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Kopczynski

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[54] **FEED MECHANISM FOR COMBINED BENDING AND PUNCHING MACHINE**

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[52] **U.S. Cl.** ..... **72/420,** 72/422, 113/113 R

[51] **Int. Cl.** **B21j 13/10**

[58] **Field of Search** ..... 72/420, 422, DIG. 11; 113/113 R

[56] **References Cited**

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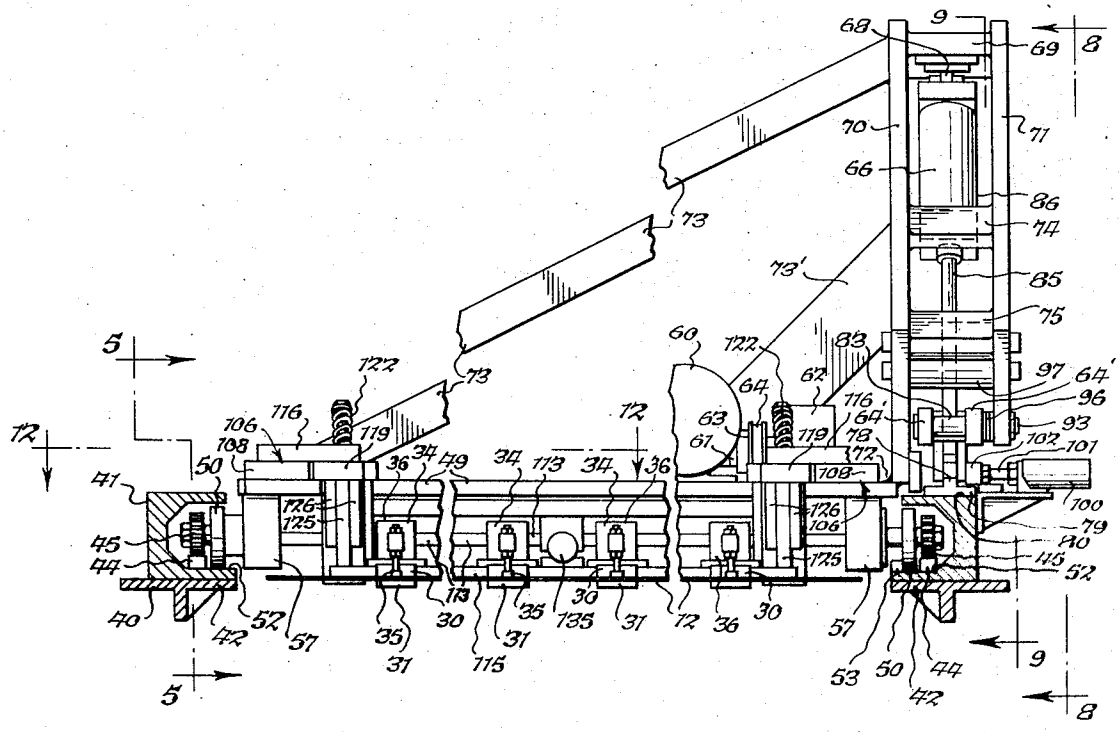
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Assistant Examiner—Robert M. Rogers
Attorney, Agent, or Firm—Joseph P. Gastel, Esq.

[57] **ABSTRACT**

A feed mechanism for advancing a sheet through a combined bending and punching machine in predetermined accurately gauged increments comprising a table, a feed carriage on said table, clamping means on said feed carriage for clamping onto the end portion of the sheet, a scalloped track extending the length of the feed table, a toggle linkage on the carriage, motor means and an associated linkage for bending the toggle linkage and causing a free end thereof to be placed in a scallop prior to straightening the linkage so as to cause the carriage to move a predetermined increment due to the straightening of the toggle linkage, and floating connections to the clamping mechanism for permitting the clamping mechanism to yield in a direction toward the bending machine as the workpiece is being bent and for permitting the portion of the workpiece located between the clamping mechanism and the bending machine to move up and down during the bending, to thereby insure accurate bending as well as the obviating of excessive strain on the portion of the workpiece located between the clamping mechanism and the bending machine.

13 Claims, 16 Drawing Figures



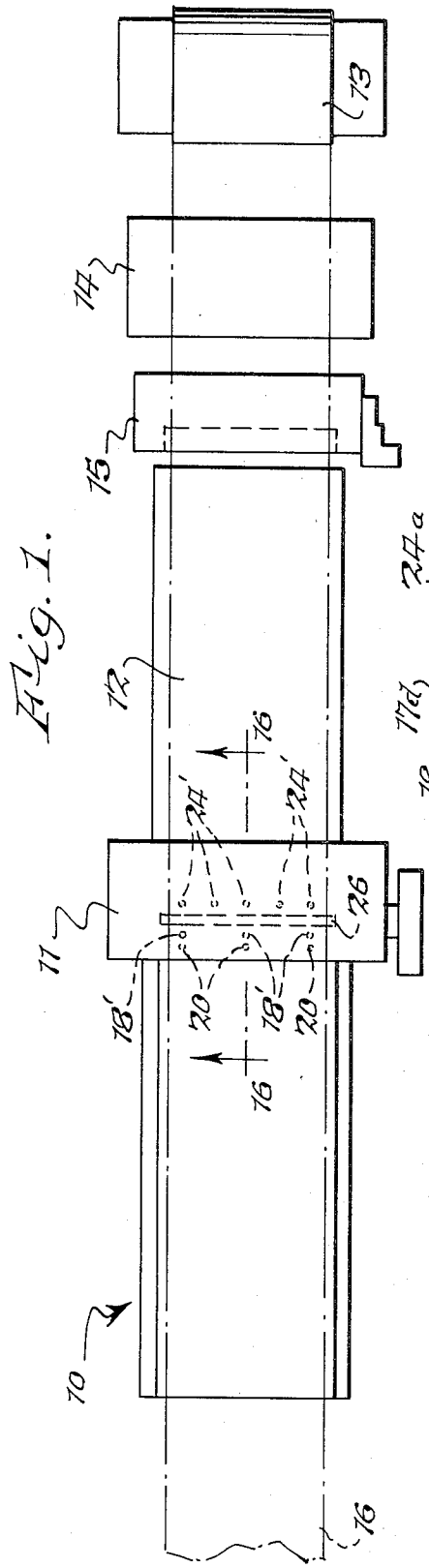

13
14
15
12
16
24'
24'
26
11
18'
20
18'
20
16
10
16

Fig. 1.

