(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 592 848 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **93115381.1**

(51) Int. Cl.5: **B21D 39/02**

(22) Date of filing: **23.09.93**

(30) Priority: **14.10.92 US 960955**

(43) Date of publication of application:
20.04.94 Bulletin 94/16

(84) Designated Contracting States:
DE ES FR GB SE

(71) Applicant: **Litton Industrial Automation Systems, Inc.**
7300 Turfway Road
Florence Kentucky 41042-1355(US)

(72) Inventor: **Brown, Gerald A.**
1844 Woodside
Trenton, Michigan 48183(US)
Inventor: **Hartley, William R.**
56428 Meadowlane
Macomb City, Michigan 48042(US)
Inventor: **Jehmlich, Mark P.**
11661 Lakepointe
Detroit, Michigan 48224(US)
Inventor: **McNamara, Jeffrey S.**
23507 Parklane
Grosse Ile, Michigan 48138(US)
Inventor: **Verzura, John C.**
34167 Zimmer Drive
Sterling Heights, Michigan 48310(US)

(74) Representative: **TER MEER - MÜLLER - STEINMEISTER & PARTNER**
Mauerkircherstrasse 45
D-81679 München (DE)

(54) Hemming press.

(57) A press (20) with both prehemming and final hemming tools or steels (22, 24) each driven by the same prime mover (44). Each steel is mounted on a separate carrier (36, 38) driven through separate toggle joints (40, 42) to advance and retract the steels (22, 24) for prehemming and final hemming of an upturned flange (26) along the edge of a steel panel (30). To facilitate synchronizing the operation of at least two presses (20), the prime mover (44) may be a screw and servo motor drive assembly (158).

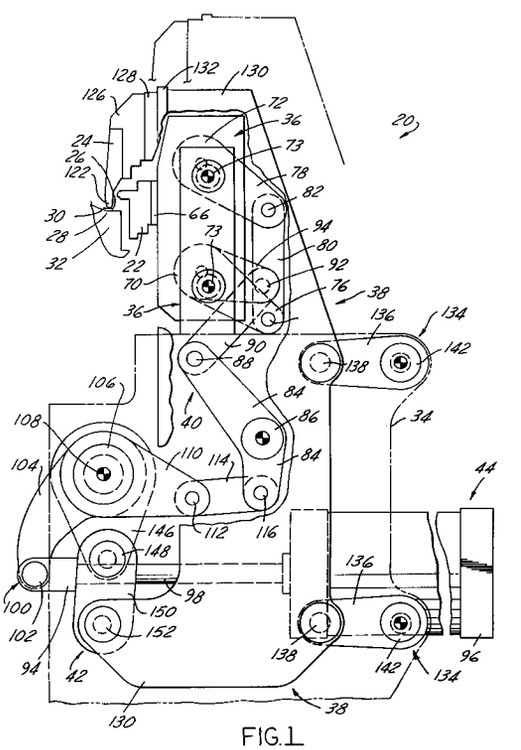

FIG.1

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Field of the Invention

This invention relates to hemming sheet metal and more particularly to an apparatus for forming a hem on an edge of a sheet of a structural member such as a vehicle body panel.

Background

Door, hood, and trunk deck lids of vehicles have been formed of one unitary outer skin of sheet metal joined around its periphery to a second inner reinforcing panel of sheet metal by hemming a generally upturned flange along each edge of the outer sheet over an adjacent edge of the inner panel.

This hemming has been accomplished in two separate stages. Prior to performing the first stage, the reinforcing panel is nested within the outer panel fixtured on an anvil die on a base of a prehemming machine. Upon fixturing the assembly, a tool of the machine, commonly referred to as a hemming steel, engages and bends an edge of the outer panel to an acute included angle with respect to the outer panel. After the prehemming of all edges to be joined, both panels are released, transferred to and fixtured in a second hemming machine where a second tool completely bends the prehemmed edge of the outer panel over the peripheral edge of the reinforcing panel to secure and attach the panels together as a unitary structural member for assembly on a vehicle.

Typically, a plurality of both prehemming and final hemming machines are respectively grouped around the periphery of a panel to perform all prehemming and hemming operations for one assembly either sequentially or substantially simultaneously. This type of hemming process and equipment has proven to be commercially successful and is still in widespread use.

However, this hemming process has disadvantages. Such a two stage hemming process is costly and inefficient by requiring multiple components, namely a prehemming machine, a transfer mechanism and a final hemming machine to perform the entire hemming assembly operation. Additionally, a considerable amount of tooling and transfer equipment is required for this type of process, it consumes a great deal of valuable manufacturing floor space and it increases the likelihood of equipment malfunction which can undesirably delay production. Furthermore, the process requires numerous steps to completely hem a single component. For example, the assembly must be fixtured, prehemmed, released, transferred, fixtured and final hemmed resulting in a low finished part production rate. Finally, this two stage process requires a relatively larger sheet flange depth which increases component weight and cost.

This two stage process is also susceptible to quality control problems. During transfer to the final hemming station, the panels may loosen from each other, become skewed with respect to each other, or not be properly located with respect to the final hemming station resulting in a finished hemmed assembly of lesser quality and poor structural integrity. An assembly with these characteristics may have to be repaired or scrapped, thereby increasing production costs and lowering profits. Even worse, an ill-assembled structural member with these flaws, if incorporated into an assembled vehicle may fit poorly and affect perceived quality by prospective purchasers, thereby reducing vehicle sales and profits. An assembled defective structural member may further lose integrity as the vehicle is subjected to road vibration during use and possibly require replacement and negatively impact an owners' future vehicle purchasing decision.

More recently, hemming machines have been designed which perform both the prehem and final hem operation in a single machine tool station which eliminates the need for a complex transfer mechanism. Hemming machines of this type vary in the kind of mechanism used and the manner of carrying out the hemming operations. Representative of these hemming machines are U.S. Patents: Kollar et al 3,191,414; E. R. St. Denis 3,276,409; Dacey Jr. 4,706,489; and Dacey Jr. 5,083,355.

The hemming machines embodied in the Kollar '414 and E. R. St. Denis '409 patents are of similar construction and operation. Both patents disclose a pair of fluid powered drives carried by a frame of the machine for driving a single hemming steel through both the prehem and final hemming stages. Each machine utilizes one drive to control the sideward motion of the hemming tool toward the anvil and sheet during the prehem operation and a second drive for downwardly moving the tool to clinch the flange in a hem overlapping the structural reinforcing panel.

A disadvantage of these single station prior art machines is that the hemming tool or steel continuously contacts the sheet edge during both stages of bending the flange which may produce undesirable distortion and highlighting in the sheet. A further drawback is that failure to maintain precise actuation sequencing of the first and second drives during hemming may result in the outer panel being defectively hemmed to the reinforcing panel causing the costly scrapping of the assembly. Furthermore, they have an abrupt motion of the hemming steel due to cam drives and high actuation forces. Also, the equipment to accurately sequence the actuation of each drive adds to the complexity of the machine, requiring additional costly maintenance while reducing reliability. Finally, the

sequencing complexity of this type of hemmer limits the number of assemblies which may be produced during a given period of time.

Dacey Jr. '489 discloses a hemming machine utilizing a single drive and hemming steel connected by a complicated system of linkages and a cam and follower arrangement to perform both the prehem and final hem operations. Dacey Jr. '355 discloses a hemming machine having dual drives and a single hemming steel connected by a linkage and eccentric shaft arrangement to perform both the prehem and final hem operations.

