiece body portion between the arms 28. After arm 22 clears the extreme end 58 of curved surface 52, the workpiece 12 will drop from slots 29 into a depression 43 of wheel 19. Alternatively, if a wheel 19 is not used, the workpiece can drop freely as indicated by workpiece 12' in FIG. 2.

In FIGS. 11 and 12 an adjustable block 53' is shown, this block being similar to block 53 described above. Block 53' includes a lower block portion 60 which is fixed to the frame of the rolling machine by screws 60'. Block 53' also includes an upper block portion 61 which is movable relative to the lower block portion 60. In this respect, lower block portion 60 includes parallel spaced upstanding sides 62 which slidably receive lower portion 63 of upper block 61 therebetween. A screw 64 is journalled against axial movement in bracket 65 which is secured to lower block portion 60 by means of screws 66. Screw 64 is threaded into a mating tapped bore 67 in block portion 63. It will be appreciated that when screw 67 is rotated, upper block portion 61 can be adjusted in the direction of arrow 68. After upper block portion 61 has reached its adjusted position, a set screw 69, which was previously loosened, is tightened. The adjustment of upper block portion 61 permits workpieces having different sized central portions 18 to be passed through the machine.

A modified arm 22' of arm 22 of FIGS. 6–8 is shown in FIGS. 9 and 10. This arm is substantially identical in all respects to the arm of FIGS. 6–8 except that it has been modified to include a slidable pin 70 which aids in ejecting a workpiece 12 from spaced slots 29. In this respect, when workpiece 12 is received from hopper 13, pin 70 is in a position shown in FIG. 9 wherein the head 71 of pin 70 is resting against pin 24 which retains arm 22' between spaced plates 25, as shown in FIGS. 6 and 7. When arm 22' reaches a downwardly extending position, such as shown in FIG. 10, pin 70 will slide downwardly so that the lower end 72 thereof engages workpiece 12 and pushes it out of its position between ends 28 of arm 22'. The lowermost position of pin 70 is when head 71 thereof is in engagement with annular shoulder 73.

In FIG. 13 a still further modified type of arm 22'' is shown for mounting on a modified type of feed wheel 11'. In this respect, feed wheel 11' is similar in outward configuration to feed wheel 11 shown in FIG. 1, and numerals which are identical to those used in FIGS. 1–8 designate identical parts. Feed wheel 11' includes spaced side walls 25', which are analogous to side walls 25, between which a pin which may be identical to pin 24 of FIGS. 6–7 extends and which is held in position between walls 25' by means of a spring-biased detent 39 mounted in screw member 40 which is threaded into tapped bore 74. A first leaf spring 75 is secured to block 76 of wheel 11' by means of screws 77. The end 78 of spring 75 bears against one side of arm 22''. Another leaf spring 79 is secured to block 80 by means of screws 81 and has an outer end 82 which bears against the opposite side of arm 22''. It can thus be seen that

leaf springs 75 and 79 bias arm 22'' to a central position and that the outer end of arm 22'' which includes spaced end portions 28 and slots 29 can move in opposite directions about the axis of pin 24 as a fulcrum so as to adjust the position of a workpiece 12 carried thereby, as required by the positions of the rolls between which the leads are straightened. With the type of mounting for arm 22'', as described above, shaft 27, which mounts the feed wheel, can rotate continuously at a substantially uniform speed, rather than intermittently, as described above relative to the figures other than FIG. 13, because the ability of arm 22'' to pivot in both directions permits it to maintain engagement with the workpiece while the workpiece is momentarily held against rotation with wheel 11' when it is being acted on by roll sets 14—14', 15—15' and 16—16'. In order to obtain continuous movement of shaft 27, the Geneva gear mechanism 28 is replaced by a straight gear drive or any other suitable drive mechanism.