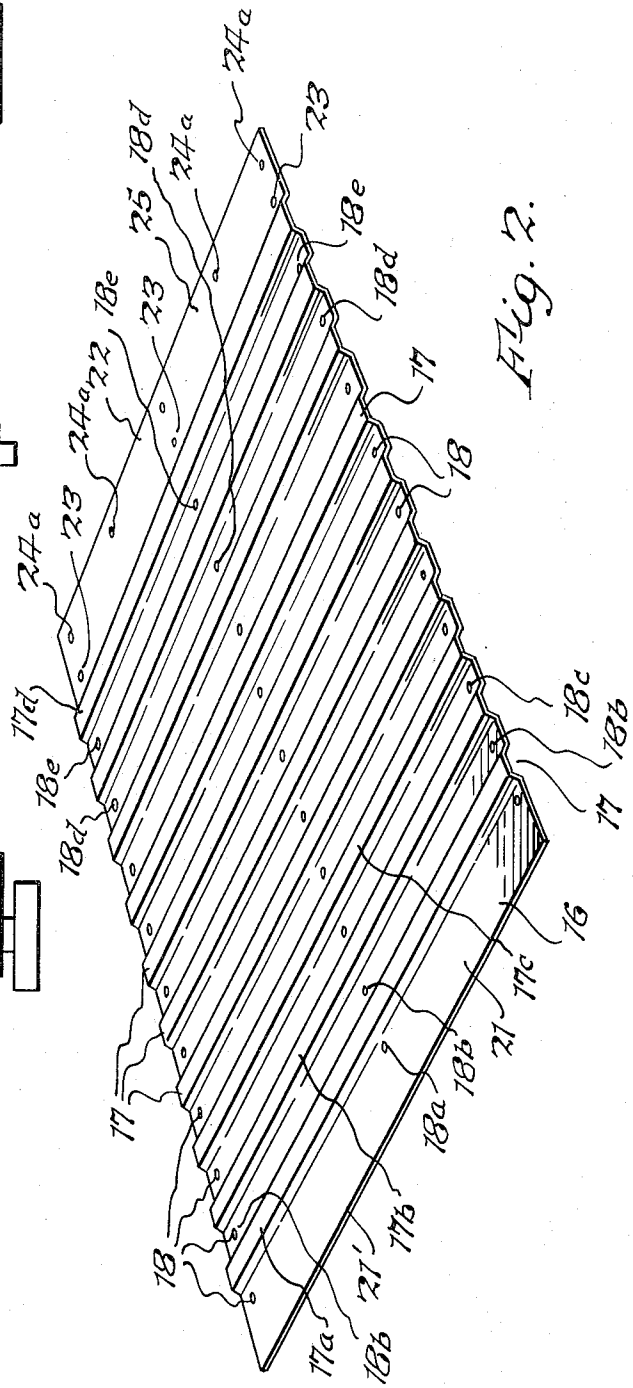

24a
23
18d
25
24a
18e
18d
17
18
18e
23
22
24a
24a
23
17d
18e
18d
18c
18b
17
16
17c
21
18b
18a
17b
17a
18
21'
18b

Fig. 2.

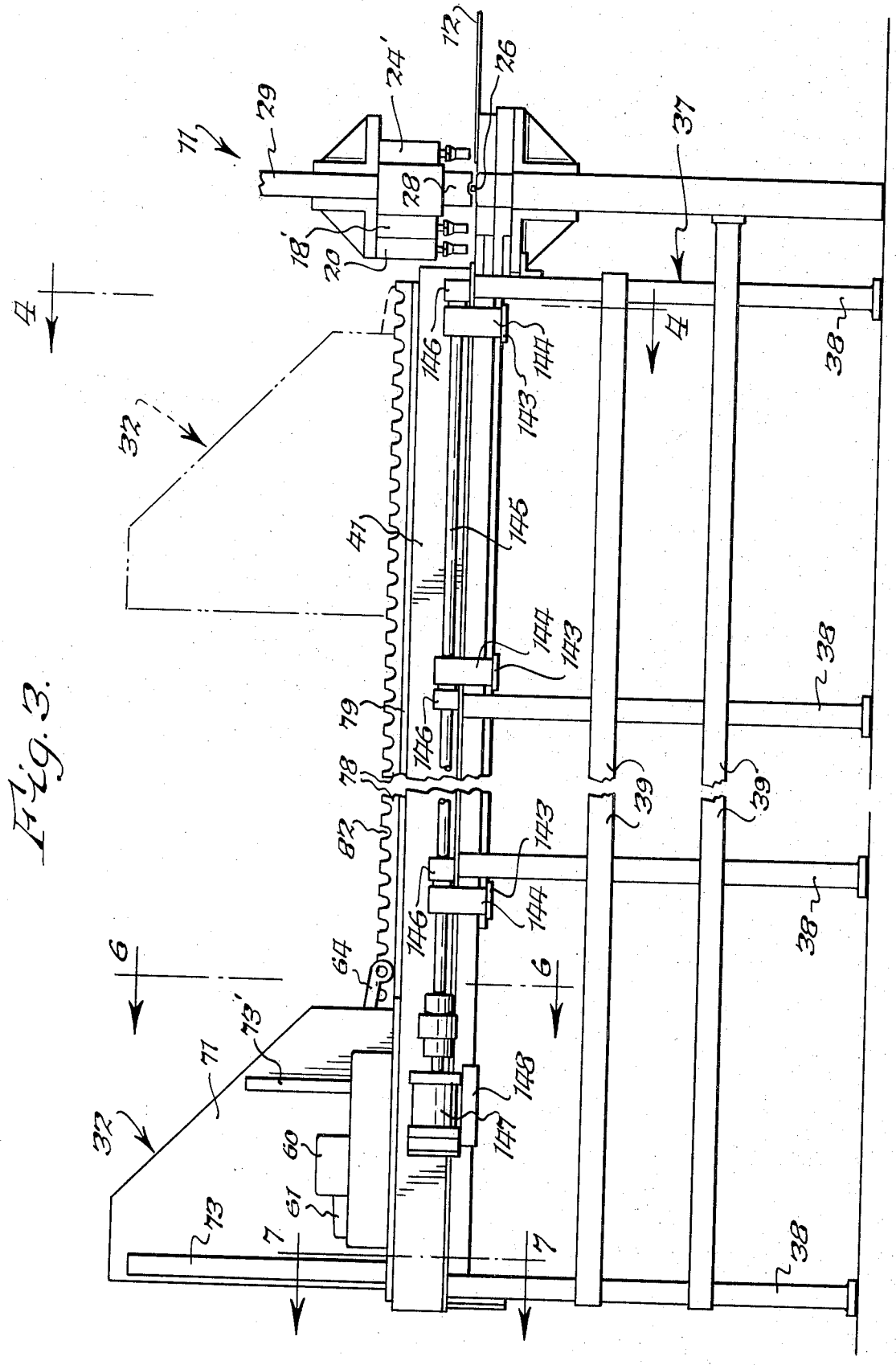

71
29
24'
12
26
37
28
18'
20
4
4
38
32
146
144
143
41
145
144
143
38
79
146
78
39
39
82
143
146
144
38
64
6
6
71
75'
32
148
147
60
61
73
7
7
38

Fig. 3.