A shortcoming of these prior art machines is that the hemming tool follows an arcuate sideways path, literally "wiping" the flange while prehemming the sheet edge which can introduce unwanted distortion or highlights in the outer panel adjacent the hem which are visual even after finishing and painting it. Moreover, the outer panel bends immediately adjacent the edge of the inner panel rather than at a predetermined desired break point which results in undesirable variations and inconsistencies from one panel assembly to another. The drive and sequencing machanism is also complicated and requires frequent and costly production-delaying adjustment and is prone to unacceptable wear limiting the machines commercial usefulness.

Summary of the Invention

A press for prehemming and final hemming a sheet received on an anvil with separate prehemming and final hemming tools or steels each driven through linkage powered by the same prime mover, such as a cylinder or a screw and servo motor. Each steel is mounted on a separate carrier or subframe pivotally mounted by links in a main frame and each driven through separate toggle joints to produce the force for bending the sheet by the steels. Preferably, to provide a more compact structure the pre-hem carrier is also eccentrically as well as pivotally mounted on the main frame. Preferably, the toggle joints are connected through rocker arms to the prime mover and the linkage provides a dwell in the movement of the prehemming steel so that it does not interfere with movement of the final hemming steel.

Objects, features and advantages of this invention are to provide a combined prehemming and hemming press which eliminates highlights, provides a consistent break point in the outer panel, produces a hem with improved tolerances, requires only one prime mover to drive both the prehemming and hemming steels, utilizes mechanical linkage to sequence and synchronize the movement of both steels, is of relatively simple design, compact construction and arrangement and is rugged, reliable, durable, of economical manufacture and assembly, has a long useful life in service and requires relatively little maintenance and repair in use.

Brief Description of the Drawings

These and other objects, features and advantages of this invention will be apparent from the following detailed description, appended claims and accompanying drawings in which:

FIG. 1 is a fragmentary side view of a hemming press embodying this invention.

FIG. 2 is a fragmentary front view of the hemming press of FIG. 1.

FIG. 3 is, a top view of the hemming press.

FIG. 4 is a kinematic diagram illustrating a prehemming tool and drive linkage of the press in a retracted position.

FIG. 5 is a fragementary sectional side view of an anvil supporting a panel assembly and the prehemming tool in the retracted position of FIG. 4.

FIG. 6 is a kinematic diagram illustrating the prehemming tool and its drive linkage in an extended position.

FIG. 7 is a fragmentary sectional side view of the anvil supporting the panel and the prehemming tool in the extended position of FIG. 6.

FIG. 8 is a kinematic diagram illustrating a final hemming tool and its drive linkage in a retracted position in solid lines and in an extended position in phantom lines.

FIG. 9 is a fragmentary sectional side view of the final hemming tool adjacent the prehemmed edge of the sheet on the anvil.

FIG. 10 is a fragmentary sectional side view of the final hemming tool in a final hem position having formed a return bend in the outer sheet and forced the flange into overlapping engagement with the edge of the inner sheet of the panel assembly received on the anvil.

FIG. 11 is a fragmentary side view of a screw drive and servo motor operably connected with a crank arm of the hemming press of FIG. 1.

Detailed Description

Referring in more detail to the drawings, Figs. 1-3 illustrate a hemming press 20 embodying this invention with a prehemming tool 22 and a hemming tool 24 for prehemming and final hemming an upright flange 26 along an edge 28 of a sheet metal panel 30. The edge 28 to be hemmed is supported by an anvil 32 fixed to a main frame 34. Each tool or steel 22 & 24 is received on a separate carrier or subframe 36 & 38 assembly mounted on the main frame 34. Each steel 22 & 24 is driven by a seprate toggle linkage assembly 40 &

42 both of which are powered by a single prime mover 44, such as a fluid actuated cylinder assembly.

A single press 20 may be used to produce a finished hem along an edge of a single sheet or an edge of an outer panel of a nested assembly 46 of inner 48 and outer panels 50. However, frequently either two or four of these presses are arranged around the periphery of a sheet 30 or panel assembly 46 to either sequentially or simultaneously hem either two or four peripheral edges of the sheet 30 or assembly 46.

Frame

As shown in Figs. 1 and 2, the main frame has two pairs of upright inner 52 and outer 54 or long and short upstanding support plates fixed at their lower ends to a base or a base plate (not shown). The prehemming carrier 36 is mounted on the inner plates 52 and the final hemming carrier 34 is mounted on all of the plates. Preferably, the anvil 32 is also supported by all of the plates.

For some applications, usually to facilitate insertion in, removal from and transfer of the panels through the press 20, it is pivotally mounted so it can be tilted by stub shafts fixed to the outer plates 54 and received in a cradle like base (not shown).

Prehemming Tool

The prehemming steel 22 extends longitudinally the length of the flange to be hemmed 26 and, as shown in Fig. 1, has a horizontally projecting lip 58 with a downwardly and inwardly inclined face 60 which in use bears on the flange 26 to bend it over an adjacent portion of the sheet 30, usually to an acute included angle of about 35° to 55° and preferably about 45°. Preferably, the face 60 is inclined downwardly and inwardly at an angle of about 45° to the horizontal. Preferably, to limit the extent to which the steel 22 can be advanced toward the anvil 32, it is constructed so that its bottom edge bears on a shoulder 62 in the anvil 32 when the steel 22 is fully advanced by the press 20.

Prehemming Carrier

In use, the steel 22 is secured by cap screws 64 to a mounting plate 66 of the carrier or subframe assembly 36. The mounting plate 66 is fixed such by welding to a pair of spaced apart and parallel side plates 68. The carrier 36 is pivotally mounted on the main frame 34 for movement in a generally arcuate path by a pair of torque tubes 70,72 journalled for rotation by bearings 73 received in the side plates 68 and eccentrically mounted for pivotal movement on the main frame 34. Each tube 70,72 is eccentrically mounted by stub shafts 74 journalled in bearings carried by the inner support plates 52 of the main frame. So that the torque tubes 70,72 can be rotated in unison to advance and retract the carrier 36 and steel 22, a pair of spaced apart arms 76,78 are fixed to each tube and connected by a link 80 and pivot pins 82 received in the arms.

To provide the desired arcuate motion for the steel 22, as viewed in Figs. 1 and 4, the eccentric pivot point for each stub shaft 74 of the tubes 70,72 is in the lower right hand quadrant of the tube when the prehemming steel 22 and carrier 36 is in the fully retracted or raised position.

This arrangment of torque tubes, location of the eccentric pivot points, connecting arms and links provides a compact arrangement for mounting the prehemming carrier and steel. However, where a less compact arrangement is acceptable, a single torque tube could be utilized by locating the eccentric pivot points of its shaft in the upper right hand quadrant as viewed in Figs. 1 and 4. This would eliminate the second torque tube 72 and the interconnecting link 80 and arms 76,78.

Prehemming Toggle Joint

The carrier 36 and steel 22 are driven through a toggle joint assembly 40 which provides a mechanical advantage multiplying the force applied to the flange 26 of the sheet 30 as the steel 22 approaches its fully advanced position. The toggle assembly 40 has a pair of spaced apart arms 84 fixed to a shaft 86 journalled for rotation on the upright inner plates 52 of the frame 34and pivotally connected by a pin 88 to one end of a link 90, the other end of which is received between and pivotally connected by a pin 92 to one end of a pair of arms 94 fixed to the lower torque tube 70.