The above described feed mechanism carries workpieces 12 to the work station between the roll sets 14—14', 15—15' and 16—16'. Roll set 14—14' includes a plurality of rolls 14 which are coaxial with a plurality of rolls 14'; roll set 15—15' includes a plurality of rolls 15 which are coaxial with a plurality of rolls 15' and roll set 16—16' includes a plurality of rolls 16 which are coaxial with a plurality of rolls 16'. All of the rolls are fabricated from suitable hard plastic material. It is a salient feature of the rolling machine that each roll set 14—14', 15—15' and 16—16' is cantilever-mounted with a space therebetween so that the various above-described portions of the feed mechanism can be located in the space between each roll set. In this respect, as noted above, roll set 14—14' (FIG. 1) has a space 50 between rolls 14 and 14'; roll set 16—16' has a space 85 between rolls 16 and 16' (FIGS. 3 and 5); and roll set 15—15' has a space 54 between rolls 15 and 15' for receiving block 53 which also extends into space 50 in roll set 14—14'.

The feed wheel 11, which is keyed to shaft 27, is driven with an intermittent motion to pick up workpieces 12 from hopper 13, one at a time, and convey them to the rolling machine where leads 17 are straightened. More specifically, a suitable motor (not shown) drives shaft 88 which is journalled in spaced bearings 89 mounted on base or frame 90 of the rolling machine. Shaft 88 is also coupled to Geneva gear mechanism 28 having an intermittently operating output shaft 27 on which feed wheel 11 is mounted. Because the Geneva gear mechanism 28 is coupled to drive shaft 88, the Geneva gear mechanism will operate in synchronized relationship with the rolling machine. A gear 91 is keyed to shaft 88 and is in mesh with gear 92 keyed to shaft 93 journalled in bearings 94 and 95 mounted in frame members 96 and 97, respectively. Rolls 16' are keyed to shaft 93, and as noted above, shaft 93 is cantilever mounted. A gear 98 is also keyed to shaft 88 in spaced relationship to gear 91. A gear 99 is in mesh with gear 98 and is keyed to shaft 100 journalled in bearings 101 and 102 which are mounted on frame members 103 and 104, respectively. Rolls 16 are keyed to shaft 100 and are mounted on the overhanging portion of shaft 100 which is supported in a cantilevered manner. Rolls 16' and 16 and their supporting structure are of a suitable construction so that the rolls can be mounted and demounted from shafts 93 and 100, as required.

Gear 105 (FIG. 4) is in mesh with gear 91 keyed to shaft 88. Gear 105 is keyed to shaft 106 journalled in bearings 107 and 108 in frame portion 109. At the end of shaft 106 remote from gear 105 is a crank 110 having a pin 111 exxentrically mounted thereon. A bearing 112 is mounted on pin 111 and mounts portion 113 (FIGS. 4 and 2) of connecting arm 114 which has its upper end journalled on pin 115 extending through lever 116 having its lower end journalled on shaft 117 mounted on frame member 118. Therefore, as shaft 106 rotates, connecting arm 114 will move up and down and carry lever 116 between its solid line position F and its dotted line position G as indicated by arrow 119. A plurality of spaced rolls 14' (FIG. 1) are journalled on shaft 120 extending outwardly from member 121 whch forms a part of arm 116. A plurality of spaced rolls 14 (FIG. 1) are journalled on frame member 122 which forms a part of the outer end of lever 116 and is coaxial with and axially spaced from portion 121. When lever 116 is in dotted line position G, the feed wheel 11 will advance the distance between adjacent arms 22 to carry the workpiece from position B to a position C. Thereafter, lever 116 will move to the solid line position F to cause the workpiece leads 17 to be rolled between the three roll sets 14—14', 15—15' and 16—16' and thereafter roll sets 14—14' will move downwardly from the position of FIG. 6 to the position shown in FIG. 8 to push the workpiece 12 through the space between the roll sets 15—15' and 16—16'. When this occurs, lever 22 can move from the position shown in FIG. 6 to the position shown in FIG. 8 against the bias of leaf spring 30, without the necessity of feed wheel 11 rotating at this time. During the rolling of the leads 17, body portion 18 of member 12 will be supported against surface 55 of block 53, as described in detail above.

