

[54] **FORCE-EXERTING APPARATUS**

[72] Inventor: James J. Van Gompel, Fremont, Ind.

[73] Assignee: Brammall, Inc., Angola, Ind.

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[51] Int. Cl.B66f 3/24
[58] Field of Search254/93 R, 93 H, 122, 124;
269/48.1

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Primary Examiner—William S. Lawson

Assistant Examiner—David R. Melton

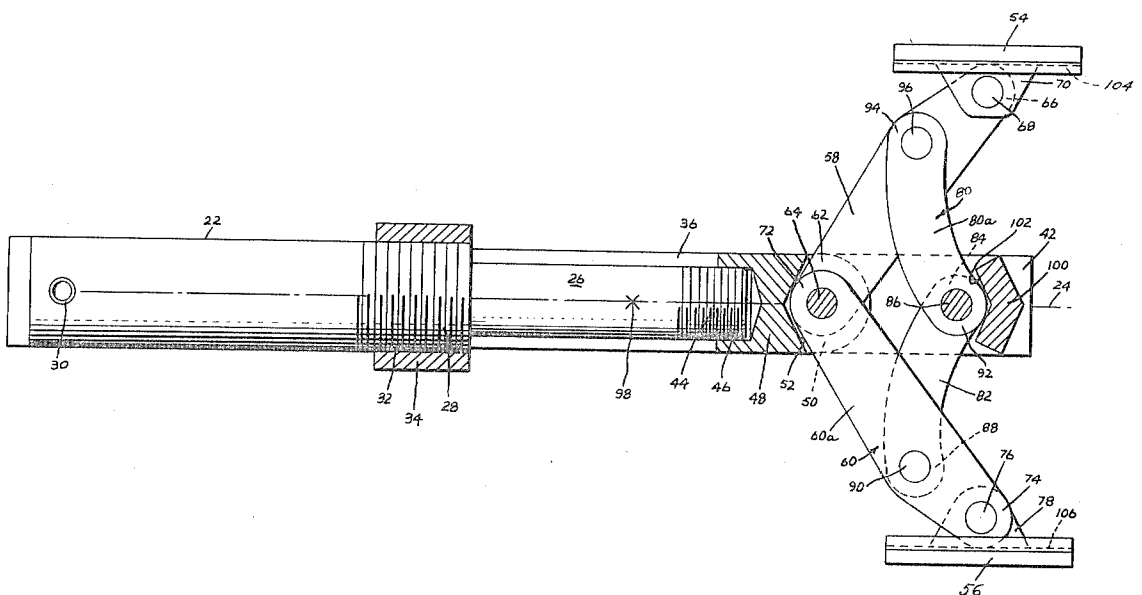
Attorney—Hood, Gust, Irish & Lundy

[57]

ABSTRACT

Apparatus for exerting force in lateral directions with respect to a longitudinal axis, the apparatus being particularly adapted for use in straightening deformed rolls of sheet stock. A fluid power cylinder is provided having a piston rod coaxial with the axis and being movable between retracted and extended positions. A pair of elongated, transversely spaced, parallel frame members is provided having rear ends secured to opposite sides of the cylinder and extending longitudinally forwardly on opposite sides of the piston rod. A pair of force-exerting shoes is provided respectively on opposite sides of the frame members and movable laterally outwardly away from and inwardly toward the frame members. A first pair of links is provided having inner ends respectively pivotally connected to the outer end of the piston rod and outer ends respectively pivotally connected to the shoes. A second pair of links is provided respectively having outer ends pivotally connected to the first links intermediate their ends and inner ends respectively pivotally connected to the frame members longitudinally forwardly of the outer end of the piston rod when the same is in its extended position. The first and second pairs of links form a toggle, movement of the piston rod toward its extended position causing the toggle simultaneously to move the shoes laterally outwardly in opposite directions away from the frame members, and movement of the piston rod toward its retracted position causing the toggle simultaneously to move the shoes laterally inwardly toward the frame members.

24 Claims, 18 Drawing Figures



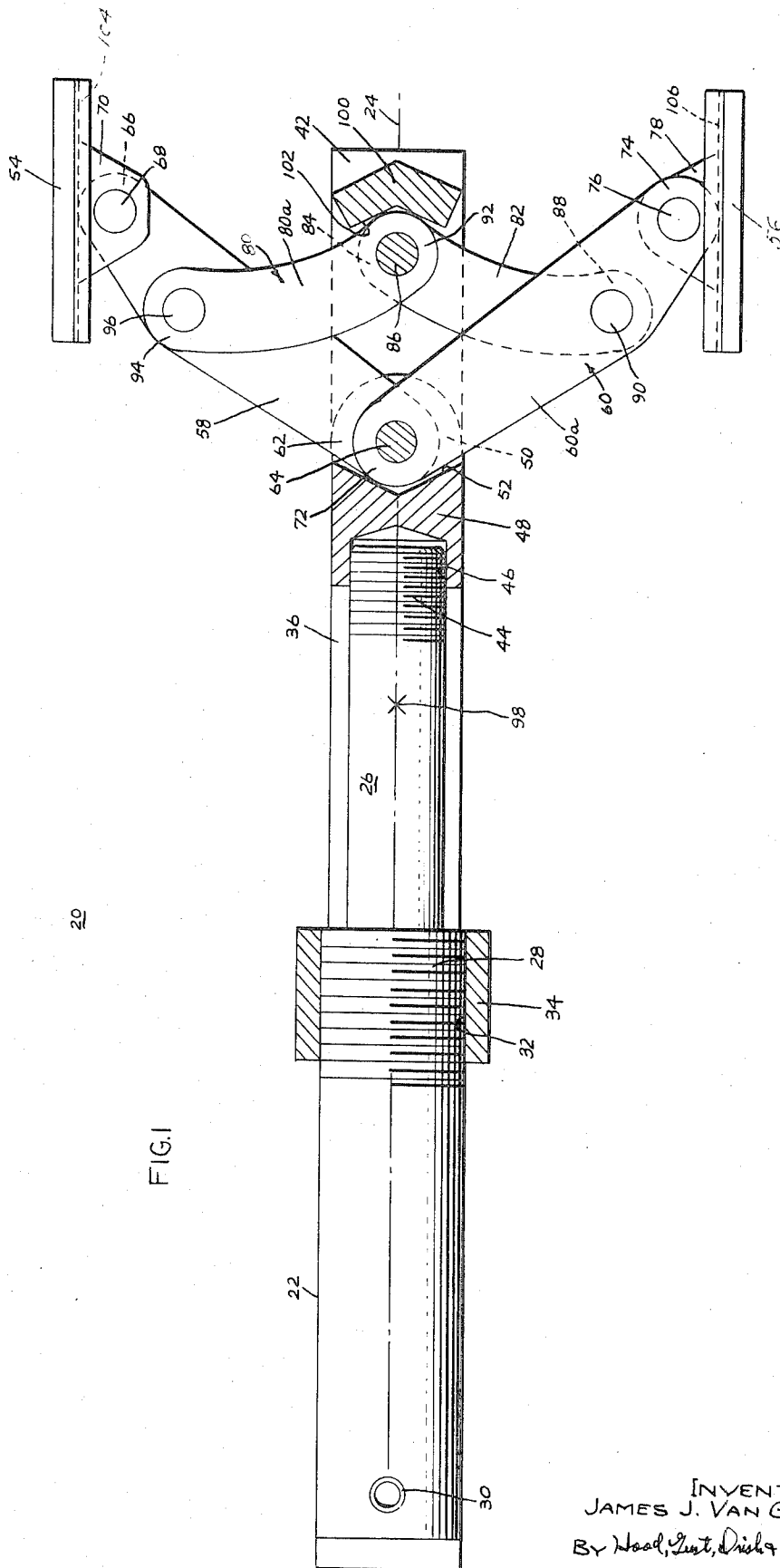
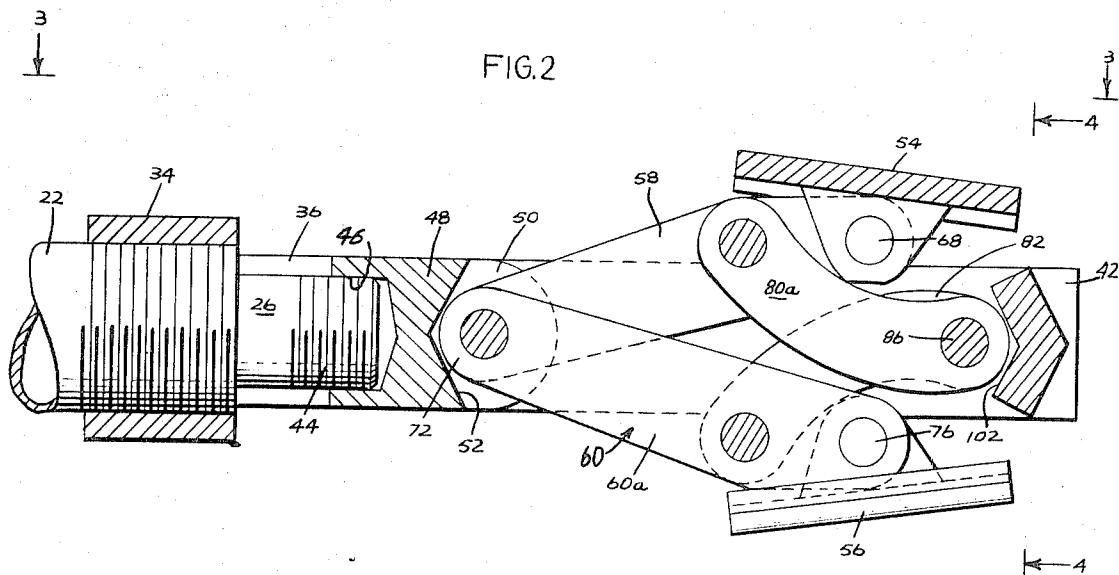
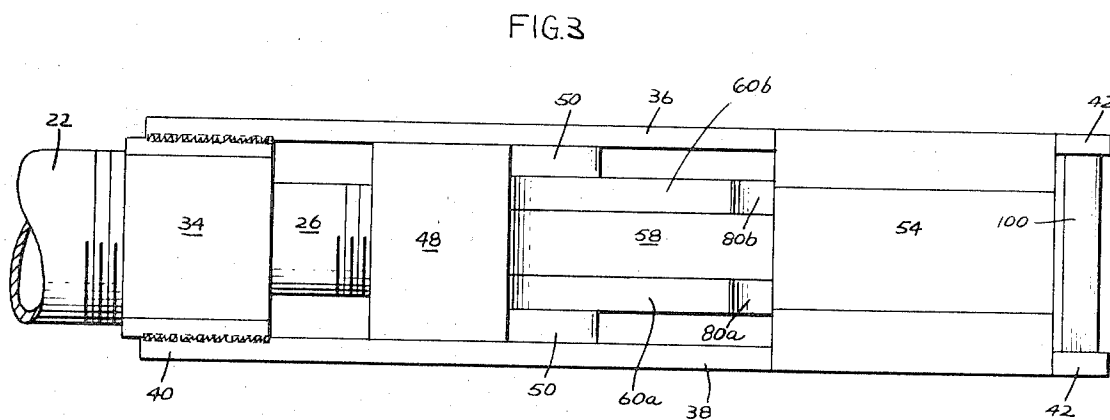
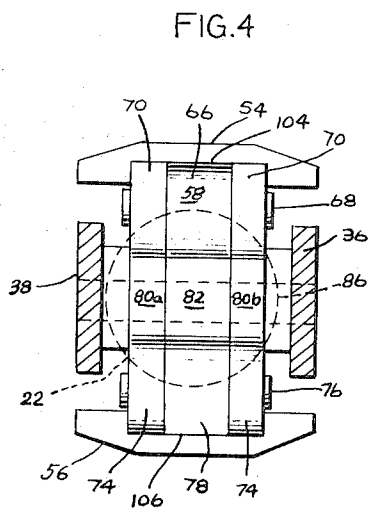