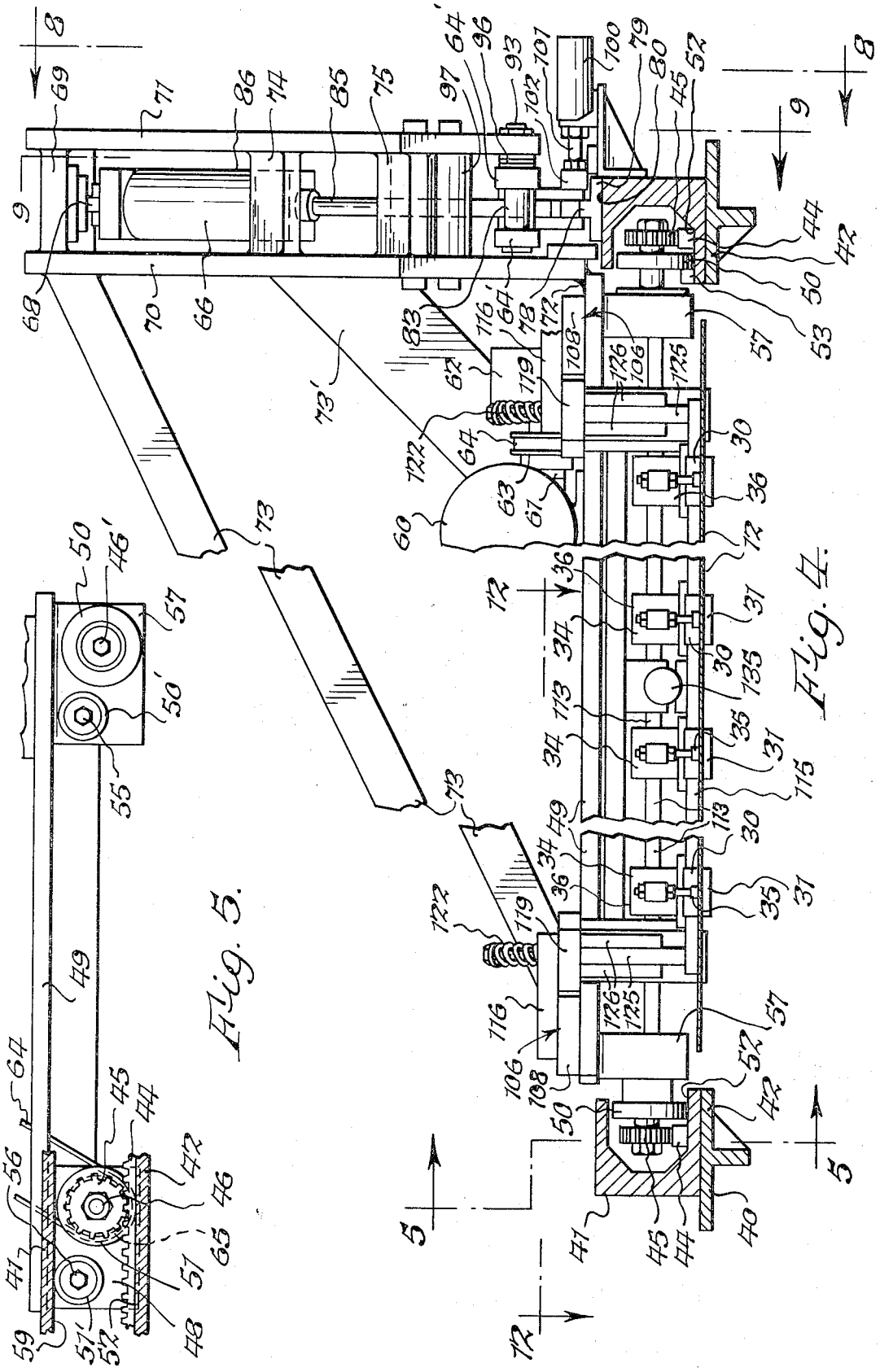


Fig. 4.

Fig. 5.

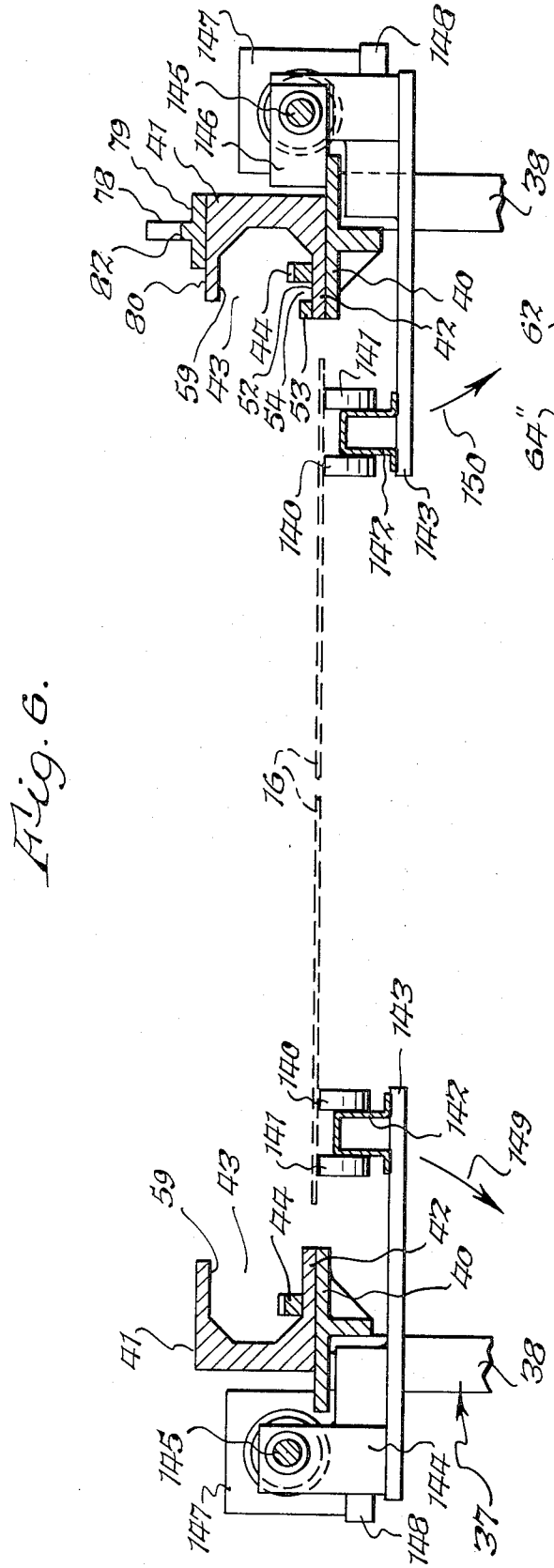


Fig. 6.