Roll sets 15—15' (FIG. 4) are mounted on a lever 123 having spaced arms 124—124' and 125—125'. Arm 125 is journalled on bearing 126 mounted on shaft 88, and arm 124 is journalled on bearing 127 mounted on shaft 188. A follower roller 128 (FIGS. 2 and 2A) is journalled at the lower end of arm 124'' of lever 123 and a cam 129 is keyed to shaft 106. Therefore, periodically lever 123 will pivot about shaft 88 to cause roll sets 15—15' to recede from roll sets 16—16'. This is shown in FIGS. 6 and 8. More specifically, in FIG. 6 roll sets 15—15' are relatively close to roll sets 16—16' and in FIG. 8 they are more spaced therefrom. Because of the action of lever 14, as described above, roll sets 14—14' will move downwardly from the position shown in FIG. 6 to the position shown in FIG. 8 to thereby push the leads 17 through the work station at which they were rolled, and at this time rolls 15—15' will move to the position of FIG. 8 to release the leads 17.

At this point it is to be noted from FIGS. 3 and 7 that corresponding rolls of roll sets 15—15' and 16—16' are in alignment with each other. It is also to be noted from FIG. 2 that the rolls of roll sets 14—14' move down into the spaces between adjacent rolls of roll sets 15—15' and between adjacent rolls of roll sets 16—16' so as to provide the relationship between roll sets 14—14', 15—15' and 16—16' as shown in FIG. 2. This is also shown in FIG. 15.

It is to be noted that gears 91 and 98 at the ends of shaft 88 are in mesh with gears 130 and 131, respectively, on shafts 132 and 133, respectively. Shaft 132 is

journalled in arms 124—124' by bearings 134 and 135. Shaft 133 is journalled on arms 125—125' by bearings 136 and 137. Rolls 15' are keyed to shaft 132 and are supported in cantilevered relationship relative to lever arm 124. Rolls 15 are keyed to shaft 133 which is supported in cantilevered relationship to lever arm portion 125.

As noted above, workpieces 12 are deposited in slots 43 of roll 19. If for any reason part of workpiece 12 is stuck in slots 29, it will be retained in slots 29 when it passes over surface 30' which is of the same curvature as curved surface 57 but spaced therefrom. Thereafter, the stuck workpiece will be stripped from slots 29 by stripper 31' as arm 22 moves past it, and the workpiece will drop into pan 32'.

In FIGS. 14 and 15 an alternate embodiment of the present invention is disclosed. In this embodiment feed wheel 11' is substantially identical to the feed wheel 11' described above in FIG. 13, except that magnets 140 are mounted at the outer ends of arms 142 which are identical in all respects to arms 22' of FIG. 13, except that the outer ends carry magnets 140 instead of the structure shown in FIG. 13. The drive to shaft 27 which mounts feed wheel 11' rotates continuously and not intermittently, this action being possible because arms 142 can yield in both directions about their pivot mounting 24 when the workpiece leads 17 are being straightened.

In the embodiment of FIGS. 14 and 15, a feed hopper 143 includes a bin 144 having a bracket 145 secured to its underside, the bracket being connected to a vibratory motor structure (not shown) which thus imparts vibration to the bin. The opposite side panels 146 of bin 144 are magnetic so as to cause the opposed leads 17, which are generally in axial alignment with each other, to line up crosswise of bin 144 when the hopper is vibrating, leads 17 extending outwardly from body portion 18 of the electrical component 12, as shown in FIG. 1A. Electrical component 12 may be a diode or a resistor or condensor or any other type of component having a central body portion and a pair of substantially axially aligned leads extending from opposite sides thereof. Within bin 146 is a baffle plate 147 which extends across the bin between sides 146 and is supported at its upper end on link 148. The lower end 149 of plate 147 is spaced from the bottom 150 of the bin to permit the workpieces 12 to pile up as shown in FIG. 14 as a result of vibrating bin 143 and subjecting workpieces 12 to the magnetic action of spaced parallel sides 144.