Drive Assembly

The toggle joint 40 is powered by a drive assembly 44 having a single fluid, preferably air, actuated cylinder 96 connected through linkage to the toggle joint 40. A piston rod 98 of the cylinder is connected by a clevis 100 and pin 102 to one end of an arm 104 fixed to a drive torque tube 106 journalled for rotation by a pair of stub shaft and bearing assemblies 108 mounted on the outer plates 54 of the main frame 34. The toggle joint 40 is operably connected with the torque tube 106 through an arm 110 which is fixed at one end to the torque tube 106 and at the other end pivotally connected by a pin 112 to one end of a link 114, the other end of which is pivotally connected by a pin 116 to one end of the pair of arms 84 fixed to

the shaft 86 of the toggle joint assembly 40. The housing of the cylinder 96 is pivotally mounted on the inner plates 46 of the main frame 34 by stub shaft and bearing assemblies 118 and a yoke 120 secured to the housing.

To avoid interference and provide clearance between the prehemming 22 and hemming 24 steels, preferably the prehemming steel 22 dwells in its retracted position while the hemming steel 24 is in its extended position, as shown in Fig. 1. This dwell is provided by the arcuate or circumferential location of the arm 110 on the torque tube 106 relative to the toggle assembly 40 when the piston rod 98 of the cylinder 96 is fully extended. With these components disposed in the position shown in Fig. 1, so that the axis of the arm 110 extends at an angle of about 15° below a line through the centers of the main tube 106 and the pivot pin 112, the prehemming steel 22 substantially dwells through about 30° of rotation of the torque tube 106 and arm 110 by the cylinder 96.

Final Hemming Tool

The final hemming steel 24 extends longitudinally the full length of the flange 26 to be hemmed and has a preferably slightly arcuate bottom face 122 which bears on the prehemmed flange 26 and bends it to the final fully hemmed position (Fig. 10), as the steel 24 is fully advanced by the press 20. Preferably, the steel 24 is removably received on a spacer plate 126 which is secured to a mounting plate 128 of the carrier assembly 38.

Final Hemming Carrier

As shown in Figs. 1 and 2, the mounting plate 128 of the carrier assembly 38 is fixed to the upper end of the carrier or subframe assembly. The carrier 38 has a pair of spaced apart and parallel side plates 130 fixed by welds to spacer plates 132 disposed on their front edges.

The carrier is pivotally mounted on the main frame for generally arcuate movement by four link assemblies 134. Each link assembly has a pair of spaced apart arms 136 pivotally connected adjacent one end by a pin 138 to one of the carrier side plates 130 and fixed adjacent the other end to a bushing 140 journalled on a pin and bearing assembly 142 mounted on each pair of inner 52 and outer 54 plates of the main frame 34.

Final Hemming Toggles

The final hemming carrier 38 and steel 24 are driven through a pair of toggle assemblies 42. Each toggle assembly 42 has an arm 146 fixed at one end to the main drive tube 106 and adjacent the other end pivotally connected by a pin and bearing assembly 148 to one end of a pair of toggle links 150, the other ends of which are pivotally connected by a pin and bearing assembly 152 to one of the side plates 130 of the carrier assembly.

Press Operation

In a hemming cycle of the press 20, initially the piston rod 98 of the cylinder 96 is fully retracted which places both the prehemming steel 22 and the final hemming steel 24 in their fully raised and retracted positions. The assembly 46 of an outer panel 50 with an upturned flange 26 along an edge to be hemmed 28 over an adjacent edge of a reinforcing panel 48 nested therein is deposited on the anvil 32. Usually, a fixture is utilized to accurately locate the panel assembly on the anvil 32.

The prehemming operation is initiated by energizing the cylinder 96 to advance its piston rod 98. The hemming tool 22 and carrier 36 are moved downwardly in a generally arcuate path to bear on and bend the flange 26 from the position shown in Fig. 5 to that shown in Fig. 7 by movement of the drive linkage and toggle 40 from the position shown schematically in solid line Fig. 4 to that shown in Fig. 6. As the toggle joint 40 moves to its mid point position (Fig. 6), it provides the maximum multiplication of the force produced by the cylinder 96 and applied to the steel 22 as the steel approaches its fully extended position to complete the prehemming bend of the flange 26.

To prevent distortion and highlighting of the panel adjacent the hem during bending, the curve of the generally arcuate movement of the steel 22 is designed to substantially eliminate relative sliding motion between the flange 26 and the inclined face 60 of the tool 22 as it forces the flange 26 into its prehemmed position. This is accomplished by constructing and arranging the eccentric mounting of the carrier 36 to produce a path of movement of the steel 22 complementary to that of the flange 26 during bending about its desired break point.

After the prehemming bend is completed, the steel 22 is retracted by continuing advancement of the cylinder piston rod 98 which continues to rotate the arm 84 of the toggle joint 40 clockwise (from the position shown in Fig. 6) to the position shown in phantom in Fig. 4. This movement of the toggle joint 40 rotates the carrier torque tubes 70,72 clockwise which raises and thereby retracts the carrier 36 and hence the steel 22 along the generally arcuate path to its fully raised or retracted position.

By the advancement of the cylinder rod 98, the carrier 38 and hence the final hemming steel 24 is also lowered or advanced in a generally arcuate path from the solid line to the phantom line positions shown in Fig. 8 to bear on the prehemmed

flange 26 and bend it into the fully hemmed position, shown in Fig. 10, to form a return bend with the flange 26 overlying and firmly engaging an edge 154 of the inner panel 48. As shown in Fig. 8, the clockwise rotation of the drive tube 106 moves the toggle joints 146,150 from the solid line position to the phantom line position in which the toggle joints 146,150 approach their respective mid points **m** to thereby lower or advance the steel 24 to its fully extended position. As the toggle joints 146,150 approach their mid point position **m**, they produce the greatest multiplication of the force produced by the cylinder 96 and applied to the steel 24 as the steel approaches its fully advanced position to complete the bend and force the flange 26 into firm engagement with the underlying edge 154 of the reinforcing panel 48 to complete the hem 156.

To prevent distortion and highlighting of the panel during final hemming, even though the carrier 38 and steel 24 move in an arcuate path, as the flange 26 approaches its fully hemmed position (Fig. 10), the associated segment of the path is substantially at a right angle to the plane of the final fully hemmed position of the flange 26 and there is substantially no relative lateral movement between the flange 26 and the face 122 of the tool 24 bearing on the flange 26. This is achieved by the construction and arrangement of the pivotal link assemblies 134 so that (as shown in Fig. 8) when the steel 24 approaches the fully hemmed position there is substantially no lateral movement of the carrier 38 and steel 24 due to the portion of the arc in which the pivot link assemblies 134 are moving in which (as shown in phantom in Fig. 8) the longitudinal axis through their pivot points extends substantially parallel to the plane of the flange 26 when in its fully hemmed position.

After the finished hem is completed, the steel 24 is retracted by actuating the cylinder 96 to move its piston rod 98 to the fully retracted position. This rotates the main tube 106 counter-clockwise (as viewed in Figs. 1, 4, 6 and 8), which through the associated linkage and toggle joints, retracts and raises both carriers 36,38 and their associated steels 22,24 to their fully retracted positions. As will be apparent, while the main steel 24 is being raised and retracted, the prehemming steel 22 will be initially again moved to its advanced position and then retracted. However, since the hem 156 has already been completed, the prehemming steel 22 will not strike it when it is advanced.