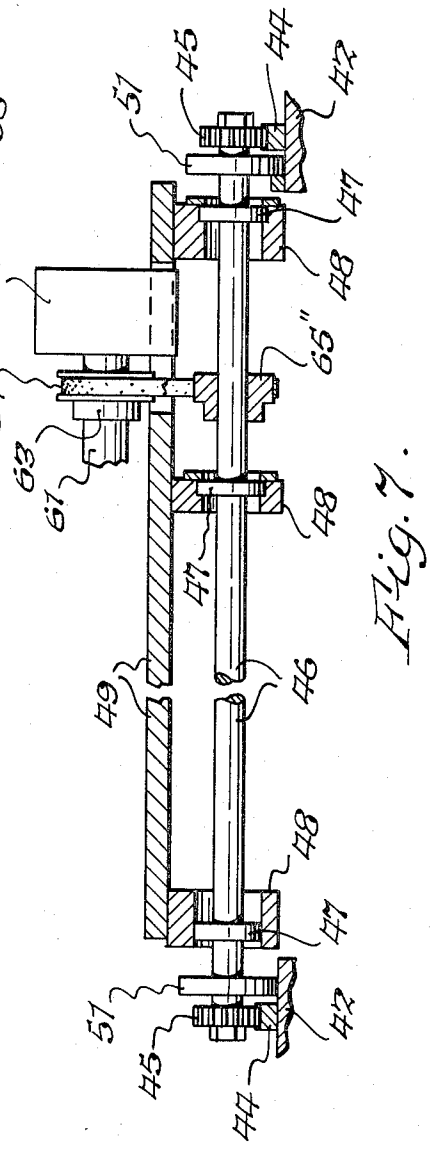


Fig. 7.

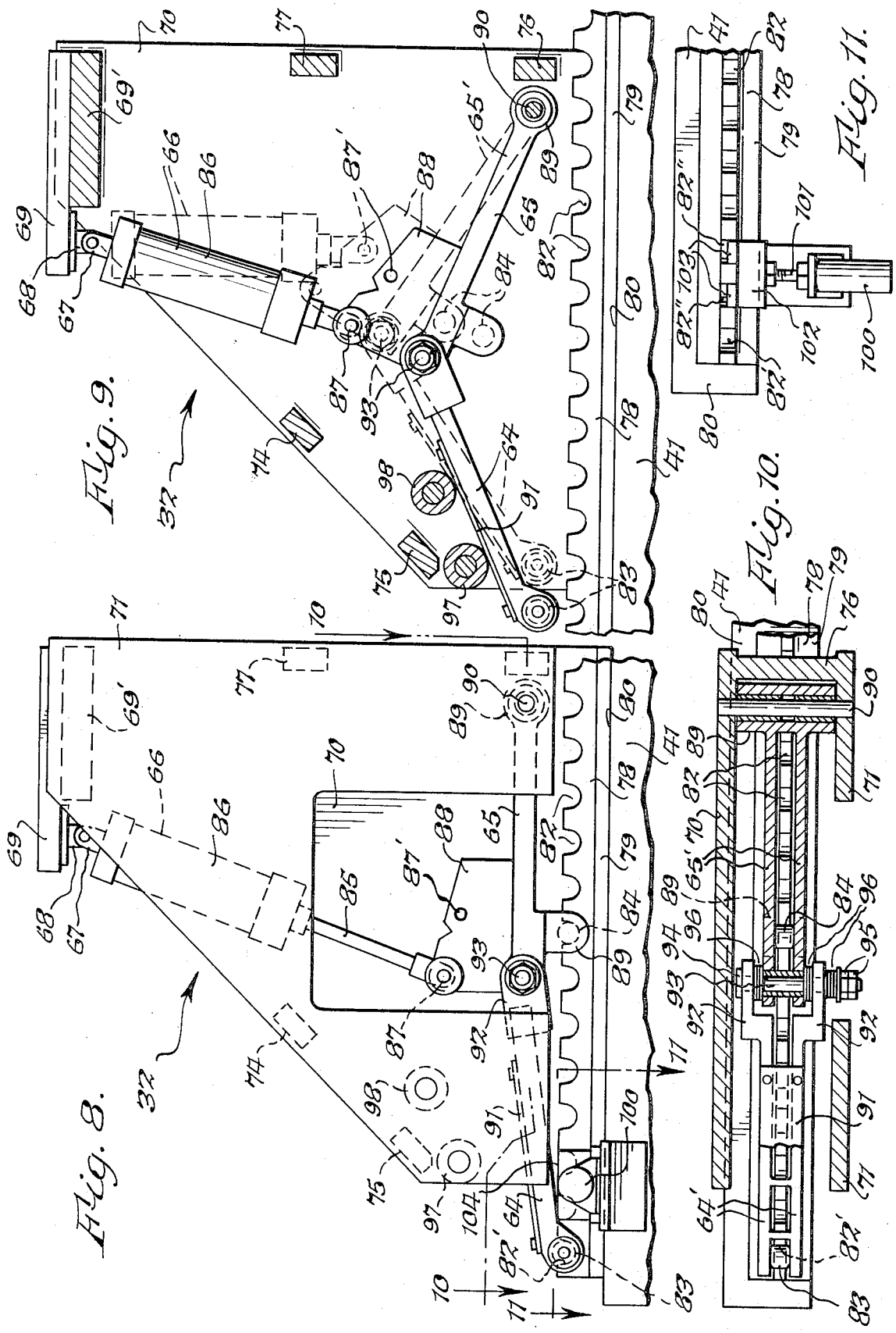


Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 15.
Fig. 14.
Fig. 16.
Fig. 13.
Fig. 12.

FEED MECHANISM FOR COMBINED BENDING AND PUNCHING MACHINE

The present invention relates to an improved feed mechanism for a combined bending and punching machine.

It is the object of the present invention to provide an improved feed mechanism for a combined bending and punching machine which will feed a sheet of material through the machine in accurately gauged increments and will also provide compensatory movements to the sheet while it is being deformed so as to further insure that the bending and punching of the sheet is carried out in an extremely accurate and precise manner. Other objects and attendant advantages of the present invention will be more readily perceived hereafter.

The improved feed mechanism of the present invention advances a sheet through a bending machine in accurately gauged increments and comprises attachment means for attachment to the sheet, advancing means coupled to the attachment means for advancing said sheet in predetermined increments through the machine, and compensating means coupled to the attachment means for permitting said sheet to yield in a direction toward and away from said bending machine during the bending operation and for permitting the portion of said sheet held by the attachment means to yield in the direction of bending, whereby the bending is effected in an extremely accurate manner without placing excessive strain on the portion of the sheet located between the bending machine and the feed mechanism. 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 schematic plan view of the improved feed mechanism of the present invention in relation to associated structure;

FIG. 2 is a perspective view of the sheet which is fabricated by using the feed mechanism of the present invention in conjunction with a bending and punching machine;

FIG. 3 is a fragmentary side elevational view of the improved feed mechanism of the present invention in relation to the bending and punching machine 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. 3 and showing the relationship between the feed carriage and the table on which it is mounted;

FIG. 5 is a cross sectional view taken substantially along line 5—5 of FIG. 4 and showing the rollers for mounting the carriage on the feed table and the rack and pinion arrangement for maintaining it in square relationship to the table during its travel;