The feed wheel 11', which is keyed to shaft 27, is driven with a continuous motion to pick up workpieces 12 from bin 143, one at a time, and convey them to the space between roll sets 14—14', 15—15' and 16—16', as described in detail above, where leads 18 are straightened. The workpieces 12, which are aligned in parallelism with each other in bin 43, are picked up as the outer magnet ends 140 of arms 142 move past opening 151 at the bottom left-hand corner of bin 143. Each magnet 140 has a shelf portion 152 on which the body 18 of workpiece 12 comes to rest. A protuberance 153 bears on the rear of body portion 18 to hold it in alignment, as required, on magnet 140. Shelf 152, which is the outer side of the magnet, is of a size to receive only one body portion 18 and it carries this body portion upwardly in a counterclockwise direction in FIG. 14. Parallel spaced plates 154 permit the central body portion 18 to be carried by the magnet while leads 17, extending from opposite sides of body portion 18, are supported by the outer edges of plates 154. A freely rotatable sponge-like wheel 155 is mounted on shaft 156 carried by bracket 157. An air hose 158, which conducts compressed air, terminates at nozzle 159. The compressed air leaving nozzle 159 causes wheel 155 to rotate in a counterclockwise direction to pick off any workpiece 12 in excess of one which is attracted by magnet 140, in the event for any reason that more than one workpiece has been picked up. This workpiece will then fall downwardly along the outside surface of plates 154 back onto the pile of workpieces 12 shown at the bottom of bin 143.

As noted above, feed wheel 11' will be driven in a continuous manner and when each workpiece reaches a work station between roll sets 14—14', 15—15' and 16—16', the leads will be straightened and arm 142 will deflect as required to permit the straightening to occur while the arm maintains engagement with the workpiece 12. A suitable testing circuit may be associated with the rolling machine so as to pass an electric current through the workpiece while it is being rolled. Apparatus for performing this function is disclosed in copening application Ser. No. 286,547, of John F. Kopczynski, now U.S. Pat. No. 3,799,216. The information obtained from testing the workpiece while it is at the work station is fed to a shift register (not shown). If the value which is obtained from testing indicates that the workpiece is substandard and that rejection should occur, solenoid 160 will be energized to move piston 161 upwardly against the bias of spring 162 which is interposed between collar 163 associated with piston 161 and a shoulder on the inside of bore 164. Solenoid 160 is energized when the defective workpiece is directly above it. This will cause magnet 165 at the upper end of piston 161 to approach workpiece 12. The strength of magnet 165 is greater than the strength of magnet 140 which holds workpiece 12 on feed wheel 11'. Therefore, magnet 165 will provide a greater pulling force and pull workpiece 12 away from magnet 140. Thereafter, solenoid 160 will be deactuated and spring 162 will expand to move piston 161 back to the position shown in FIG. 14. However, in moving to the position shown in FIG. 14, it will move below the upper surface 166 of a plurality of spaced parallel tines 167 to thereby disengage workpiece 12 from magnet 165 and thereafter workpiece 12 will pass down chute 168 and drop into a reject receptacle 169.

If the workpiece is not defective, and therefore has not been withdrawn by the action of magnet 165, it will move counterclockwise from the rejection position. At this point a pair of spaced tines 170, which are attached to link 145, will engage the leads 17 on opposite sides of the body portion 18 and cause the workpiece to drop downwardly into the space 171 between adjacent teeth 172 formed on spaced belts 173 of conveyor 173'. Actually the teeth are approximately the length of each lead 17 and there are two belts 173 in side-by-side relationship and in exact alignment so as to provide a space between belts 173 for receiving body portion 18. There is an electric eye arrangement including a transmitter portion 174 and a receiver portion 175 located at the point where the workpieces 12 are removed from the feed wheel 11'. If a workpiece is removed, this information will be sensed by the electric eye 174–175 and wheel pulley 176 on which belts 173 are mounted will be advanced one space between teeth 172 in a clock-

wise direction so as to provide an open space between a subsequent pair of teeth **172** to receive the next workpiece which is to be placed on the belt. However, if the workpiece **12** was rejected by the action of magnet **165**, as described in detail above, then there is no workpiece **12** in position to be placed onto belt **173'**. Therefore, electric eye **174–175** will not provide a signal to a suitable advancing mechanism (not shown) for advancing belts **173** one increment.