Multiple Presses

In some applications, it may be desirable to arrange two or more presses to operate simultaneoulsy or sequentially for hemming different edges on the same panel assembly while it is received in a fixture. For example, a generally rectangular hood assembly may have an outer panel with upturned flanges along all four sides to be hemmed. This panel assembly could be received on a fixture disposed between four hemming presses each positioned to hem one of the flanges of the hood panel assembly. To minimize the tendency of the panel being forced during hemming to shift or move relative to the fixture, all four edges of the panel could be prehemmed and final hemmed simultaneoulsy. Alternatively, one pair of generally opposed flanges can be prehemmed and hemmed simultaneously by two of the presses and thereafter the other opposed pair of flanges can be prehemmed and hemmed simultaneoulsy by the other two presses.

Where at least two presses are operated simultaneoulsy or in a rapid sequence, it is preferred to utilize as the prime mover for each press a screw and servo motor 158 in lieu of a fluid acutated cylinder. This servo motor and screw drive 158 provides a more accurate and precise control of the cycle of each press which facilitates synchronizing the cycle and operation of two or more presses.

Fig. 11 illustrates a suitable screw and servo motor prime mover 158 with a screw 160 journalled for rotation in a housing 162 and driven by a reversible servo motor 164 which is preferably a stepper motor. The housing is pivotally mounted on the main frame 34 by a pair of stub shaft bearing assemblies 108 secured to the upright inner plates 52 of the frame 34. A traveling nut 166, preferably with recirculating ball bearings, is received on the screw 160 and pivotally connected to a pair of arms 104 fixed to the main drive tube 106. The use of a servo motor 164 also facilitates manual "jogging", by controlled stepping or manual cycling of a press for setup, maintenance and repair purposes, such as when installing, adjusting or changing the prehemming 22 and hemming steels 24.

Claims

1. A press (20) for hemming an edge (28) of a sheet (30), comprising:

a frame (34);

an anvil (32) carried by said frame (34) for receiving and supporting an edge (28) of a sheet (30) to be hemmed;

a first subframe (36) carried by said frame (34) for movement relative thereto;

a first hemming tool (22) carried by said first subframe (36) for bending a flange (26) adjacent an edge (28) of the sheet (30) to a pre-hem position;

a second subframe (38) carried by said frame (34) for movement relative thereto;

a second hemming tool (24) carried by said second subframe (38) for bending the flange (26) of the sheet (30) from the pre-hem position to a hem position having a return bend and overlapping the sheet (30); and

a drive (44) operably connected with said first subframe (36) for moving said first hemming tool (22) to bend the flange (26) of the sheet (30) to the pre-hem position and operably connected with said second subframe (38) for moving said second hemming tool (24) to bend the flange (26) of the sheet (30) to the hem position.

2. The press of claim 1 also comprising:
said first subframe (36) having a pair of spaced apart support plates (68) carrying said first hemming tool (22), and

at least one eccentric (70) movably mounting said first subframe (36) on said frame (34) for generally arcuate reciprocating motion and operably connected with said drive (44) for moving said first subframe (36) and first hemming tool (22) to bend a flange (26) of the sheet (30) to a pre-hem position.

3. The press of claim 2 also comprising an arm (94) fixed to said eccentric (70) and operably connected with said drive (44) to turn said eccentric (70) to move said first subframe (36) and said first hemming tool (22) in a generally arcuate motion toward said anvil (32) and the flange (26) of the sheet (30) and generally downwardly when bending the flange (26) of the sheet (30) to the pre-hem position.

4. The press of claim 2 also comprising at least two eccentrics (70, 72) spaced apart and mounting said first subframe (36) on said frame (34) and operably connected with said drive (44) for being turned in unison to move said first subframe (36) in a generally arcuate motion toward said anvil (32) and the flange (26) of the sheet (30) and generally downwardly when bending the flange (26) of the sheet (30) to the pre-hem position.

5. The press of claim 4 which also comprises an arm (76, 78) fixed to each eccentric (70,72) and a link (80) pivotally connected to each said arm (76, 78).

6. The press of claim 4 also comprising another arm (94) fixed to one of said eccentrics (70) and operably connected with said drive (44).

7. The press of claim 1 wherein said first hemming tool (22) has a beveled forward face (60) for engaging the flange (26) of a sheet (30) to bend the flange (26) to a pre-hem position.

8. The press of claim 1 wherein said first hemming tool (22) engages the flange (26) of a sheet (30) to bend it to an acute included angle with respect to the sheet (30) when bending the flange (26) to the pre-hem position.

9. The press of claim 1 wherein said first hemming tool (22) engages the flange (26) of a sheet (30) to bend it to an acute included angle of about 35° to 55° with respect to the sheet (30) when bending the flange (26) to the pre-hem position.

10. The press of claim 1 wherein said second hemming tool (22) engages the flange (26) of the sheet (30) and bends it to have a return bend with the flange (26) overlapping the sheet (30).

11. The press of claim 1 also comprising at least one toggle (40) operably connected with said first subframe (36) and said drive (44) for driving said first hemming tool (22) and multiplying the force applied to the flange (26) of the sheet (30) through said first tool (22) by said drive (44) when said first tool (22) engages and bends the flange (26).

12. The press of claim 11 wherein said at least one toggle joint (40) comprises a first toggle link (84) pivotally carried by said frame (34) and operably associated with said drive (44), a second toggle link (90) pivotally connected at one end to said first link (84) and at the opposite end operably pivotally connected with said first subframe (36) for advancing said first tool (22) as said first (84) and second (90) toggle links approach a midpoint of displacement where said first (84) and second (90) toggle links are generally longitudinally aligned, multiplying the force applied by said first tool (22) to the flange (26) of the sheet (30) when said first (84) and second (90) toggle links are adjacent the midpoint and generally aligned with each other to fully extend said first tool (22), and for retracting said first tool (22) from the sheet (30) as said first (84) and second (90) toggle links are moved away from the midpoint.

13. The press of claim 11 wherein said at least one toggle joint (40) also comprises a shaft

(86) journalled for rotation and carried by said frame (34), a first arm (84) fixed to said shaft (86) and operably connected to said drive (44), a second arm (84) spaced circumferentially from said first arm (84) and fixed to said shaft (86), a toggle link (90) pivotally connected at one end to said second arm (84) and at the opposite end operably pivotally connected with said first subframe (36) for driving said first tool (22) for advancing said first tool (22) as said second arm (84) and toggle link (90) approach a midpoint of displacement where said arm (84) and link (90) are generally longitudinally aligned, multiplying the force applied by said first tool (22) to the flange (26) of the sheet (30) when said second arm (84) and toggle link (90) are adjacent the midpoint and generally longitudinally aligned to fully extend said first tool (22) and for retracting said first tool (22) from the sheet (30) when said arm (84) and toggle link (90) are moved away from the midpoint.

14. The press of claim 1 also comprising a tube (86) journalled for rotation and carried by said frame (34), at least two circumferentially spaced apart arms (84) fixed to said tube (86), a dwell link (90) at one end pivotally operably connected with said first subframe (36) and at the opposite end pivotally connected to one arm (84) of said tube (86) for retaining said first tool (22) in a position retracted from said anvil (32) when said link (90) and said arm (84) of said tube (86) are generally longitudinally aligned with each other while said second tool (24) is advanced toward said anvil (32) and engaged with the flange (26) to bend the flange (26) from the pre-hem position to the hem position with the flange (26) having a return bend and overlapping the sheet (30).