FIG. 6 is a fragmentary cross sectional view taken substantially along line 6—6 of FIG. 3 and showing the mechanism for supporting the workpiece on the table and for releasing the workpiece from the table after it has been completed;

FIG. 7 is a fragmentary cross sectional view taken substantially along line 7—7 of FIG. 3 and showing the mechanism for driving the carriage back to a position proximate the bending machine after a workpiece has been released from the table;

FIG. 8 is a fragmentary side elevational view taken in the direction of line 8—8 of FIG. 4 and showing a side view of the carriage with the toggle link extended to the position which it occupies after it has moved the carriage a predetermined increment;

FIG. 9 is a view similar to FIG. 8 but taken substantially along line 9—9 of FIG. 4, and showing the toggle linkage in an intermediate position which it occupies in preparing to advance the carriage a single increment or a double increment;

FIG. 10 is a fragmentary cross sectional view taken substantially along line 10—10 of FIG. 8 and showing further details of the toggle linkage;

FIG. 11 is a fragmentary view in the direction of line 11—11 of FIG. 8 and showing the mechanism for causing the carriage to occupy a predetermined starting position on the feed table proximate the bending machine;

FIG. 12 is a fragmentary view taken substantially along line 12—12 of FIG. 4 and showing various details of the linkage for effecting the compensating movements of the sheet during the bending operation;

FIG. 13 is an end elevational view of the clamping and compensating mechanism taken substantially in the direction of line 13—13 of FIG. 12;

FIG. 14 is a fragmentary cross sectional view taken substantially along line 14—14 of FIG. 12 and showing the compensating linkages and their directions of movement;

FIG. 15 is a fragmentary cross sectional view taken substantially along line 15—15 of FIG. 12 and showing the compensating mechanism associated with the clamping member for providing punched holes at a predetermined distance from previously punched holes when there are no intervening bent portions in the sheet; and

FIG. 16 is a fragmentary cross sectional view taken substantially along line 16—16 of FIG. 1 and showing the action of the material being bent with relationship to the bending die for the purpose of setting forth the basic underlying principle of operation of the compensatory mechanism of the present invention.

As can be seen from FIG. 1, the improved feed mechanism 10 of the present invention is adapted to be used in conjunction with a combined bending and punching machine 11 which receives an elongated sheet of material 12 from a coil 13 after the material on the coil has been straightened by straightener 14 and sheared to length by shear 15. The finished workpiece, after having been deformed by combined bending and punching machine 11, is shown in FIG. 2 at 16. The workpiece includes ridges 17 which have been formed by bending the original sheet 12 upwardly into the shape shown. In addition, holes, such as 18, are punched along the opposite side edges of workpiece 16 on the centerlines between the ridges 17. Also, a series of holes are punched along the longitudinal centerline of the workpiece 16 and on the centerlines between adjacent ridges 17. Trailing end 22 of sheet 16 includes a first line of punched holes 23 which are spaced an equal amount beyond the last ridge 17 as are the preceding row of holes 18*e* ahead of this last ridge 17. In addition, a last series of holes 24*a* are positioned proximate the trailing edge 25 of the workpiece. The foregoing described finished sheet 16 is fabricated by pulling a planar sheet 12 through the combined bending and punching machine 11 by the use of feed mechanism 10 and causing the punching and bending to occur at predetermined times during the travel of sheet 12 through machine 11.

The manner in which each sheet **12** is deformed into finished plate **16** of FIG. **2** can be seen from FIG. **16.** In this respect the base **11'** of machine **11** includes a movable male die **26** which can be moved vertically in the direction of arrow **27** to the position shown in FIG. **16.** Thereafter female die **28** is driven downwardly by ram **29** to form a ridge **17.** During deformation the portions of the sheet adjacent each ridge **17** move to the dotted line position **12'** of FIG. **16,** and while female die **28** is holding sheet **12** in this position, the row of punches **18'** (FIG. **1**) are caused to descend by suitable mechanism (not shown) to punch holes such as **18** adjacent each ridge **17.** More specifically, the first ridge **17***a* is formed and thereafter the sheet is advanced by feed mechanism **10** a predetermined increment and ridge **17***b* is formed. While dies **26** and **28** engage the workpiece at ridge **17***b*, a row of holes **18,** which are also designated with numeral **18***a*, are punched. Thereafter, sheet **12** is advanced to form ridge **17***c* and at this time the holes **18** which are also designated by numeral **18***b* are punched. It can thus be seen that a row of holes **18** is punched by punches **18'** while a ridge two ridges away is being held by dies **26** and **28.** This procedure continues until such time as the row of holes **18***d* are punched while ridge **17***d* is being held between dies **26** and **28.** Thereafter, sheet **12** is advanced to the left a normal distance which it is usually advanced between adjacent ridges **17** and after the sheet **12** has stopped, a compensatory mechanism, to be described in detail hereafter, causes the sheet **12** to move to the right an amount which it would move if a ridge **17** were formed into it, and thereafter dies **18'** and **24'** are simultaneously actuated to form the row of holes at **18***e* and **24***a*. Thereafter, sheet **12** is again advanced to the left a normal distance as if a ridge **17** were to be formed and since no ridge is actually formed, compensatory mechanism causes the sheet **12** to move to the right an amount that it would if a ridge were formed, and thereafter the row of holes **23** are formed by dies **18'**. Suitable mechanism (not shown) is provided to retract male die **26** so that the top thereof is flush with base **29** for the purpose of preventing die **26** from interfering with the punching of the rows of holes **18***e*, **23,** and **24***a*, as these holes are formed without a corresponding forming of a ridge **17.**

In order to move sheet **12** through the machine **11** and thus place it in the proper position for bending and punching, the leading edge **21'** is threaded through the machine and caused to abut shoulder **30** of each clamp base **31** (FIGS. **4, 12** and **13**) of each clamping unit **36,** a plurality of which are spacedly mounted crosswise of the carriage **32.** The lead portion **21** of sheet **12** rests on shelf **33** of each clamp base **31.** A clamping foot **35** forms a part of each clamping unit **36** for clamping the leading portion **21** of sheet **12** to shelf **33.** The mechanism for causing clamping foot **35** to move into the positions shown in FIGS. **4** and **13** is contained within housing **34** and may include a hydraulic motor or an electric motor and suitable linkage for the purpose of causing clamping foot **35** to move between a clamping position shown in FIGS. **4** and **13** and an open position (not shown) wherein the workpiece is threaded into position against shoulder **30.**

When the above threading of the workpiece **12** onto carriage **32** takes place, carriage **32** is substantially in the phantom line position shown in FIG. **3.** Thereafter, it is caused to move in increments from the phantom line position to the solid line position shown in FIG. **3.** When carriage **32** is stopped after each increment of movement, the above described bending and punching is caused to occur. Carriage **32** is mounted for movement on table **37** having a plurality of legs **38** mounted both lengthwise and crosswise of the table, said legs being braced by suitable horizontal struts **39.** Plates **40** (FIG. **6**) which extend lengthwise the entire length of the table, are suitably secured, as by welding, to the tops of legs **38.** Rails **41,** which extend the entire length of table **37,** have their base portions **42** secured, as be welding, to the tops of plates **40** and have hollow portions **43** facing each other, with these hollow portions containing elongated racks **44** which extend substantially the entire length of the table and are engaged by pinions **45** keyed at the ends of shaft **46,** which is journalled in bearings **47** (FIG. **7**) mounted in blocks **48** which depend downwardly from plate **49** which extends crosswise across the width of carriage **32.** Because of the construction which includes shaft **46** and rack and pinion **44–45,** as the carriage **32** moves lengthwise of the table, it will be kept square relative to the table because each side of the carriage **32** must always move the same distance because of the rack and pinion interconnections on opposite sides of the table.