FIG. 1

INVENTOR:
JAMES J. VAN GOMPEL,
By Wood, Gust, Dink & Pinsky
ATTORNEYS.



INVENTOR:
JAMES J. VAN GOMPEL,
BY *Hood, Gutz, Dink & Lenchy*
ATTORNEYS.

FIG. 5

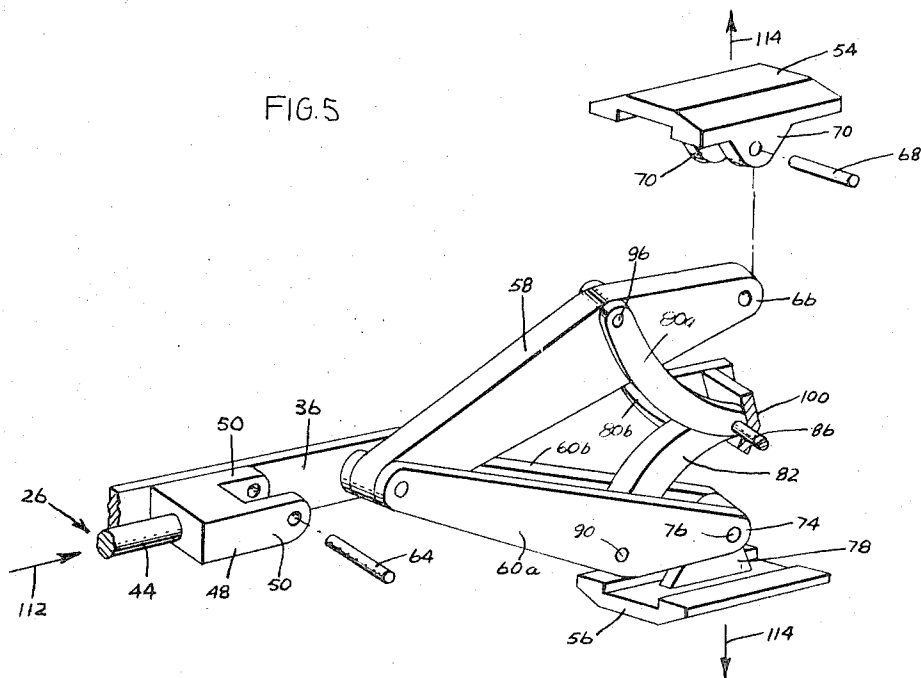
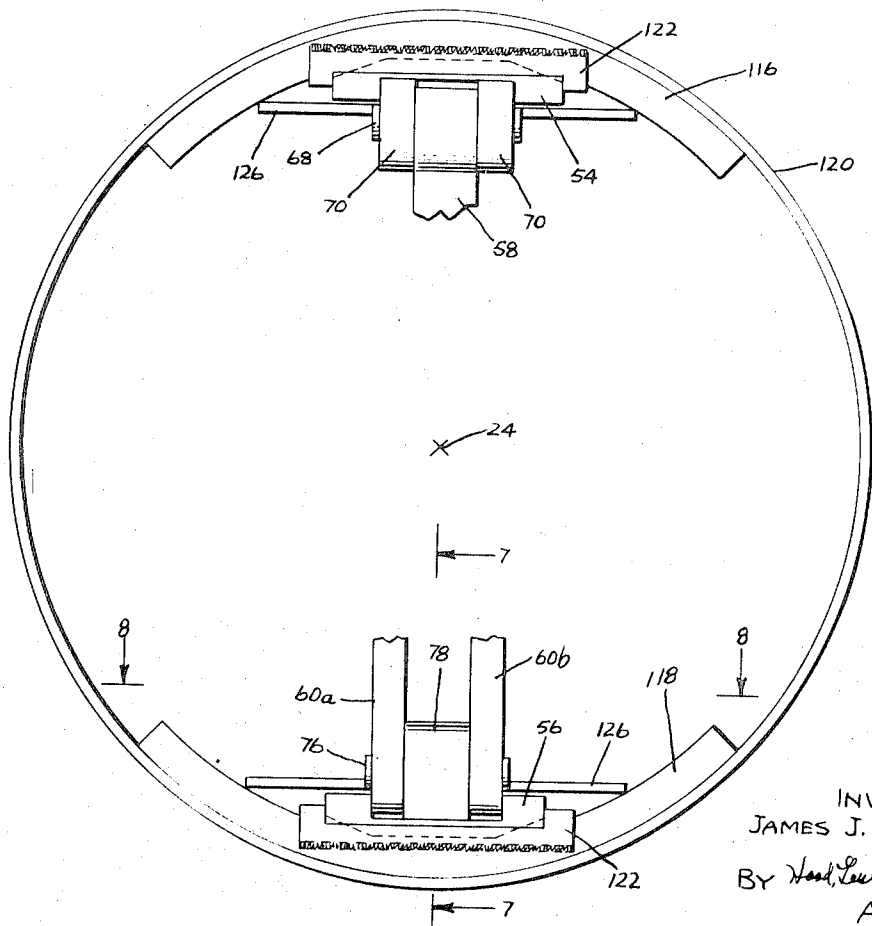