15. The press of claim 1 wherein said drive (44) comprises a fluid actuated cylinder (96).

16. The press of claim 1 wherein said drive (44) comprises a screw (160) operably connected to a servomotor (164).

17. The press of claim 1 also comprising said second subframe (38) having a pair of spaced apart support plates (130) carrying said second hemming tool (24), at least two links (134) pivotally connected to said frame (34) and said second subframe (38) for generally arcuate reciprocating motion and said second subframe (38) being operably connected with said drive (44) for moving said second subframe (38) and second hemming tool (24) to bend a flange (26) of the sheet (30) from the pre-hem position to a final hem position having a return bend and the flange (26) overlapping the sheet (30).

18. The press of claim 1 also comprising said second subframe (38) having a pair of spaced apart support plates (130) carrying said second hemming tool (24), at least two links (134) pivotally connected to said frame (34) and said second subframe (38) for generally arcuate reciprocating motion, a drive link (150) pivotally connected to said second subframe (38) and operably connected with said drive (44) for moving said second subframe (38) and second hemming tool (24) to bend a flange (26) of the sheet (30) from the pre-hem position to a final hem position having a return bend and the flange (26) overlapping the sheet (30).

19. The press of claim 1 also comprising said second subframe (38) having a pair of spaced apart support plates (130) carrying said second hemming tool (24), at least two spaced apart links (136) pivotally connected to each of said support plates (130) of said second subframe (38) and pivotally connected to said frame (34) for generally arcuate reciprocating motion of said subframe (38) and said tool (24), a pair of drive links (150) pivotally connected to each plate (130) of said subframe (38) and operably connected with said drive (44) for moving said second subframe (38) and second hemming tool (24) to bend a flange (26) of the sheet (30) from the pre-hem position to a final hem position having a return bend and the flange (26) over-lapping the sheet (30).

20. The press of claim 1 also comprising said second subframe (38) having a pair of spaced apart support plates (130) carrying said second hemming tool (24), at least two links (136) pivotally connected to each plate (130) and pivotally carried by said frame (34) for generally arcuate reciprocating motion of said second subframe (38) and tool (24) and supporting said subframe (38), a tube (106) journalled for rotation and carried by said frame (34), at least two arms (104, 146) fixed to said tube (106), a pair of toggle links (150) each pivotally connected to an arm (146) of said tube (106) and pivotally connected to a plate (130) of said second subframe (38) for advancing said tool (24) as said toggle links (150) and arms (146) approach a midpoint of displacement where each of said links (150) is generally aligned with its respective arm (146), and multiplying the force applied by said second tool (24) to

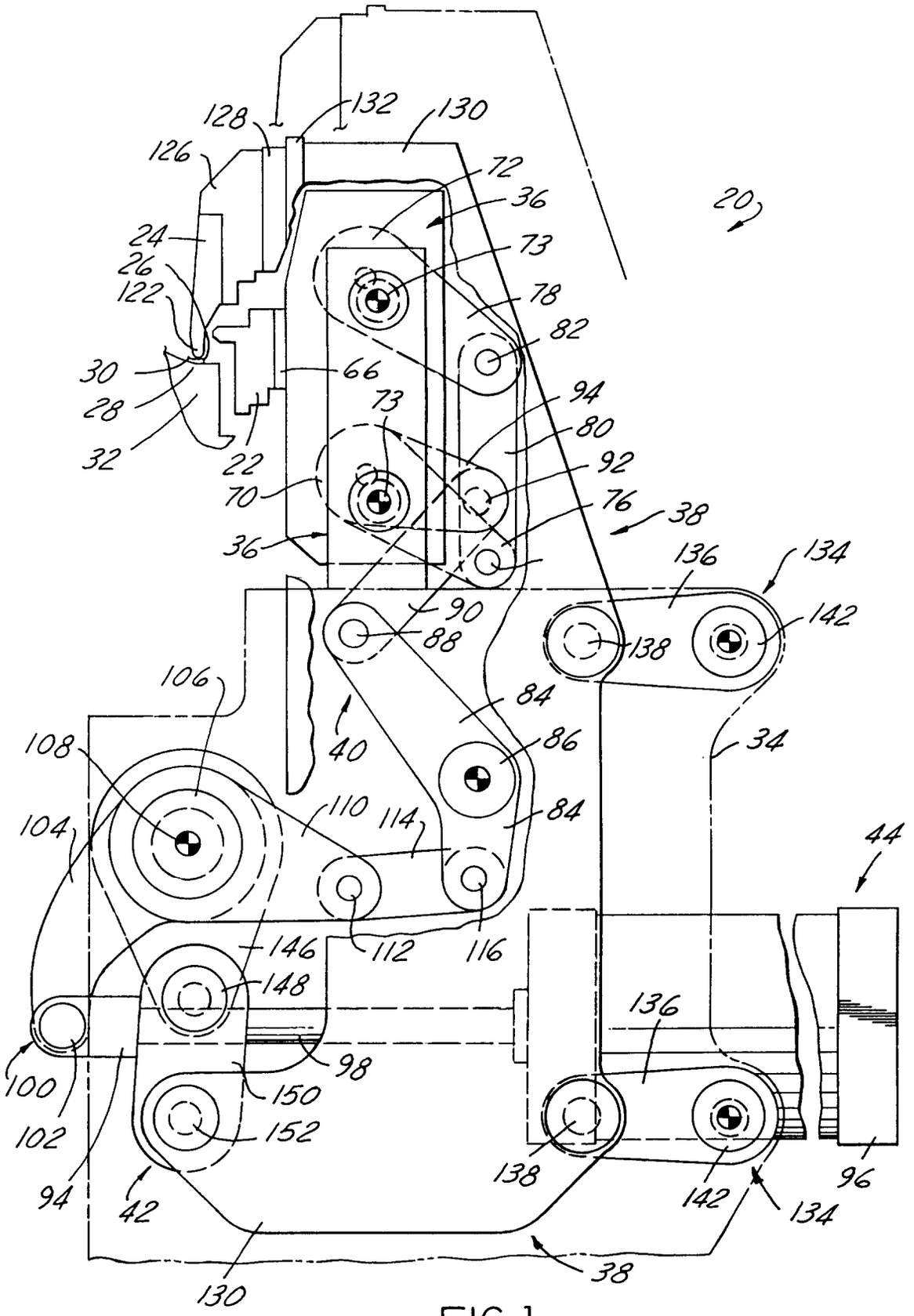
the flange (26) of the sheet (30) when said toggle links (150) are adjacent the midpoint for bending a flange (26) of the sheet (30) from the pre-hem position to a final hem position having a return bend and the flange (26) overlapping the sheet (30).

21. The press of claim 1 which also comprises a first toggle (40) operably connected with said first subframe (36) and said drive (44) for driving said first hemming tool (22) and multiplying the force applied to the flange (26) of the sheet (30) through said first tool (22) by said drive (44) when said first tool (22) engages and bends the flange (26) to a pre-hem position, and a second toggle (42) operably connected with said second (38) subframe and said drive (44) for driving said second hemming tool (24) and multiplying the force applied to the flange (26) of the sheet (30) through said second tool (24) by said drive (44) when said second tool (24) engages and bends the flange (26) from the pre-hem position to a final hem position having a return bend and the flange (26) overlapping the sheet (30).