A pair of wheels **50** and a pair of wheels **51** are provided on opposite sides of the carriage. Wheels **51** are journalled on shaft **46,** as noted above, and wheels **50** are journalled on stub shafts **46'** mounted on blocks **57** secured to plate **59.** A pair of wheels **50–51** are located on each side of the carriage and they run on surfaces **52** of rail **41.** An elongated bar **53** extends the entire length of the right rail **41** (FIG. **6**) so as to provide a track **54** which receives the pair of wheels **50–51** on one side of the carriage **32** to confine the carriage against lateral shifting on the table. Wheels **50'** and **51'** are located on each side of the carriage (FIG. **5**) and are journalled on stub shafts **55** and **56,** respectively, secured to blocks **57** and **48,** respectively. Wheels **50'–51'** bear against undersurfaces **59** of rails **41** so as to prevent carriage **32** from lifting upwardly during its travel.

At this point it is to be noted that an electric motor **60** (FIG. **3**) is suitably mounted on upper plate **49** (FIG. **7**) of the carriage and is connected through gear reducer **61** to a clutch mechanism **62** which drives output pulley **63** which in turn drives belt **64''** which encircles pulley **65''** keyed to shaft **46.** Thus motor **60** can be used to drive the carriage **32** from its solid line position shown in FIG. **3** to its dotted line position shown therein after a workpiece has been completed, to place the carriage in position to accept a new workpiece. However, clutch **62** is always engaged without the motor **60** running when carriage **32** is moved from right to left in FIG. **3,** so as to provide a braking action for carriage **32** which prevents it from overtraveling when it is moved in increments during the metal shaping process.

The mechanism for effecting the feed of carriage **32** in increments includes a toggle linkage (FIGS. **8** and **9**) which includes links **64** and **65** which are actuated in a predetermined manner by pneumatic motor **66,** which includes cylinder **86** and piston **85.** More specifically, the cylinder **86** has one end **67** pivotally mounted at clevis **68** on bar **69** which is secured to cross bar **69'** having its opposite ends welded to parallel trapezoidal plates **70** and **71.** The lower portion of plate **70** is se-

cured, so by welding, at 72 to top plate 49 of the carriage (FIG. 4). A diagonal brace 73 extends from the upper end of plate 70 downwardly and is secured to plate 49, as by welding at the opposite side of the carriage. A shorter diagonal brace 73' also extends between plates 70 and 49. A plurality of combined cross braces and spacers 74, 75, 76 and 77 secure trapezoidal plate 71 to trapezoidal plate 70. A scalloped rail 78 extends substantially the entire length of the right rail 41 (FIG. 6) and has a base 79 secured as by welding to the upper surface 80 of track 41. Track 78 includes scallops or depressions 82 spaced at equal increments along the length of track 78 for the purpose of receiving pins 83 and 84 therein during the process of moving carriage 32 in increments along track 78.

In order to move carriage 32, motor 66 is actuated to cause piston 85 to move upwardly into cylinder 86. The lower end of piston 85 is connected at pivot 87 to plate 88, the lower portion of which is secured as by welding between spaced sides 65' of link 65. The end of link 65 remote from pivot 87 is formed into a sleeve 89 (FIG. 10) which is journalled on pin 90 extending between sides 70 and 71. By drawing piston 85 into cylinder 86, plate 88 will travel from the position shown in FIG. 8 to the solid-line position shown in FIG. 9 and cause toggle link 65 to move from the position shown in FIG. 8 to the solid-line position shown in FIG. 9, as link 65 pivots about pin 90. Link 64 is fabricated of two spaced parallel link sides 64' which are suitably secured relative to each other and have plate 91 secured across the tops thereof. Link 64 has its end widened to form spaced parallel side portions 92 which are extensions of portions 64'. Pin 93 pivotally connects the adjacent ends of links 64 and 65 with a friction fit, so that links 64 and 65 will remain relative to each other in the position in which they were last placed by some external force. More specifically, pin 93 has a head 94 which bears on one side 92 and nuts 95 are secured on the opposite end of pin 93. Bellville washers 96 are suitably secured on pin 93 between links 64 and 65 so as to provide a good friction fit therebetween to thus retain them in the position in which they were last placed as noted above.

As plate 88 is moved upwardly from the position shown in FIG. 8 to the position shown in FIG. 9 by the action of motor 66, plate 91 on link 64 will engage bar 97 as the links 64 and 65 are being raised while retaining the orientation shown in FIG. 8 and thereafter link 64 will be moved in a counterclockwise direction about pivot 93 so as to assume the solid line orientation shown in FIG. 9. After the piston 85 has been moved upwardly for its entire limit of travel, the compressed air source thereto is reversed to cause it to move downwardly, and links 64 and 65 while remaining in the bent position in which they were placed by the action of bar 97 will be moved downwardly in a counterclockwise direction about pin 90. This movement will continue until such time as pin 83 enters one of the scallops or depressions 82 in track 78. Thereafter continued downward movement of piston 85 will cause pivotal movement between links 64 and 65 at pivot 93 and thus tend to straighten links 64 and 65 relative to each other so that they will assume the position shown in FIG. 8 from the position shown in FIG. 9. At the lowermost portion of travel, pin 84, which is secured between spaced ears 89 extending downwardly from sides 65' of link 65, will enter another of the scallops or depressions 82 (FIG. 8) to thus lock carriage 32 in position.

After the carriage has been moved to its new position by the action of motor 66 and the associated toggle linkage 64–65, described in detail above, the bending and punching machine 11 will be actuated to effect the desired operation on the workpiece, and it will be appreciated that after the operation has terminated, the linkages shown in FIGS. 8 and 9 are again actuated to move the plate 12 an incremental amount away from machine 11 to thereby again place it in position for a subsequent work operation. Carriage 32 will not shift while links 64 and 65 are being manipulated when pins 83 and 84 are not in depressions 82 because of the action of brake 62 acting on shaft 46, as discussed in detail above.