In the embodiment of FIGS. **16–22** a base **200** is provided which may be mounted on a suitable table top or the like **201**. Spaced arms **202** and **203** extend upwardly from base **200** and support roll series **204** consisting of cantilevered rolls **204'** and **204''** which have a space **205** therebetween through which feed wheel **206** passes. Feed wheel **206** is shown schematically but may be the feed wheel of FIG. **2** or FIG. **14**. More specifically in the foregoing respect the shaft **208** on which rolls **204'** are mounted is supported by upstanding arm **203** and upstanding arm **207**, which also extends upwardly from base **200**. Suitable bearings (not shown) in arms **203** and **207** journal the shaft **208**. Shaft **209**, which mounts rolls **204''**, is journalled for rotation in suitable bearings (not shown) in upstanding arm **202** and upstanding arm **210** which also extends upwardly from base **200**. A description of the details of construction of the bearings and the manner in which shafts **208** and **209** are mounted is not deemed necessary at this point because of the fact that the structure may be similar to that described above relative to FIGS. **1–5** or similar to the structure described relative to FIGS. **1–8** of U.S. Pat. No. 3,799,216, which is incorporated here by reference.

The roll series **204** and **227** are driven in the following manner. A belt drive is provided which includes belt **211** coupled to a suitable motor source and encircling pulley **212** which is keyed to shaft **213**. Shaft **213** is analogous to shaft **88** of FIG. **3** and shaft **213** extends all the way from the left of the machine as shown in FIG. **18** to the right portion of the machine in a manner analogous to shaft **88** of FIG. **3**. However, the portion of shaft **213** to the right of the portion shown in FIG. **18** has been omitted from FIG. **18** in the interest of clarity. Keyed to shaft **213** are gears **300** and **301**. Gear **300** is in mesh with gear **302** which is keyed to shaft **208** and therefore drives rolls **204'**. Gear **301**, which is keyed to shaft **213**, is in mesh with gear **303** which is keyed to shaft **209** which mounts rolls **204''**. Gear **301** is also in mesh with gear **304** which is keyed to shaft **305** journalled in bearings (not shown) in frame portions **306** and **307**. Shaft **305** mounts rolls **227''** with a space **227'** at their central portion. It is through the medium of shaft **213** and the various gears mounted thereon and associated therewith that roll series **204** and **227** are driven.

Provision is also made for guiding the workpieces **31** through roll series **204** and **227**. This structure includes cams **226** which are mounted on shaft **223** which is driven in a suitable manner. The use of cams **226** eliminates the need for an oscillating lever such as **116** of FIGS. **1–5** and the complicated structure appurtenant thereto because it is the shape of the cams which provides the periodic clearance necessary for feeding the workpieces between the rolls and not the bodily movement of rolls **14—14'** which the cams **226** replace. The simplified structure provided by the use of cams **226** permits more rapid machine operation as well as providing simplified machine structure. More specifically, shaft **213** also has pulley **214** keyed thereon. A second belt **215** encircles pulley **214** and pulley **216** which is keyed to shaft **217** which in turn is journalled in bearings **218** and **219** mounted within housing **220**. A gear **221** is keyed to shaft **217** and in turn is in mesh with gear **222** keyed to shaft **223** journalled in spaced bearings **224** and **225** mounted in housing **220**. The series of cams **226** are keyed to the portion of shaft **223** which extends out of housing **220** and these cams aid in pushing the workpieces **31** on feed wheel **206** through the spaced roll series **204** and **227**. At this point it is to be especially noted that the embodiment of FIGS. **16–22** is more simplified than FIGS. **1–5** in that only two spaced roll series are used, namely, **204** and **227**. The third roll series **14—14'** off FIGS. **1–5** has been eliminated but in their place cams **226** are used.