22. The press of claim 1 which also comprises a first toggle (40) operably connected with said first subframe (36) and said drive (44) for driving said first hemming tool (22) and having a midpoint of displacement where the force applied to the flange (26) of the sheet (30) through said first tool (22) by said drive (44) when said first tool (22) engages and bends the flange (26) to a pre-hem position is multiplied, and a second toggle (42) operably connected with said second subframe (38) and said drive (44) for driving said second hemming tool (24) and having a midpoint of displacement where the force applied to the flange (26) of the sheet (30) through said second tool (24) by said drive (44) when said second tool (24) engages and bends the flange (26) from the pre-hem position to a final hem position having a return bend and the flange (26) overlapping the sheet (30) is multiplied, and arranged and constructed so that when one of said toggles (40,42) is at a midpoint of displacement the other toggle is generally distal from its mid-point.

23. A hemming station for hemming at least two flanges along different edges of a sheet (30), comprising at least two presses (20) spaced apart in generally opposed relationship around the periphery of the same sheet (30) for substantially simultaneously hemming two generally opposed flanges of the sheet (30) at two edges of the same sheet, each press (20) having a frame (34), an anvil (32) carried by each said frame (34) for receiving and supporting an edge of the sheet (30), a first subframe (36) carried by each said frame (34) for movement relative thereto, a first hemming tool (22) carried by each said first subframe (36) for bending a flange adjacent an edge of the sheet (30) to a pre-hem position, a second subframe (38) carried by each said frame (34) for movement relative thereto, a second hemming tool (24) carried by each said second subframe (38) for bending the flange of the sheet (30) from the pre-hem position to a hem position having a return bend and the flange overlapping the sheet (30), and a drive (44) operably connected with each said first subframe (36) for moving each said first hemming tool (22) to bend the flange of the sheet (30) to the pre-hem position and operably connected with each said second subframe (38) for moving said second hemming tool (24) to bend the flange of the sheet (30) to the final hem position.

24. The press of claim 20 wherein each said drive (44) comprises a screw (160) operably connected to a servomotor (164).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92
70
76
38
36
136
134
90
142
88
138
106
84
40
86
34
108
110
114
84
104
44
146
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96
94
42
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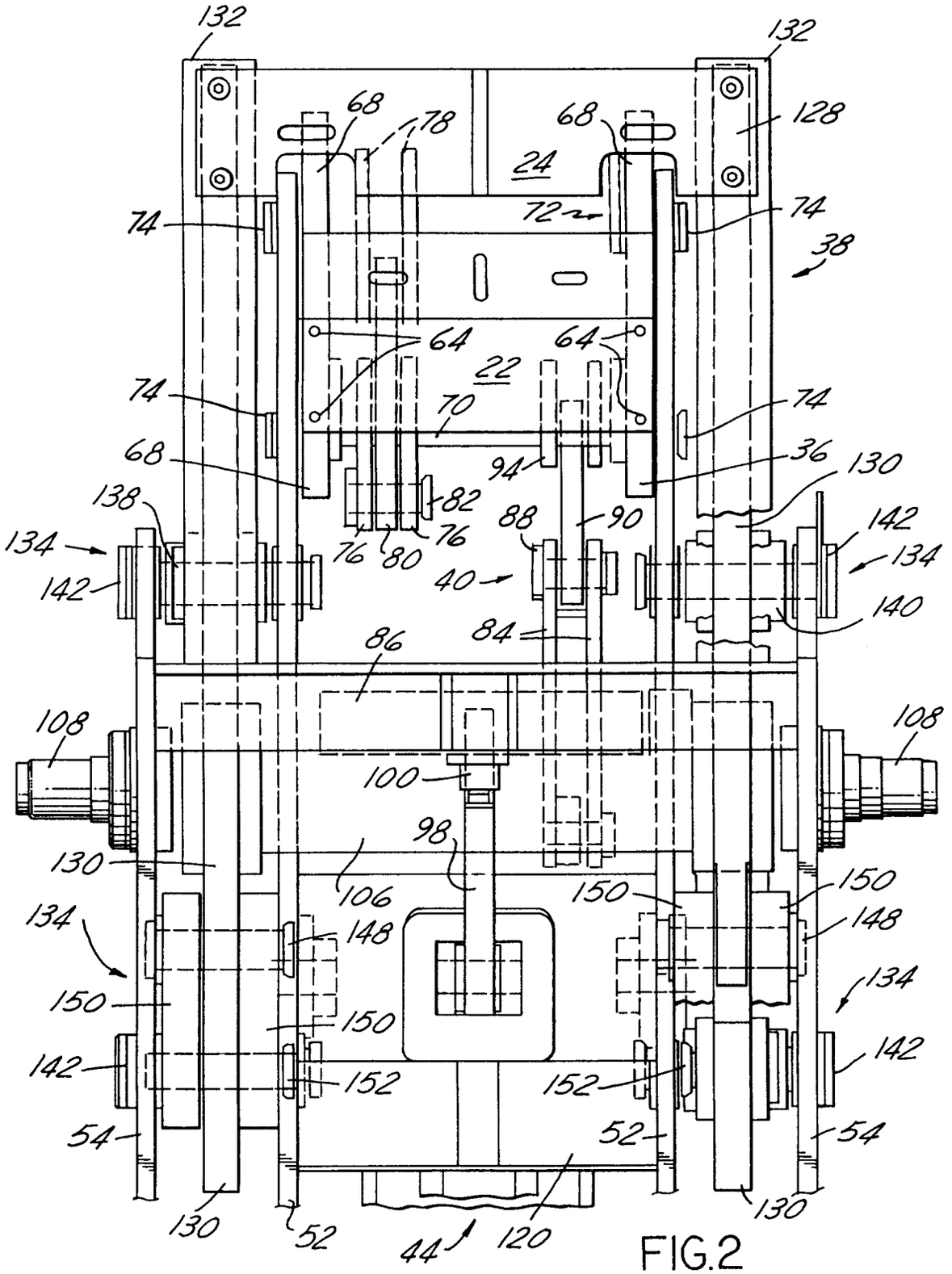
134
130
38