At this point it is to be noted that a special mechanism is included for insuring that carriage 32 starts its travel away from machine 11 at the endmost scallop 82' (FIG. 11) on track 78. In this respect after carriage 32 has been moved from the solid-line position of FIG. 3 to generally the dotted-line position shown therein by the action of motor 60 and the associated linkage which it drives, as described in detail above, a pneumatic motor having a cylinder 100 (FIGS. 8 and 11) is actuated to cause piston 101 thereof to move plate 102 from a retracted position (not shown) to the position shown in FIG. 11 wherein tooth members 103 enter depressions 82'' so as to provide a surface 104 (FIG. 8) which is flush with the top surface of track 78. This will cause pin 83 at the end of link 64 to ride over depressions 82'' and enter depression 82' at the very end of track 78 when motor 66 is actuated. Thus even though carriage 32 may not have moved to a position which is exactly where it should be to cause pin 83 to enter scallop 82', the obstructing of scallops 82'' by the end portions 103 of plate 102 will insure that the pin 83 will enter scallop 82' to provide a very accurate and fixed point from which the carriage 32 begins its travel along table 37. After pin 83 has entered scallop 82' and the links 64–65 have been straightened to the position of FIG. 8, plate 102 is withdrawn from scallops 82'' so that the carriage 32 can be moved an increment upon the subsequent actuation of the links 64–65.

When the lower end of piston 85 is secured to the pivot at 87, as shown in FIG. 8, the toggle links 64–65 will be bent by the movement of motor 66 to a condition where they will move the carriage 32 a distance which is equivalent to the distance between the centerlines of adjacent scallops. In other words, pin 83 will move from the solid line position of FIG. 8 to the solid line position of FIG. 9 during one cycle of operation of motor 6. However, if it is desired to move carriage 32 a distance of two scallops during a single cycle of operation of motor 66, it is merely necessary to relocate pivot 87 in hole 87' in plate 88, and this will cause pin 83 at the end of link 64 to be moved a distance of two scallops 82 during one cycle of operation of motor 66. In this respect plate 88 will be raised to the dotted line position of FIG. 9 and plate 91 on arm 64, after contacting bar 97, as noted above, will continue to move upwardly and engage bar 98 (FIG. 9) so as to cause arm 64 to be moved to the dotted line position of FIG. 9. When motor 66 is reversed, pin 83 at the end of arm 64 will move into the scallop 82 which is twice removed from the one from which it was withdrawn. At this point it is to be noted that there are a row of dies 20 ad-

jacent the row 18' (FIGS. 1 and 3). This row of dies is used instead of the row of dies 18' whenever the toggle linkage moves carriage 32 a distance of two scallops, whereas dies 18' were used when carriage 32 moved the workpiece a distance of one scallop between punching operations.

The clamping mechanism described above with respect to FIGS. 4, 12 and 13 is caused to clamp the leading end 21 of plate 12 when carriage 32 is in the dotted line position shown in FIG. 3. After it is so clamped machine 11 is actuated to cause the first bend 17*a* to be formed by dies 26–28. However, during the bending, the leading end 21 of sheet 12 will change its elevation by an amount 105 because it moves from the solid line position of FIG. 16 to the dotted line position shown therein. If the clamping mechanism did not compensate for this, there could be difficulty, as for example, stress on the sheet which could lead to tearing thereof or a very inaccurate ridge formed on the plate 12 or the disengagement of the leading end of sheet 12 from the clamps. Accordingly, compensatory mechanism is provided to permit the level of the portion of sheet 12 to the left of the dies in FIG. 16 to change during the bending without placing stress on the portion located between the bending dies and the clamps 35. In the foregoing respect, as can be seen from FIGS. 4, 12, 13 and 14, plates 106, which are Z-shaped in plan, are secured as by screws 107 to plate 49 at opposite sides of the carriage in mirror-image relationship to each other. Z-shaped plates 106 comprise rectangular portion 108 and a second rectangular portion 109. A vertical leg 110 extends downwardly from the underside of each plate 109 and each leg has a bifurcated end 110' mounting a pin 111 so as to form a clevis connection with plate 112 having an end mounted on pin 111 and extending between the sides of legs 110. Plate 112 has its opposite end secured, as by welding, to horizontal bar 113 which extends substantially the entire width of the carriage and has its opposite end supported on another link 112 (not shown) located at the opposite end of carriage 32.

Because clamping units 36 are mounted on bases 31, as noted above, and because these bases 31 are secured as by welding to bar 115 (FIG. 12) which extends across the width of the carriage and because bar 115 is effectively connected to bar 113, as described in greater detail hereafter, any clockwise pivotal movement of plates 112 about pivot 111 will cause a corresponding clockwise movement of clamp units 36 to permit the end 21 of plate 12 to adjust its level during the bending operation. In the foregoing respect it is to be noted that a bar 116 is secured in cantilevered relationship to rectangular portion 108 and includes a bore 117 (FIG. 14) therein through which screw 118 extends and the end of screw 118 is threaded into horizontal leg 119 of angle 120, the vertical leg 121 of which is secured as by welding to bar 113. Therefore, when plates 112 pivot about pins 111 in a clockwise direction (FIG. 14), in following the downward movement of plate 12 during the bending operation, it will be against the bias of spring 122 which encircles screw 118 because top leg 119 will follow the pivotal movement of plate 112 while bar 116 remains stationary, to thereby cause compression of spring 122. As noted above, the clamping units 36 are mounted on bar 115. However, during pivotal movement of plates 112 in a clockwise direction the lower corner 123 of bar 115 will be in abutting relationship to the vertical leg 121 of angle 119 at 123.

The compensating mechanism also makes allowance for tendency of the portion of plate 12 to the left of die 26 in FIG. 16 to move to the right in the direction of arrow 105' during the bending operation, as it must when sheet 12 is formed around die 26. To this end, elongated bar 115 which mounts clamp units 36, has a pair of upstanding plates 125 welded thereto and the upper ends of plates 125 are pivotally connected on pins 127 between spaced gussets 126 extending between legs 119 and 121 of angle 120. A screw 128 extends loosely through each vertical leg 121 on angle 119 and threads into plate 125 at 129. A spring 130 encircles screw 128 and bears on the surface of leg 121 which is opposite to gussets 126. Since the clamping units 36 are mounted on bases 31 which in turn are mounted on bar or plate 115 which is carried by plates 125, as the workpiece 12 moves to the right in the direction 105' during a bending operation, plates 125, which are at opposite ends of plate 115, will pivot in the counterclockwise direction of arrow 131 (FIG. 14) so as to provide the compensation in the direction 105 during the bending operation.

It can thus be seen that the clamping units 36 can yield in an up and down direction 114 to compensate for the changes in elevation of the workpiece being bent and also move in a direction 131 from left to right to compensate for the shortening of the workpiece between the die and the clamping mechanism while the workpiece is being bent.