Feed wheel **206** is driven in timed relationship to the movement of cams **226** so that the outer surfaces **240** of cams **226** follow in close proximity to the leads **29** as workpiece **31**, which may be identical to workpiece **12**, is carried by the feed wheel **206** but do not engage leads **29** until immediately prior to their engagement by roll series **204** and **227** to thereby stabilize the workpiece in this area. Cams **226** maintain engagement with leads **29** after the leads terminate engagement with roll series **204** and **227**, to thereby push workpiece **31** from the straightening area. It is to be noted that cams **226** are eccentrically mounted on shaft **223**. Furthermore, shaft **223** rotates at a constant angular speed, and therefore because of the eccentric mounting of cams **226** on shaft **223**, the portions of the surfaces **240** which are further from the axis of shaft **225**, will travel at a greater linear speed. Thus, for example, when the workpiece **31** travels on feed wheel **206** so that it is followed by the portion of cam surface **240** between points E' and C', the travel will be relatively fast. From point C' to point D' the travel will be relatively slow. This follows the type of action such as shown on curve **241** in FIG. **22** which depicts the acceleration and deceleration of feed wheel **206** between points S at which the workpieces are held between roll series **204** and **227**, with the greatest acceleration being at points F midway between points S. The cam surface **240** follows leads **29** in close proximity until point C' is reached whereas from point C' to point D' there is engagement of the workpiece leads **29** by the cams and a relatively constant rate of travel as the workpiece passes through roll series **204** and **227** as guided by cams **226**. Because of this speeding up of the workpiece from point S to point F the workpiece is carried more rapidly to the work zone than if it were dropped into the work zone by gravity. During the travel of the workpiece while it is engaged by cams **226** between points C' and D', it travels relatively slowly through the work zone between roll series **204** and **227** as guided by cams **226**, and it is during this travel that the leads **29** are straightened. Thereafter feed wheel **206** speeds up. It is to be noted that each cam **226** includes a relatively straight portion **240'** extending in a counterclockwise direction from point D'. This straight portion permits the next workpiece entering the space between roll series **204** and **227** to pass cam **226** before it is subsequently engaged by the cam at point C'.

The driving relationship for intermittently accelerating and decelerating the movement of feed wheel **206**, as described above, is obtained by a special gearing ar-

rangement. More specifically, a gear **228** is keyed to shaft **223** in spaced relationship to gear **222** and gear **228** is in mesh with gear **229** (FIG. **19**) keyed to shaft **230** which also has gear **231** keyed thereon which is in mesh with gear **232** keyed to stub shaft **233.** Gear **232** is in mesh with gear **234** keyed to shaft **235** journalled in spaced bearings **236** and **237** mounted in housing extension **238.** Feed wheel **206** is mounted on shaft **235** and carries the workpieces **231** from the hopper mechanism (not shown) to the rolls where the leads **29** are straightened and then to a station where the workpieces **31** are removed from the feed wheel and carried to a packaging station as described in detail above relative to FIGS. **1–5.**

As can best be seen from FIG. **21,** gears **228** and **229,** which are in mesh with each other, are elliptical so that the motion of shaft **230** which mounts gear **229** will be of an accelerating and decelerating characteristic as shown by curve **241** of FIG. **22.** Therefore, gear **234** will be driven according to this same accelerating and decelerating characteristic because it is in mesh with gear **231** keyed on shaft **230** through idler gear **232.** Furthermore, since gear **234** is keyed to shaft **235** on which wheel **206** is mounted, wheel **206** will have the accelerating and decelerating characteristic noted above and shown at **241** in FIG. **22.** It will be appreciated that when feed wheels such as shown in FIGS. **13** and **14** are used which permit the arms to pivot in both directions, the oval gears of FIG. **21** may be replaced by conventional circular gears so that the shaft **235** and the feed wheel carried thereby can have uniform rotary motion.