FIG.1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82
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130
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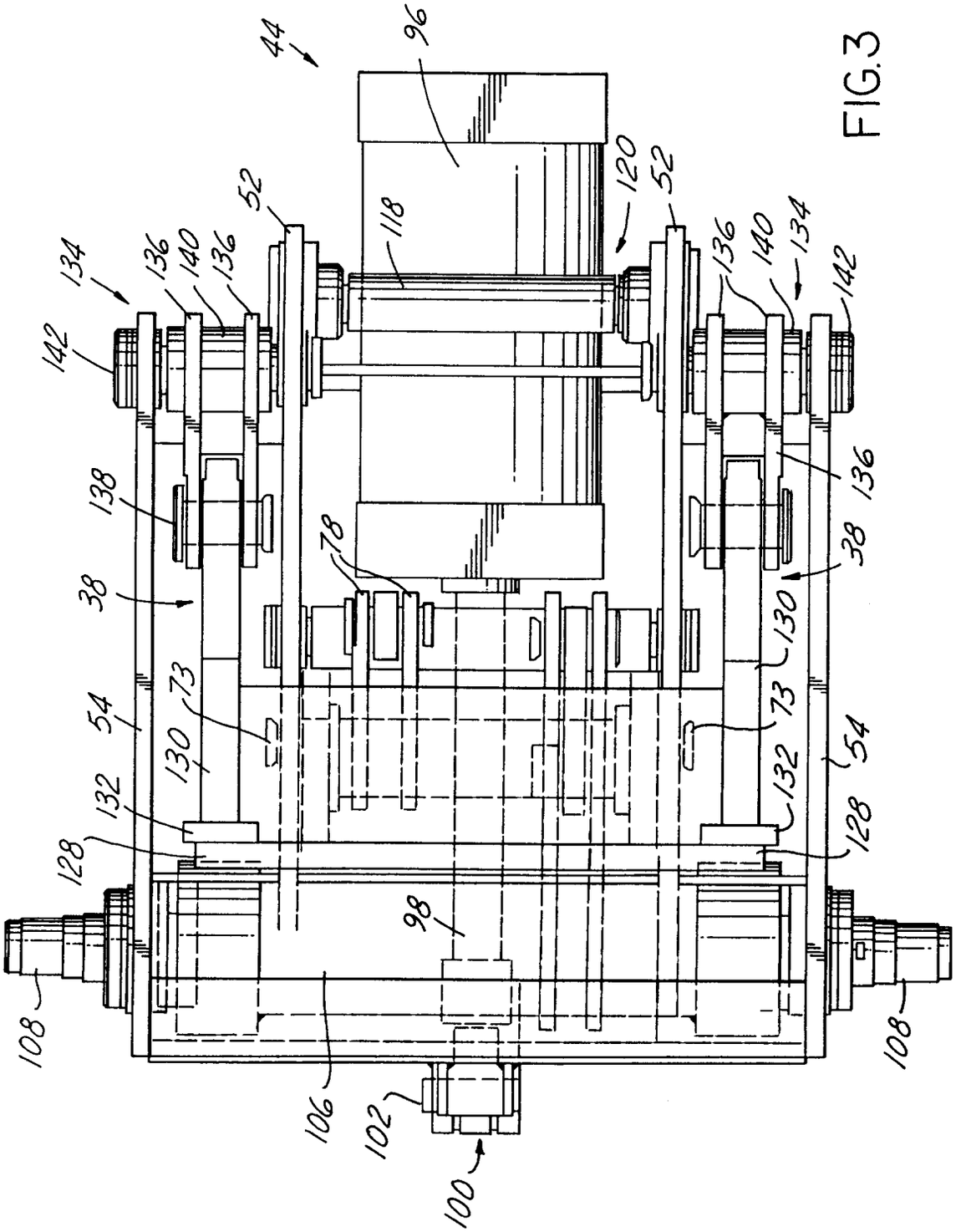
44
120