The line of holes 23 at the trailing end 22 of the workpiece 12 is spaced the same amount from ridge 17*d* as the preceding holes 18*e* are spaced from this ridge. However, it is to be noted that there is no ridge to the right of holes 23. Therefore, after the simultaneous punching of the last holes 18*e* and 24*a*, the workpiece is advanced a distance of one scallop 82 by the use of the advancing mechanism shown in FIGS. 8 and 9. Thereafter, pneumatic cylinder 135 (FIG. 15) mounted on plate 115 is actuated and piston 136 of cylinder 135 will extend to the left (FIG. 15) and abut block 137 secured to plate 113 depending downwardly therefrom. This causes plate or bar 115 to move from the solid line position shown in FIG. 15 to the dotted line position to thereby cause the clamping units 36 mounted on plate 115 to move to the right from the solid line position of clamps 35 to the dotted line position thereof. This will move the workpiece 12 to the right through the machine 11 so as to locate plate 12 in proper position for punching holes 23 with these holes spaced the same amount from ridge 17*d* as the latter is spaced from the preceding holes 18*e*. The reason that sheet 12 is moved to the right through machine 11 by piston and cylinder 135–136 after sheet 12 has been moved to the left by the carriage 32 is because holes 23 are to be formed when there has been no corresponding take-up of sheet 12 to the right as a result of forming a ridge 17 thereon. In other words, the holes 18*a*, 18 *b* and 18*c* are formed after a ridge 17 has been formed and while the sheet is still being held by the dies 26–28 which form the ridge. However, the holes 23 are formed without the formation of a corresponding ridge which causes the sheet to move to the right in FIG. 1. At this point it is to be noted that the row of holes 18*e* are also formed after the sheet has been moved to the right by the piston and cylinder 135–136 because, as

noted above, the row of holes **18***e* are not formed with the accompanying formation of a ridge, as are holes **18***a*, **18***b* and **18***c*.

As the workpiece is pulled from right to left in FIG. **3** to follow the position of carriage **32** from the dotted line position to the solid line position thereof, the edges of the workpiece **12** are supported on rollers **140** and **141** journalled relative to inverted U-shaped member **142** which extends the length of the table **37** and is supported on plates **143** located below rails **41**. Plates **143** in turn have their outer ends secured as by welding to blocks **144**, the upper portions of which are keyed to shafts **145** journalled in blocks **46** secured, as by welding, to the upper portions of plate **40** located at top of legs **38**. A rotary air motor **147** is mounted on plate **148** which is secured as by welding to an appropriate portion of the table **37**. After the sheet **12** has been formed into the finished workpiece **16** and the trailing edge **25** thereof has left the machine **11** and while it is supported on rollers **140** and **141** on opposite sides of the table after clamps **35** have released end **21**, rotary air motors **147** are actuated to cause plates **143** to pivot in the direction of arrows **149** and **150** to permit the completed workpiece **16** to drop into the space between the legs **38** on opposite sides of the table, from which it is subsequently removed.

It can thus be seen that the improved feed mechanism of the present invention is 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 embodied otherwise within the scope of the following claims.

What is claimed is:

1. A feed mechanism for advancing an elongated member having a longitudinal axis through a bending machine comprising attachment means for attachment to said member, advancing means coupled to said attachment means for intermittently advancing said member through said bending machine in predetermined increments in the direction of said longitudinal axis, said advancing means being spaced from said bending machine along said longitudinal axis so that a portion of said member which is not engaged by said attachment means or said bending machine lies between said attachment means and said bending machine, and compensating means for permitting said portion of said member located between said bending machine and said attachment means to yield in the direction of said longitudinal axis during bending while said member is being held by said attachment means.

2. A feed mechanism for advancing a member through a bending machine as set forth in claim **1** wherein said compensating means also include means for permitting said member to yield in the direction of bending.

3. A feed mechanism for advancing a member through a bending machine comprising attachment means for attachment to said member, advancing means coupled to said attachment means for advancing said member in predetermined increments, and compensating means coupled to said attachment means for permitting said member to yield toward said bending machine during bending and while said member is being held by said attachment means, said advancing means comprising a table, a carriage, means on said table for mounting said carriage, spaced depressions extending longitudinally of said table, and linkage means mounted on said carriage for sequentially engaging said spaced depressions to advance said carriage in increments determined by the spacing between said depressions.

4. A feed mechanism for advancing a member through a bending machine as set forth in claim **3** wherein said linkage means comprises a toggle linkage having first and second links having a first pivotal connected therebetween, a second pivotal connection spaced from said first pivotal connection for pivotally securing said first link to said carriage, and the end of said second link remote from said first pivotal connection having an end portion for selective insertion into said depressions, whereby said carriage may be advanced by straightening said toggle linkage after said end portion has been inserted into said depression while said first and second links are in a bent condition.

5. A feed mechanism for advancing a member through a bending machine as set forth in claim **4** wherein said first pivotal connection includes friction means for retaining said first and second links in the relative position in which they were last placed until they are forcibly moved to a new position relative to each other.

6. A feed mechanism for advancing a member through a bending machine as set forth in claim **5** including motor means mounted on said carriage and coupled in a first position relative to said first and second links for selectively bending said first and second links relative to each other, and means for coupling said motor means in a second position relative to said first and second links to vary the increments of travel of said carriage.

7. A feed mechanism for advancing a member through a bending machine as set forth in claim **5** including alignment means for causing said carriage to maintain a square alignment relative to said table.

8. A feed mechanism for advancing a member through a bending machine as set forth in claim **7** wherein said alignment means comprises a shaft journalled on said carriage and extending perpendicularly to the direction of movement of said carriage, spaced racks on said table, a pinion keyed on each end of said shaft and in mesh with said racks, whereby said carriage will remain square to said table as it travels along said table.

9. A feed mechanism for advancing a member through a bending machine comprising attachment means for attachment to said member, advancing means coupled to said attachment means for advancing said member in predetermined increments, and compensating means coupled to said attachment means for permitting said member to yield toward said bending machine during bending and while said member is being held by said attachment means, said compensating means also including means for permitting said member to yield in the direction of bending, said advancement means comprising a carriage and said compensating means comprising first mounting means for mounting said attachment means for pivotal movement about a first axis which permits said attachment means to move toward said bending machine, and second mounting means for mounting said attachment means for pivotal movement about a second axis which permits said attachmnt means to move in the direction of bending.

10. A feed mechanism for advancing a member through a bending machine as set forth in claim 9 including first spring means for biasing said first mounting means in a direction away from said machine and second spring means for biasing said second mounting means in a direction away from the direction of bending.

11. A feed mechanism for advancing a member through a bending machine as set forth in claim 3 including means for selectively preventing said linkage means for engaging certain of said spaced depressions.

12. A feed mechanism for advancing a member through a bending machine as set forth in claim 3 including support means on said table intermediate said bending machine and said carriage for supporting said member, and means for selectively retracting said support means to drop said workpiece from said table.

13. A feed mechanism for advancing a member through a bending machine as set forth in claim 3 including motor means mounted on said carriage, first means coupling said motor means in a first position relative to said linkage means for selectively causing said linkage means to advance said carriage in increments which is equal to a first distance as determined by the spacing between said depressions, and second means for coupling said motor means in a second position relative to said linkage means to advance said carriage in increments which is equal to a second distance different from said first distance and which is also based on the spacing between said depressions.

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