Roll series **227** is mounted on frame portion **260** which is pivotally mounted for movement about the axis of shaft **213.** Frame portion **260** has upper ends **261** and a lower end **262** and frame portion **260** can move from the solid line position shown in FIG. **16** to the dotted line position shown therein. In the dotted line position, roll series **227** is moved to the dotted line position away from roll series **204** to thereby permit access to the inner portions of the machine. Ordinarily when the frame portion **260** is in the solid line position, it is held there by plungers **263** which are biased upwardly by springs **264** which are housed in bores **265** in frame portion **260.** Frame member **266** is pivotally mounted on shaft **267** secured within spaced ears **268** extending upwardly from base **200.** When frame portion **266** is in the solid line position, the stop portion **268** will abut surface **269** of base **200** and it will be held there because of the overcenter relationship which frame portion **266** occupies relative to shaft axis **267** when plungers **263** engage ends **261** of frame **260.** The limit of clockwise movement of frame portion **260** about the axis of shaft **213** is determined by the adjustment of screw **269** which abuts surface **270.** It will be appreciated that the spacing between roll series **204** and **227** is such so that when a workpiece is between them, it forces roll series **227** to the left in FIG. **9** against the bias of springs **264.**

It is to be noted that the structure of roll series **204** and **227** of FIGS. **16–22** may be identical to roll series **60** and **62,** respectively, of FIGS. **1–8** of U.S. Pat. No. 3,799,216, which is incorporated here by reference, and that a detailed description of the former has been omitted in the interest of brevity. In addition, if desired, the structure of roll series **204** and **227** of FIGS. **16–22** may be mounted in a manner identical to roll sets **16—16′** and **15—15′** of FIGS. **1–5.** It will also be appreciated that the feed mechanisms shown in FIGS. **1–15** may be used with the rolling machine of FIGS. **16–22** when the rolls of the machine of FIGS. **16–22** are cantilever-mounted.

It can thus be seen that the various embodiments of the present invention are manifestly capable of achieving the above-enumerated objects, and while preferred embodiments of the present invention have been disclosed, it will be appreciated that it is not limited thereto but may be otherwise embodied within the scope of the following claims.

What is claimed is:

1. A machine for simultaneously straightening the leads extending from opposite sides of the central portion of a workpiece comprising a base, first, second and third substantially parallel roll sets mounted on said base to define a first space in which said leads are placed when they are engaged by said roll sets, each of said roll sets comprising first and second coaxial roll means with a second space therebetween, and means for mounting said first and second roll means of said first and second roll sets in a cantilevered manner.

2. A machine as set forth in claim **1** including means for mounting said first and second roll means of said third roll set in a cantilevered manner.

3. A machine as set forth in claim **1** wherein each of said first and second roll means comprises a plurality of spaced rolls.

4. A machine as set forth in claim **1** including feed means for conveying said workpiece to and from said first space and for maintaining substantial engagement with said workpiece while conveying said workpiece and while said workpiece is in said first space.

5. A machine for simultaneously straightening the leads extending from opposite sides of the central portion of a workpiece comprising a base, a plurality of substantially parallel roll means mounted on said base for defining a space for receiving said leads for simultaneously rolling said leads therebetween, feed means for conveying said workpiece to and from said space and maintaining substantial engagement with said workpiece while conveying said workpiece and while said workpiece is in said space, said feed means comprising arm supporting means, outwardly extending arm means on said arm-supporting means for carrying said workpiece, and means movably mounting said arm means on said arm supporting means to permit said arm means to adjust to the position of said workpiece carried thereby while said workpiece is in said space.

6. A machine as set forth in claim **5** including pivot means for pivotally mounting said arm means on said arm supporting means.

7. A machine as set forth in claim **6** wherein said pivot means is located substantially centrally of said arm means.

8. A machine as set forth in claim **6** including means for biasing said arm means to a predetermined position on said arm supporting means.

9. A machine as set forth in claim **8** wherein said biasing means comprises spring means for biasing said arm means in a single direction.

10. A machine as set forth in claim **9** including drive means for driving said arm supporting means in an intermittent manner.

11. A machine as set forth in claim **8** wherein said biasing means comprises means for biasing said arm

means to a central position on said arm supporting means while permitting said arm means to yield in opposite directions from said central portion.