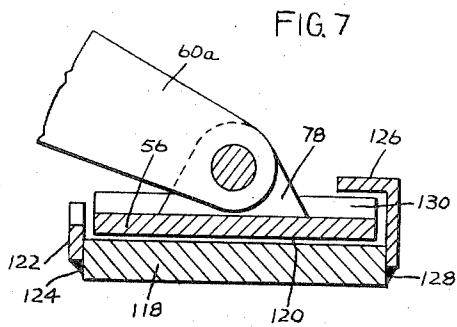
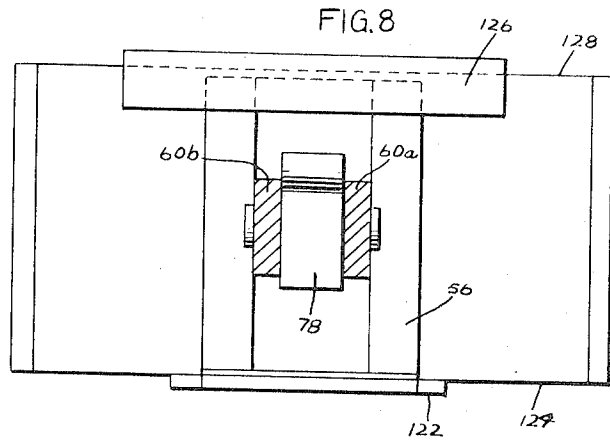
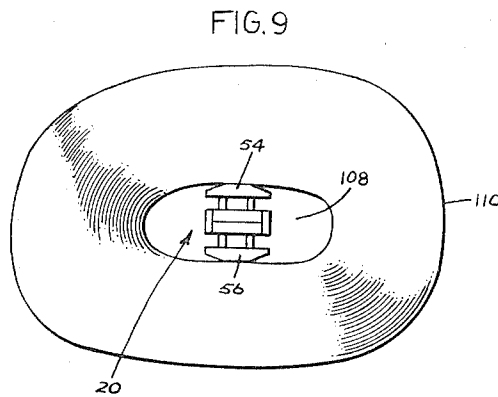
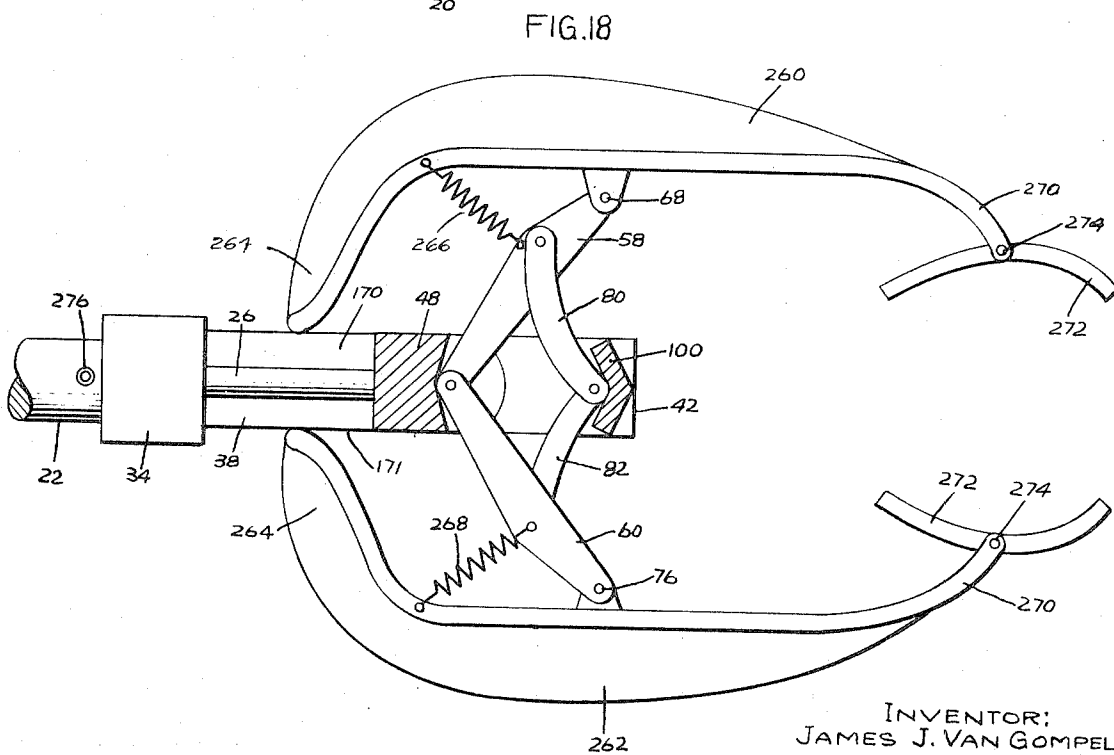


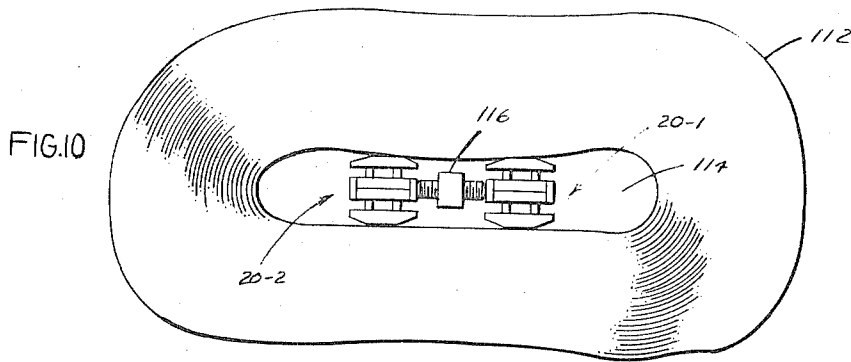
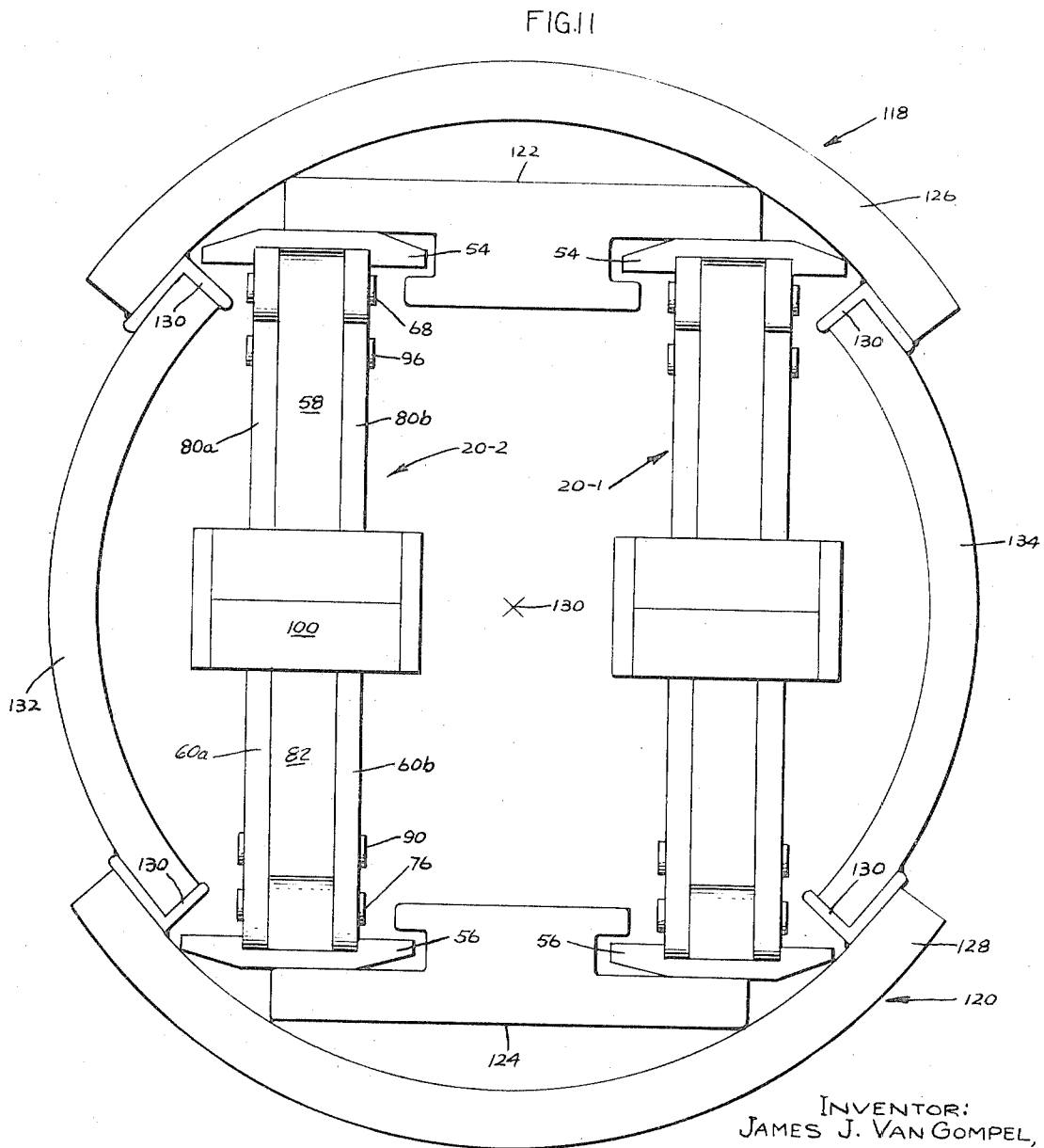
FIG. 6