FIG.2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100

FIG.3

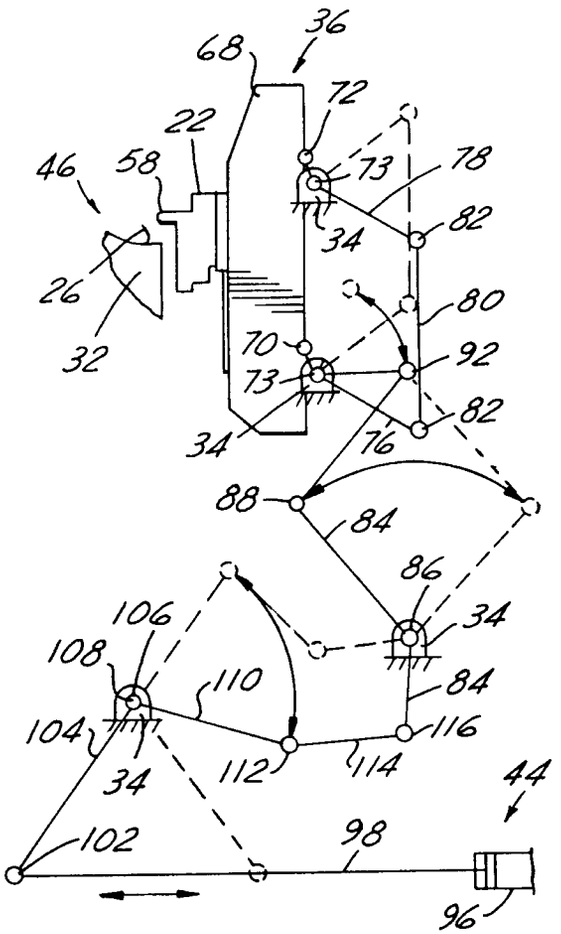

FIG.4

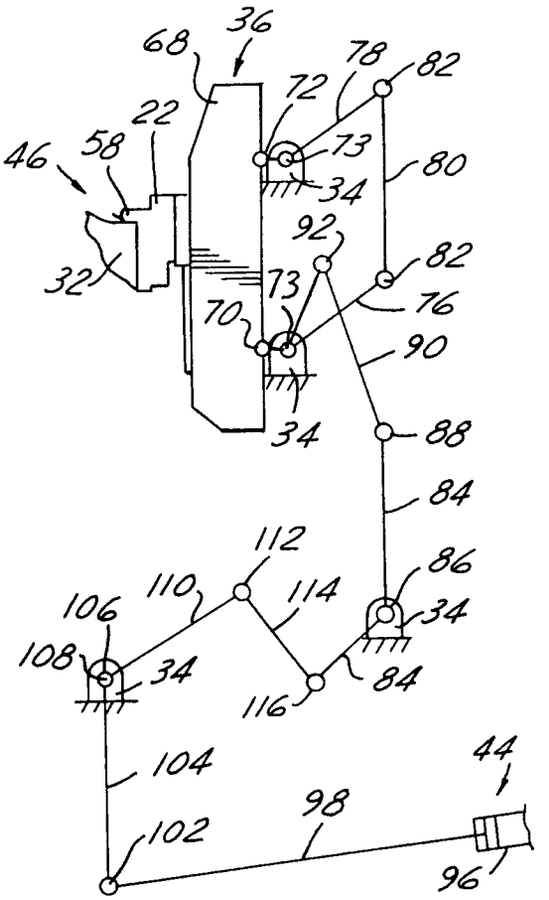

FIG.6

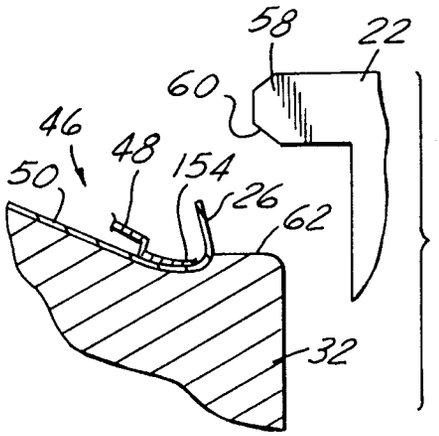

FIG.5

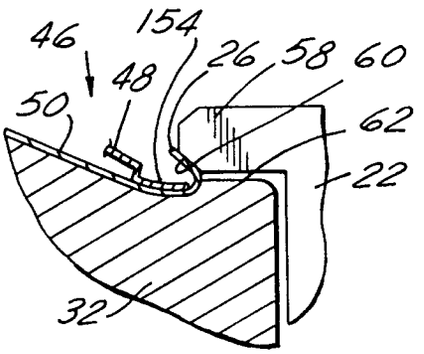

FIG.7

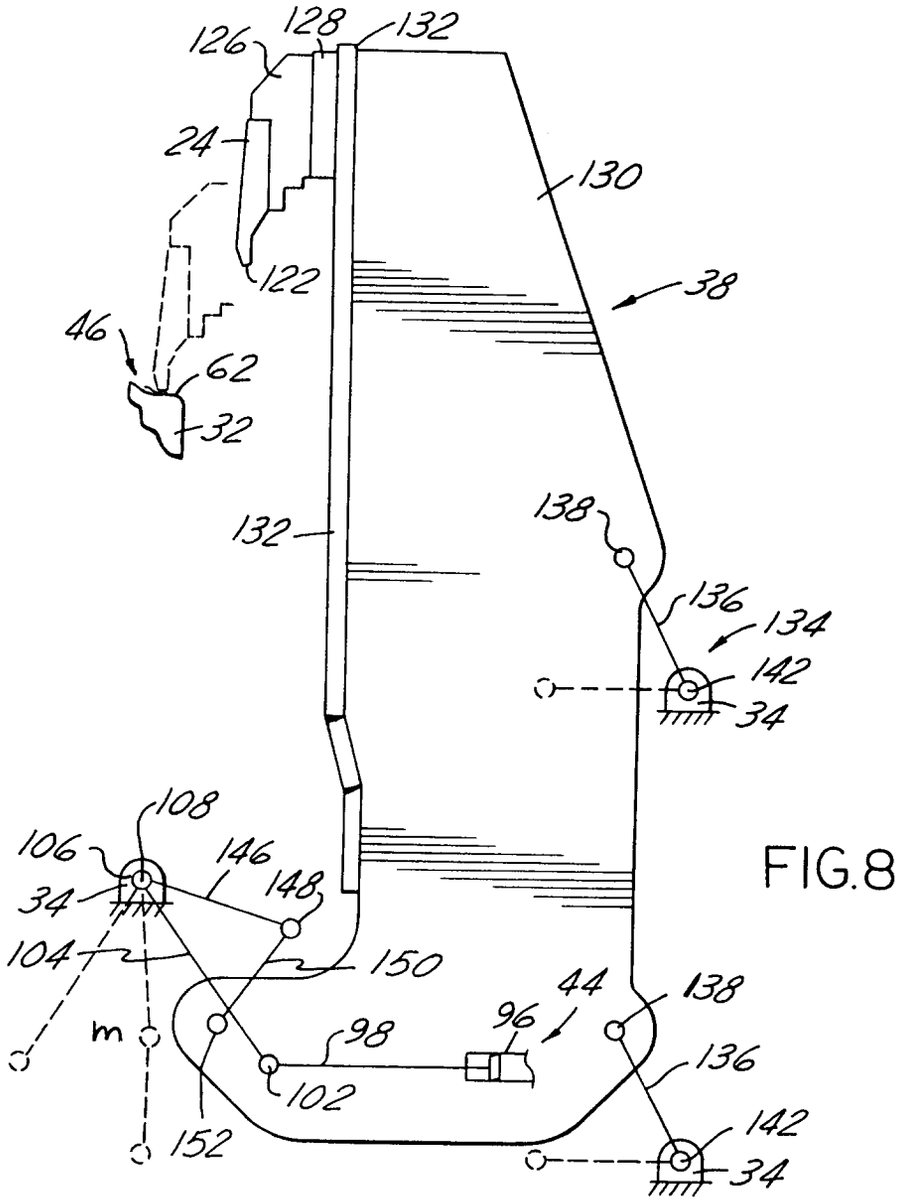

FIG.8

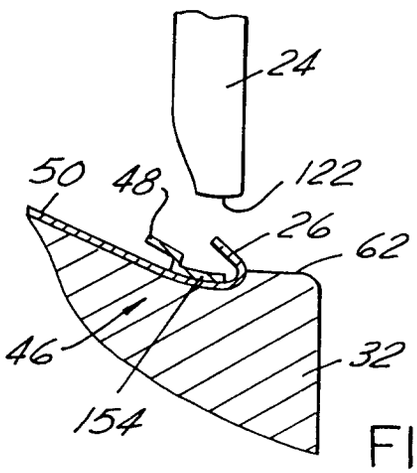

FIG.9

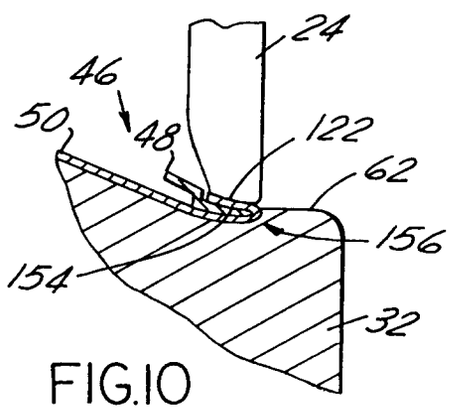

FIG.10

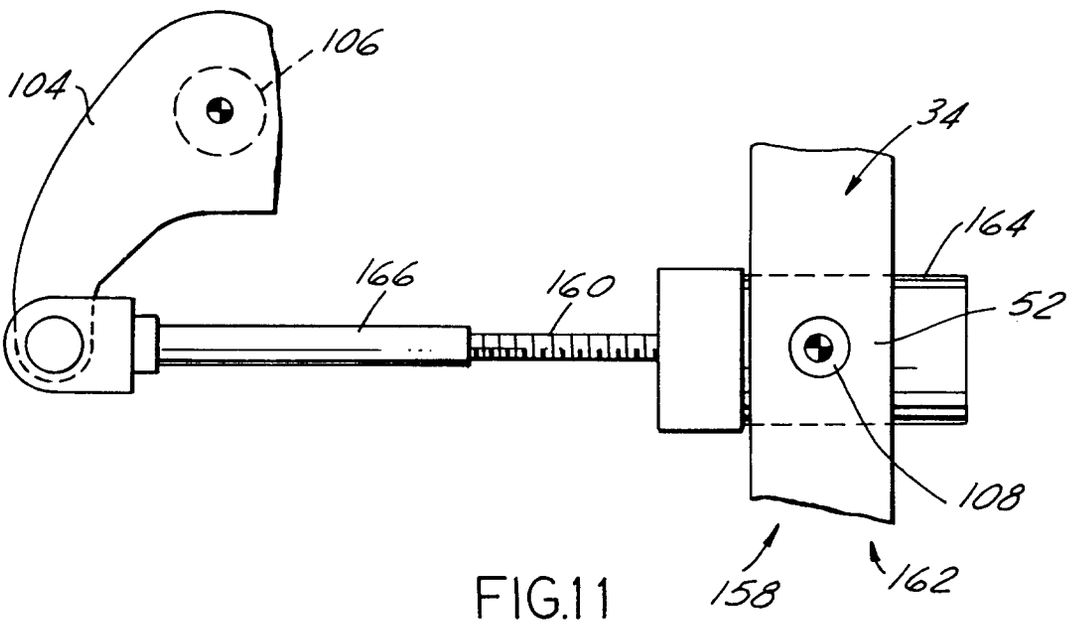

FIG.11

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 11 5381

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X Y	WO-A-89 09101 (DORSETT) * the whole document *	1,7-13, 15 23	B21D39/02
Y	US-A-5 005 398 (CRAFTMATION) * figure 1 *	23	
P,A	WO-A-93 05902 (DORSETT)		
A	AUTOMOBILE ENGINEER vol. 55, no. 3 , March 1965 , LONDON GB pages 110 - 113 'clinching machines'		

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 January 1994	Ris, M

CATEGORY OF CITED DOCUMENTS

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Y : particularly relevant if combined with another document of the same category
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L : document cited for other reasons

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