12. A machine as set forth in claim **11** including drive means for driving said arm supporting means in a substantially continuous manner.

13. A machine as set forth in claim **5** including ejector means for aiding in discharging said workpiece from said arm means.

14. A machine as set forth in claim **13** wherein said ejector means comprises pin means slidably mounted on said arm means.

15. A machine as set forth in claim **5** including a second space between said roll means, and guide means in said second space for engaging said central portion of said workpiece while said workpiece is in said first space.

16. A machine as set forth in claim **15** wherein said guide means comprises a stationary member, and a curved surface on said stationary member of a configuration which substantially defines the path generated by the outer surface of said central portion of said workpiece.

17. A machine as set forth in claim **16** including means for adjusting the position of said curved surface.

18. A machine as set forth in claim **5** including workpiece engaging means on said arm means, said workpiece engaging means comprising spaced arm means for receiving said central portion of said workpiece therebetween, and slots in said arm means for receiving said leads.

19. A machine as set forth in claim **5** including workpiece engaging means on said arm means, said workpiece engaging means comprising magnet means on the outer ends of said arm means.

20. A machine for rolling a lead extending from a workpiece comprising roll means for engaging said lead, and feed means for conveying said workpiece toward and away from said roll means comprising arm means for maintaining engagement with said workpiece while it is in engagement with said roll means and while it is being carried toward and away from said roll means, arm-supporting means, and mounting means movably mounting said arm means on said arm-supporting means to permit relative movement between said workpiece and said arm means while said workpiece is in engagement with said roll means.

21. A machine as set forth in claim **20** including means for driving said arm-supporting means in an intermittent manner.

22. A machine as set forth in claim **20** including means for driving said arm-supporting means at a substantially uniform constant speed.

23. A machine as set forth in claim **22** wherein said mounting means include means for permitting said arm means to move in opposite directions.

24. A machine for straightening an elongated wire-like workpiece comprising a base, first and second substantially parallel sets of roll means mounted on said base and defining a work station therebetween for said workpiece, said first set of roll means comprising a plurality of coaxial spaced first rolls with first spaces therebetween, said second set of roll means comprising a plurality of coaxial spaced second rolls with second spaces therebetween, cam means, and cam mounting means mounting said cam means relative to said first and second rolls to cause said cam means to periodically enter said first and second spaces to move a workpiece through said work station.

25. A machine as set forth in claim **24** including a feed wheel for carrying said workpiece from a pick-up station to a delivery station and maintaining engagement therewith throughout the travel between said stations.

26. A machine as set forth in claim **25** wherein said cam means is of a contour to closely follow said workpiece during a major portion of its travel and to engage said workpiece only substantially at said work station.

27. A machine as set forth in claim **26** wherein said feed wheel is driven at a substantially uniform rotary speed.

28. A feed mechanism for feeding elongated magnetic workpieces to a rolling machine comprising a hopper, spaced magnetic sides on said hopper for causing said magnetic workpieces to line up therebetween, a feed wheel, pick-up means on the outer portions of said feed wheel for picking up single workpieces, a rolling machine, and drive means for causing said feed wheel to advance to carry said workpieces from said hopper to said rolling machine, said pick-up means including means for maintaining contact with said workpiece while said workpiece is acted on by said rolling machine.

29. A feed mechanism as set forth in claim **28** wherein said pick-up means comprise a plurality of magnets on said feed wheel.

30. A feed mechanism as set forth in claim **29** wherein said pick-up means comprise arm means mounting said magnets, and pivot means mounting said arm means on said feed wheel.

31. A feed mechanism as set forth in claim **30** wherein said pivot means include means for permitting said arm means to pivot in opposite directions from a central position.

32. A feed mechanism as set forth in claim **28** wherein said pick-up means comprise arm means, and pivot means mounting said arm means for pivotal movement on said feed wheel.

33. A feed mechanism as set forth in claim **32** wherein said pivot means include means for permitting said arm means to pivot in opposite directions from a central position.

34. A feed mechanism as set forth in claim **33** including means for driving said feed wheel at a substantially constant uniform speed.

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