INVENTOR:
JAMES J. VAN GOMPEL,
BY *Wood, Leet, Oriskany & Lindley*
ATTORNEYS.



INVENTOR:
JAMES J. VAN GOMPEL,
BY *Wood, Hart, Chick & Lundy*
ATTORNEYS.



INVENTOR:
JAMES J. VAN GOMPEL,
BY *Wood, Gust, Dicks & Lundy*
ATTORNEYS.

FIG.12

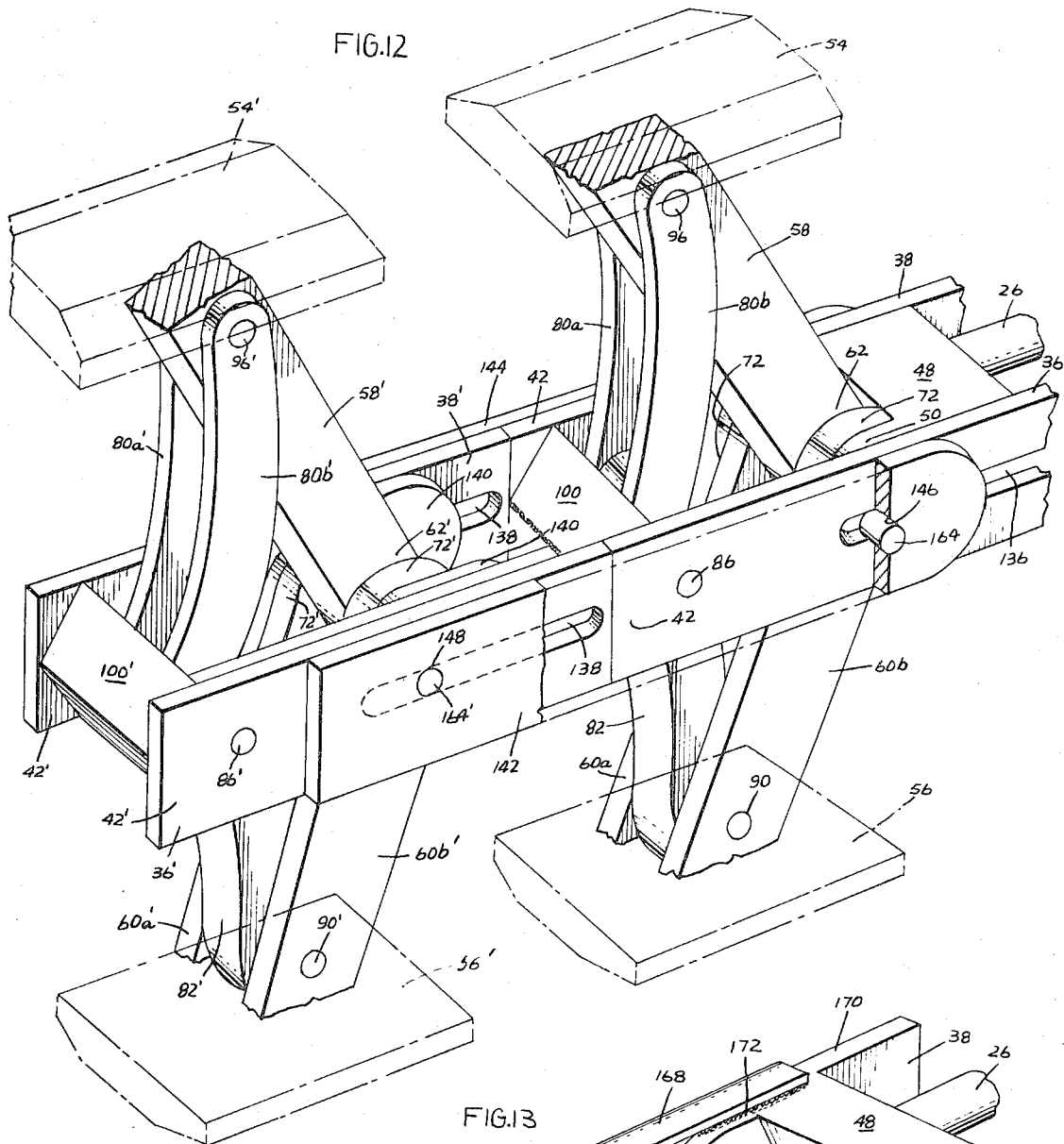
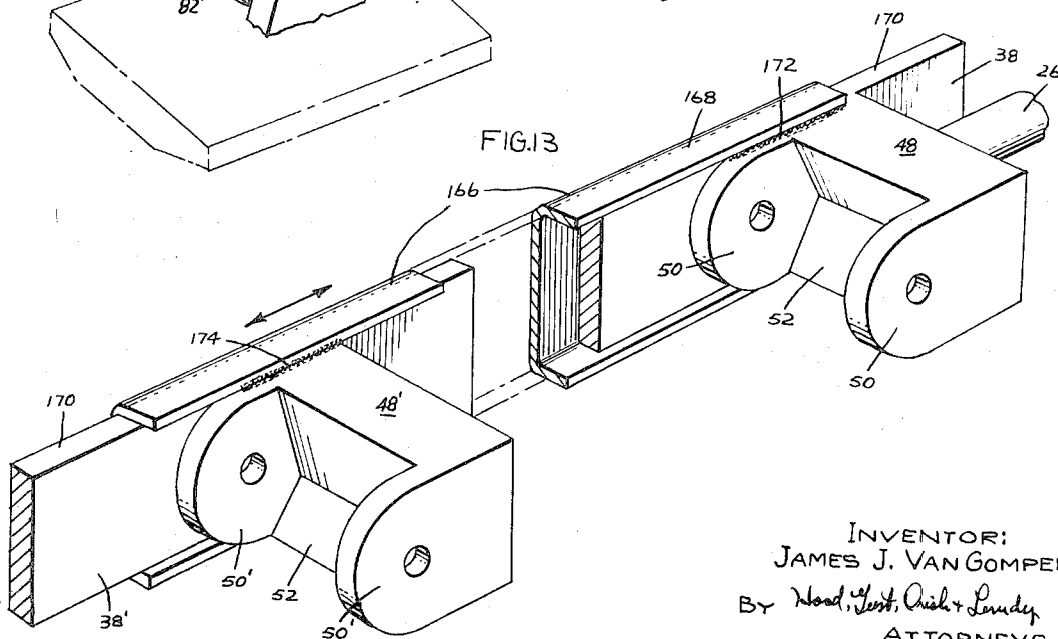


FIG.13



INVENTOR:
JAMES J. VAN GOMPEL,
BY Wood, West, Oak & Lundy
ATTORNEYS.

FIG. 14

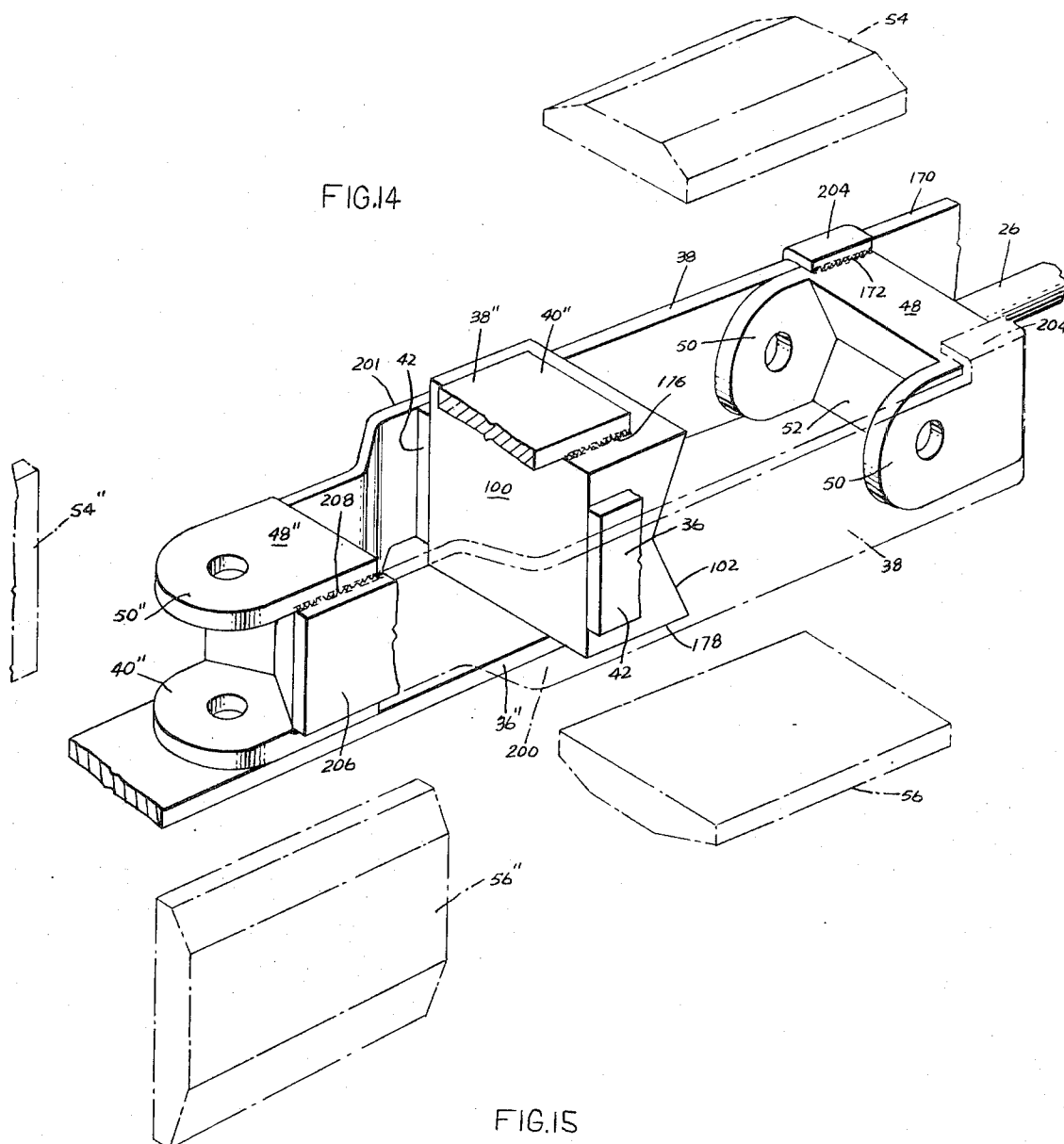
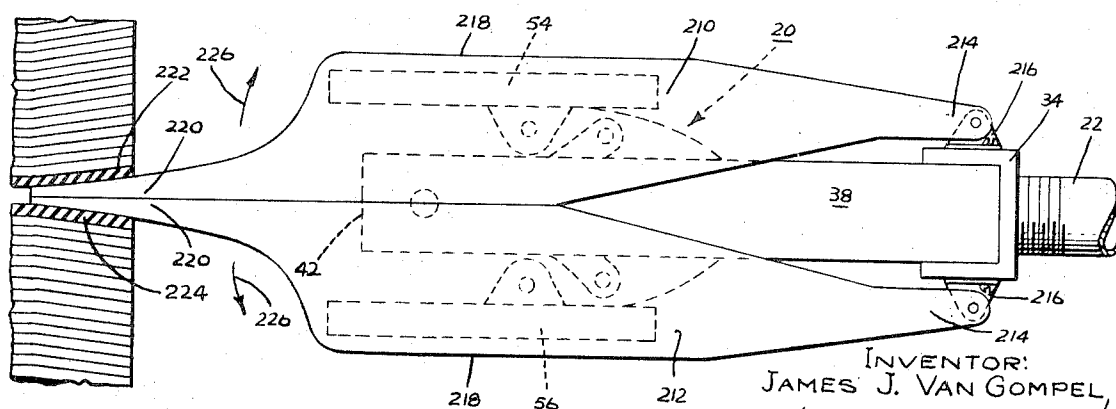


FIG. 15



INVENTOR:
JAMES J. VAN GOMPEL,
Hood, Gust, Irish & Lundy
BY ATTORNEYS.

FIG. 16

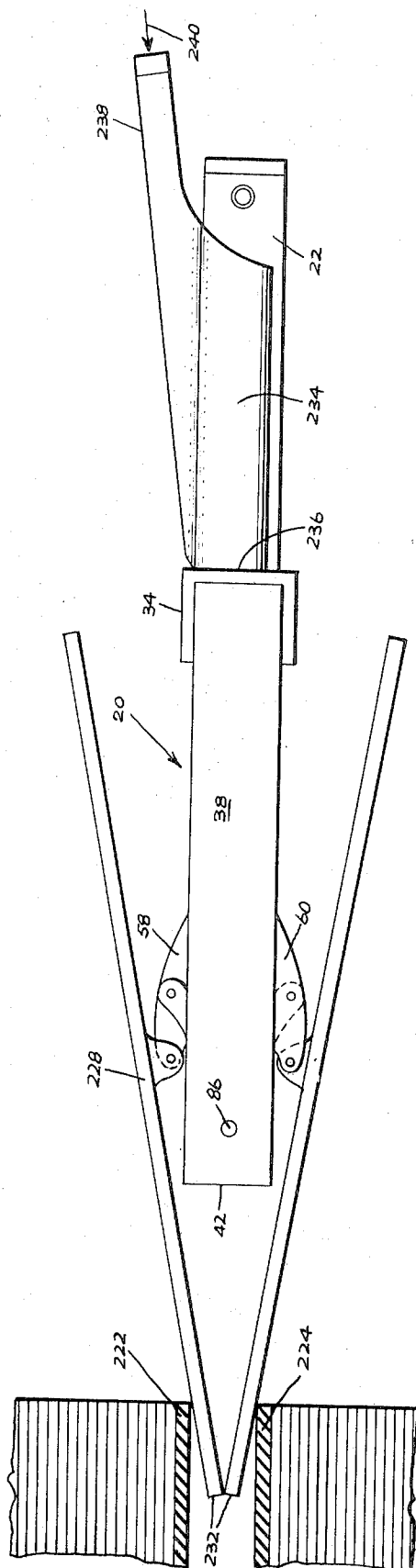
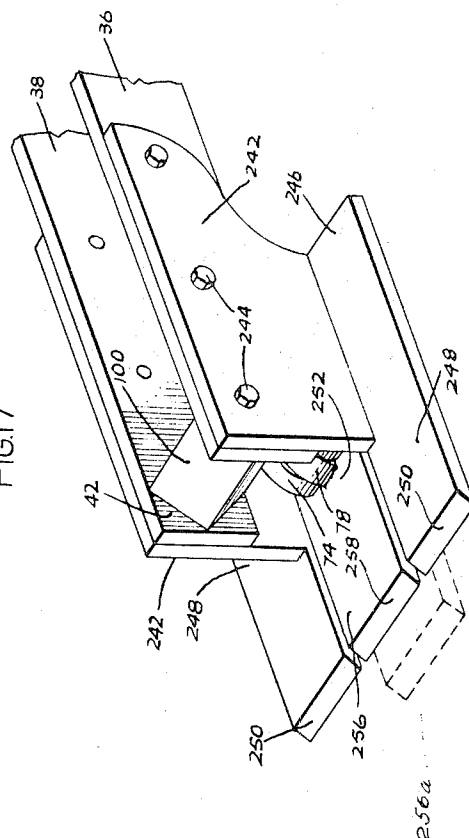


FIG. 17



INVENTOR:
JAMES J. VAN GOMPEL,
BY *Wood, Hust, Dink & Lundy*
ATTORNEYS.

FORCE-EXERTING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to force-exerting apparatus, and more particularly to apparatus for straightening deformed cylindrical articles such as rolls of sheet stock.

2. Description of the Prior Art

Large rolls of sheet material, such as printing paper and paper used in the paper conversion industry, are conventionally supported on cylindrical cores formed of relatively thin-walled material, such as cardboard or metal. Large rolls or coils of sheet metal, such as tin plate, aluminum or steel are conventionally wound on mandrels and after removal therefrom are self-supporting, i.e., no core is provided. During the transportation of such large rolls or coils and/or the handling thereof at the utilization plant, there are times when the roll or coil is dropped or otherwise jostled resulting in deformation or depression of the roll with resultant deformation of the core or central opening. Such deformed rolls cannot be employed on modern, high-speed equipment due, among other things, to vibration. The scrap value of a deformed roll of paper or sheet metal is a small fraction of the original cost of the paper or metal and thus, a substantial loss is incurred unless the material can be salvaged. The paper or sheet metal on the roll can, of course, be salvaged by rewinding from the deformed roll onto a new cylindrical core or mandrel. However, this is a time-consuming operation requiring rewinding apparatus which is not commonly available at the utilization plant.

U.S. Pat. No. 3,292,903 granted Dec. 20, 1966, discloses apparatus for straightening deformed rolls which comprises a pair of shoes inserted in an end of a deformed core, and an external ram-actuated mechanism for separating the shoes thereby to straighten the core. By reason of the arrangement and configuration of the apparatus, the shoes can only be positioned in the entrance of the deformed core and thus, such apparatus is not suitable for straightening certain severely deformed rolls since it cannot be inserted into the interior core or central opening to apply spreading force at points spaced inwardly from the ends.

SUMMARY OF THE INVENTION

In the straightening of certain large rolls, it is necessary that the spreading apparatus be capable of insertion interiorly of the core or center opening in order to exert spreading force throughout its length. It is further desired that the spreading apparatus exert progressively greater spreading force as the size of the opening increases with maximum force being exerted when the opening approaches a full circle at which point maximum resistance to further expansion is reached. It is further desirable that the spreading apparatus have a minimum transverse dimension when fully collapsed in order to permit its insertion into the interior of the core or center opening of a substantially flattened roll, and that its maximum transverse dimension when fully extended be substantially greater than that which is attainable by employment of a transversely extending ram, i.e., it is desirable that the maximum "lift" provided by the apparatus be substantially greater than the maximum extension of a ram which could be accommodated within the desired minimum transverse dimension of the apparatus.

In accordance with the invention, roll-straightening apparatus is provided capable of insertion into the interior of the core or central opening of a badly deformed core, the apparatus employing a longitudinally disposed ram which actuates spreading shoes by means of a toggle linkage which thus provides a maximum "lift" or separation of the shoes substantially greater than could be provided by a transversely disposed ram which could be accommodated between the collapsed position of the shoes. The toggle linkage further provides the desired progressively increasing force as the shoes are progressively separated by the ram. While the apparatus of

the invention is particularly adapted for use in straightening deformed rolls, it can, with simple attachments or modifications, be employed in other applications, as will be apparent as the description proceeds.

In accordance with its broader aspects, the invention provides apparatus for exerting force in lateral directions with respect to a longitudinal axis. A fluid power cylinder is provided having a piston rod coaxial with the axis, the piston rod having an outer end and being longitudinally movable between retracted and extended positions. A pair of elongated, transversely spaced, parallel frame members are provided respectively having opposite ends, the frame members having first ends respectively secured to opposite sides of the cylinder and extending longitudinally forwardly therefrom on opposite sides of the piston rod in spaced, parallel relationship therewith, the other ends of the frame members extending longitudinally forwardly from the outer end of the piston rod when in its extended position. A pair of force-exerting elements are provided respectively on opposite sides of the frame members and movable laterally outwardly away from and inwardly toward the frame members. A first pair of links are provided respectively having opposite ends, and first means are provided for pivotally connecting first ends of the first links to the outer end of the piston rod, the other ends of the first links being respectively pivotally connected to the force-exerting elements. A second pair of links is provided respectively having opposite ends, a first end of each of the second links being pivotally connected to a respective first link. Second means are provided for pivotally connecting the other ends of the second links to the frame members longitudinally forwardly of the outer end of the piston rod when it is in its extended position. The first and second pairs of links form a toggle whereby movement of the piston rod toward its extended position causes the toggle simultaneously to move the force-exerting elements laterally outwardly in opposite directions away from the frame members and movement of the piston rod toward its retracted position causes the toggle simultaneously to move the elements laterally inwardly toward the frame members.

It is accordingly an object of the invention to provide improved apparatus for exerting force in lateral directions with respect to a longitudinal axis.

Another object of the invention is to provide improved apparatus for straightening deformed rolls.

A further object of the invention is to provide improved apparatus for straightening deformed rolls having a minimum transverse dimension in its collapsed position and providing a maximum separation of its force-exerting elements greater than that which could be provided by a ram transversely disposed between the force-exerting elements.

Yet another object of the invention is to provide improved apparatus for straightening deformed rolls wherein the force exerted progressively increases as the force-exerting elements are progressively separated.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side, cross-sectional view showing the apparatus of the invention in its expanded position;

FIG. 2 is a fragmentary side, cross-sectional view similar to FIG. 1 but showing the apparatus in its fully collapsed position;

FIG. 3 is a fragmentary top view taken generally along the line 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view taken generally along the line 4—4 of FIG. 2;

FIG. 5 is a fragmentary exploded perspective view of the toggle linkage employed in the apparatus of the invention;

FIG. 6 is a fragmentary end view showing enlarged shoes removably mounted on the shoes of the apparatus of the previous figures;

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

FIG. 8 is a fragmentary top cross-sectional view taken generally along the line 8—8 of FIG. 6;

FIG. 9 is an end view showing the apparatus of the invention inserted in the core or central opening of a deformed roll;

FIG. 10 is an end view showing employment of two of the apparatuses of the invention in straightening a large deformed roll;

FIG. 11 is an end view showing accessory apparatus for use with two of the apparatuses of the invention;

FIG. 12 is a fragmentary perspective view, partly broken away, illustrating apparatus incorporating the invention having tandem toggle-actuated shoes;

FIG. 13 is a fragmentary view in perspective, partly broken away, illustrating a modification of the construction of FIG. 12;

FIG. 14 is a fragmentary view in perspective, partly broken away, illustrating another embodiment of the apparatus of the invention incorporating tandem toggle mechanisms and with the respective pairs of shoes disposed at right angles;

FIG. 15 is a side view illustrating an attachment to the apparatus of the invention for initially opening substantially flattened roll cores;

FIG. 16 is a side view illustrating a modification of the apparatus of the invention for initially opening substantially flattened roll cores;

FIG. 17 is a fragmentary perspective view illustrating an attachment to the apparatus of the invention which permits its use as a toe jack; and

FIG. 18 is a side view, partly in cross section, illustrating attachments to the apparatus of the invention permitting its use as a clamp.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 through 5 of the drawings, the apparatus of the invention for spreading deformed roll cores, generally indicated at 20, comprises a conventional hydraulic cylinder 22 disposed on a horizontal axis 24, cylinder 22 has an internal piston (not shown) and a piston rod 26 extending forwardly from its end 28. Piston rod 26 is longitudinally movable between a fully retracted position, as shown in FIG. 2, and a fully extended position, as shown in FIG. 1, upon application of hydraulic fluid under pressure to inlet port 30. While cylinder 22 is shown as being of the single-acting type, it will be readily understood that a double-acting cylinder may be employed for providing both positive extension and positive retraction of piston rod 26.

Forward end 28 of cylinder 22 is threadingly secured in opening 32 in block 34. A pair of elongated, transversely spaced-apart, parallel frame members 36, 38 are provided having rear ends 40 secured to opposite sides of block 34, as by welding. Frame members 36, 38 extend longitudinally forwardly from block 34 and end 28 of cylinder 22 in spaced, parallel relationship with piston rod 26, and have their outer ends 42 spaced longitudinally forwardly from outer end 44 of piston rod 26 when in its extended position, as shown in FIG. 1.

Outer end 44 of piston rod 26 is threadingly seated in opening 46 of pivot block 48 which extends transversely between frame members 36, 38. Pivot block 48 has a pair of transversely spaced-apart, forwardly extending pivot arms 50 defining a clevis. Forward surface 52 of pivot block 48 has a forwardly facing V-shaped configuration (FIGS. 1 and 2) for a purpose shortly to be described.

A pair of force-exerting shoes 54, 56 are provided movable laterally outwardly away from and inwardly toward frame members 36, 38 between a fully collapsed position when piston rod 26 is fully retracted (FIG. 2) and a fully expanded position when piston rod 26 is fully extended (FIG. 1). A first

pair of links 58, 60 are provided. Link 58 has its inner end 62 pivotally connected to arms 50 of pivot block 48 by pivot pin 64 having its axis bisecting longitudinal axis 24. Outer end 66 of link 58 is pivotally connected by pivot pin 68 to projections 70 which depend from shoe 54.

Link 60 comprises a pair of transversely spaced link arms 60a, 60b having their inner ends 72 disposed on either side of inner end 62 of link 58 and pivotally connected to arms 50 by pivot pin 64. Outer ends 74 of link arms 60a, 60b are pivotally connected by pivot pin 76 to projection 78 depending from shoe 56.

A second pair of links 80, 82 is provided. Link 82 has its inner end 84 pivotally connected to frame members 36, 38 by pivot pin 86 which extends transversely between the frame members and has its axis bisecting longitudinal axis 24. Outer end 88 of link 82 is disposed between link arms 60a, 60b and is pivotally connected thereto by pivot pin 90 at a point spaced from pivot pin 76. Link 80 comprises a pair of transversely spaced link arms 80a, 80b. Inner ends 92 of link arms 80a, 80b are positioned on either side of inner end 84 of link 82, and are pivotally connected to frame members 36, 38 by pivot pin 86. Outer ends 94 of link arms 80a, 80b are disposed on either side of link 58 and are pivotally connected thereto by pivot pin 96 at a point spaced from pivot pin 68. Links 80, 82 are arcuately curved toward pivot pin 64, as best seen in FIG. 1.

It will now be seen that the first pair of links 58, 60, and the second pair of links 80, 82 form a toggle-coupling forward end 44 of piston 26 to shoes 54, 56. Reference to FIG. 2 will show that with piston rod 26 fully retracted, the toggle will fully retract or collapse shoes 54, 56, the curvature of links 80, 82 accommodating pivot projections 70, 78 on the shoes 54, 56 in order to permit maximum retraction of the shoes. Reference to FIG. 1 will show that with piston rod 26 fully extended, the toggle will fully extend or spread shoes 54, 56. It will further be seen that the toggle mechanism provides the desired progressive increase in outward force exerted by shoes 54, 56 as piston rod 26 is progressively extended and the shoes are progressively moved laterally outwardly. It will still further be seen that the linear movement of piston rod 26 between its fully retracted and fully extended positions is substantially less than the lateral movement of shoes 54, 56 between their fully retracted and fully extended positions; the fully retracted position of pivot pin 64 is shown at 98 in FIG. 1.

A restraining member 100 is secured to frame members 36, 38 adjacent their outer ends 42 and extends transversely therebetween forwardly of inner ends 84, 92 of links 82, 80. Restraining member 100 has a rearwardly facing V-shaped surface 102. Inner ends 62, 72 of links 58, 60 are arcuately curved about the pivot axis of pivot pin 64 and bear against forwardly facing surface 52 of pivot block 48. Inner ends 84, 92 of links 82, 80 are arcuately curved about the axis of pivot pin 86 and bear against rearwardly facing surface 102 of restraining member 100. Outer ends 66, 74 of links 58, 60 are arcuately curved about the axes of pivot pins 60, 76 and respectively bear against inner surfaces 104, 106 of shoes 54, 56. Thus, with the inner ends of the toggle links respectively bearing against the complementary surfaces of pivot block 48 and restraining member 100, and the outer ends bearing against the complementary inner surfaces of shoes 54, 56, strain is relieved from pivot pins 64, 68, 76, and 86 as piston rod 26 is extended and shoes 54, 56 move laterally outwardly applying outward force to straighten a collapsed roll core.

Reference to FIG. 4 will show that the transverse width of shoes 54, 56 is substantially the same as the transverse spacing between the outer surfaces of frame members 36, 38.

In a specific embodiment of the spreading apparatus of FIGS. 1 through 5, the apparatus had an overall length of 21½ inches, cylinder 22 having a length of 8¾ inches rearwardly from block 34, and the overall length of block 34 and frame members 36, 38 being 13½ inches. Cylinder 22 had a diameter of 2¼ inches, block 34 had a height of 3 inches, and frame members 36, 38 had a height of 2 inches. Shoes 54, 56 were 4 inches in length and ¾ inches in width. When fully collapsed,

as shown in FIGS. 2 and 4, the apparatus had an overall height of 4½ inches between the outer surfaces of shoes 54, 56 and when fully extended, the apparatus has an overall height of 10½ inches between the outer surfaces of the shoes, extension of the shoes by 6 inches being accomplished by an approximately 3½-inch extension of piston rod 26. In the fully retracted position of the shoes, the forward ends of the shoes 54, 56 were spaced 1 inch rearwardly from the outer ends 42 of frame members 36, 38, and in the fully extended position, the forward ends of the shoes were spaced by 1 inch forwardly of the outer ends of the frame members.

Referring now to FIG. 9, it will be seen that the spreading apparatus 20 in its fully collapsed position may be inserted into the interior of the core or central opening 108 of a flattened roll 110 of sheet stock. After insertion of the apparatus in the core 108, extension of piston rod 26, as shown by the arrow 112 (FIG. 5) results in laterally outward movement of shoes 54, 56 in opposite directions, as shown by the arrows 114, the shoes 54, 56 thus exerting outward force on the collapsed core 108 thereby to restore the core and the roll 110 thereon to its original cylindrical configuration. By reason of the employment of a toggle linkage 58, 60, 80, 82, the force initially exerted by the shoes 54, 56 is low, however as the shoes are progressively spread laterally apart, the force progressively increases and reaches a maximum when the shoes are fully extended, maximum spreading force being required when the core closely approaches its original cylindrical configuration. It will be readily understood that the spreading apparatus 20 may be constructed in several different sizes. Thus, in the case of a large roll which is substantially flattened, a small spreading apparatus 20 may at first be employed initially to expand the flattened core to the widest dimension with the capability of the small spreading apparatus. The small spreading apparatus may then be removed and a larger spreading apparatus inserted in the core which is capable of further expanding the core to its full cylindrical configuration.

Referring now to FIGS. 6, 7 and 8, it may be desirable to employ an apparatus 20 for restoring a roll to its original cylindrical configuration wherein the inside diameter of the cylindrical core is only slightly greater than the maximum spread of the shoes 54, 56, such as, for example, a 12-inch diameter core vis-a-vis a 10½-inch maximum spread. Here, a pair of auxiliary shoes 116, 118 are removably mounted on shoes 54, 56. It will be seen that shoes 116, 118 are transversely elongated and arcuately curved about axis 24 on radii of a circle equal to the inside diameter of the undistorted cylindrical core 120.

Shoes 116, 118 are removably retained on the outer surfaces 120 of shoes 54, 56 by means of a flange 122 secured to the rear edge 124 of the respective shoe 116, 118, and a reentrant flange 126 secured to the forward edge 128 of the respective shoe 116, 118 and overlaying the forward end 130 of the respective shoe 54, 56. With the auxiliary shoes 116, 118 thus removably retained on shoes 54, 56, the entire spreading apparatus 20 can be moved forwardly or rearwardly in the core, and/or can be rotated within the core in either direction without the auxiliary shoes 116, 118 becoming detached from shoes 54, 56.

The apparatus of FIG. 5 may be slightly altered to provide greater spread by reversing the two arms 58 and 60a, 60b. This reversal is best understood by considering the two arms 58 and 60a, 60b as having one longitudinal straight edge and one angled edge. In FIG. 5, the straight edges of the two arms are facing each other. By rotating the arms 180° about the longitudinal axes thereof to position the straight edges outermost and the angled edges facing each other, the pivot points 90, 96 will automatically dispose the shoes 54, 56 farther outwardly assuming the same positions for the curved links 80a, 80b and 82 as shown. Thus, for maximum protraction of rod 26, the shoes 54, 56 will spread farther apart. With this is gained a substantial percentage of spreading power also.

Referring now to FIG. 10, it will be seen that a pair of spreaders 20-1 and 20-2 may be employed for straightening large rolls or coils 112 of sheet metal, such as tin plate, steel or aluminum. Such coils may have a normal outside diameter of 56 inches with the central, coreless opening 114 having a normal inside diameter of 16 inches. Here, a pair of smaller spreaders 20-1, 20-2, capable for example of opening to 10½ inches, are positioned in the collapsed center opening 114, being separated by adjustable spacing device 116. Spreaders 20-1, 20-2 are then expanded to their full open positions, as above-described, at which point one or more props are inserted in the opening and the smaller spreaders are removed. A single larger spreader 20, or a pair of larger spreaders, may then be inserted in the partially spread center opening 114 for completing the expansion of the center opening and roll to the desired cylindrical configuration. It will be readily understood that in some instances it may be desirable to overstretch the core by a small amount, for instance by 1 to 3 inches in the case of a 16-inch center opening, in order to remove all starting or bubbles in the roll. Following such overstretching, the spreader 20 may be retracted slightly, rotated by 90°, and again actuated to restore the roll to its original cylindrical configuration.

Referring now to FIG. 11, a pair of smaller spreaders 20-1, 20-2, such as those opening to 10½ inches, may be employed for expanding a roll or coil having a much larger inside diameter core or central opening, such as 16 inches, by the use of adapter assemblies 118, 120. Adapter assemblies 118, 120 comprise a pair of separating members 122, 124 which respectively engage the outer surfaces of shoes 54, 56 of spreaders 20-1, 20-2, and a pair of auxiliary shoes 126, 128 arcuately curved about axis 130 of the core or central opening on radii of a circle having a diameter equal to the desired inside diameter of the core, such as for example 16 inches. Curved shoes 126, 128 are retained on spreader shoes 54, 56 and members 122, 124 by angle flanges 130, as shown.

Initially, separating members 122, 124 are assembled on shoes 54, 56 of spreaders 20-1, 20-2 in their respective collapsed positions. Auxiliary shoes 126, 128 are then assembled over shoes 54, 56 and separating members 122, 124, and the resulting assembly is then inserted into the core or central opening, which may previously have been partially expanded as above-described. Spreaders 20-1, 20-2 are then actuated to separate shoes 54, 56, thereby separating auxiliary shoes 126, 128 further to expand the core. In the case of cores or central openings having the inside diameter greater than the expansive capability of the assembly, upon reaching the maximum extension of spreaders 20-1, 20-2, stage-holding members 132, 134 are inserted with their opposite ends 20-2 abutting flanges 130, as shown. The smaller spreaders 20-1, 20-2 are then retracted slightly to permit their removal along with the separating members 122, 124, auxiliary shoes 126, 128 being held in engagement with the partially expanded core or central opening by the stage-holding members 132, 134. Larger spreaders 20-1, 20-2 are then substituted for the smaller spreaders and along with separating members 122, 124, are inserted within shoes 126, 128. The larger spreaders 20-1, 20-2 are then actuated to extend their shoes 54, 56 until auxiliary shoes 126, 128 have fully expanded the core or central opening to the desired cylindrical configuration.

Referring now to FIG. 12 in which like elements are indicated by like reference numerals and similar elements by primed reference numerals, there is shown a construction in which an additional pair of shoes 54', 56' may readily be added to the basic spreading apparatus 20, in essence to provide two spreaders in tandem. Here, a pair of extension frame members 36', 38' is attached to the outer ends 42 of frame members 36, 38, as by welding, and extend forwardly therefrom as shown. A pair of longitudinally extending, transversely aligned slots 136 is respectively formed in frame members 36, 38. Pivot pin 64 has extension portions 164 which respectively extend outwardly through slots 136 for sliding movement therein. Another pair of longitudinally elongated,

transversely aligned slots 138 is respectively formed in frame members 36', 38'.

A second pair of links 50', 60' is provided having their inner ends 62', 72' pivotally connected by a pin which is secured to spacing members 140 on either side of link arms 60a', 60b', and which has extension portions 164' respectively extending outwardly through slots 138 for sliding movement therein. Shoes 54', 56' are pivotally connected to the outer ends of links 58', 60' in the same manner as the pivotal connection of shoes 54, 56 to the outer ends of links 58, 60.

Longitudinally elongated connecting members 142, 144 are provided extending parallel with and in sliding engagement with the outer surfaces of frame members 36, 36' and 38, 38'. Pin extension portions 164, 164' are respectively seated in openings 146, 148 respectively adjacent the rear and forward ends of connecting members 142, 144. It will now be seen that the extension and retraction of piston rod 26 resulting in forward and rearward movement, respectively, of pivot block 48, pin 64, and inner ends 62, 72 of links 58, 60 will through connecting members 142, 144 result in corresponding forward and rearward movement of inner ends 62', 72' of links 58', 60'.

A second pair of links 80', 82' is provided respectively having their inner ends pivotally connected to frame members 36', 38' by pin 86', and having their outer ends pivotally connected to links 58', 60' by pivot pins 90', 96'. It will be seen that the pair of links 58', 60' and the pair of links 80', 82' form a second toggle which actuates the second pair of shoes 54', 56' laterally outwardly away from and inwardly toward frame member extension 36', 38' in response to extension and retraction, respectively, of piston rod 26. It will be observed that extension and retraction of piston rod 26 results in simultaneous extension and retraction, respectively, of shoes 54, 54' and 56, 56'.

Referring now to FIG. 13 in which like elements are again indicated by like reference numerals and similar elements by primed reference numerals, here, extension frame members 36', 38' are again attached to the outer ends 42 of frame members 36, 38 (FIG. 12). A second pivot member 48' is provided which pivotally connects the inner ends 62', 72' of links 58', 60'. Pivot members 48, 48' are connected for simultaneous longitudinal movement in response to extension and retraction of piston rod 226 by longitudinally elongated connecting members 166. Connecting members 166 are channel-shaped and are slidably positioned over the respective frame members 36, 36' and 38, 38'. The upper flanges 168 of connecting members 166 extend inwardly over the top edges 170 of the respective frame members 36, 36' and 38, 38', and are attached to the pivot blocks 48, 48', as by welding at 172, 174.

Referring now to FIG. 14 in which like elements are again indicated by like reference numerals and similar elements by double primed reference numerals, a tandem shoe construction is shown in which the two pairs of shoes 54, 56 and 54'', 56'' are disposed at right angles to each other. Here, restraining member 100 again extends transversely between outer ends 42 of frame members 36, 38 and has flat top and bottom sides 176, 178. Longitudinally elongated, transversely spaced-apart frame members 36'', 38'' have their forward ends 40'' respectively attached to the top and bottom sides 176, 178 of restraining member 100 and extend forwardly therefrom in spaced, parallel relationship, it being observed that frame members 36, 38 are transversely spaced-apart in one direction and that frame members 36'', 38'' are transversely spaced-apart in a direction at right angles thereto. A second pivot block 48'' is slidably received between frame members 36'' and 38'' and is pivotally connected to shoes 54'', 56'' by a toggle mechanism identical to that previously shown and described. Connecting members 200, 201 respectively connect pivot blocks 48, 48''. Connecting members 200, 201 have flange portions 204 adjacent their rear ends which extend over top edges 170 of frame members 36, 38 and are attached to pivot block 48, as by welding at 172. Rear ends 206 of connecting members 200, 201 are respectively attached to

the top and bottom sides of pivot block 48'', as by welding at 208.

It will now be seen that extension and retraction of piston rod 26 will result in simultaneous forward and rearward movement of pivot blocks 48, 48'', respectively, and consequent lateral outward and inward movement of shoes 54, 56 and 54'', 56'', respectively.

Referring now to FIG. 15 in which like elements are indicated by like reference numerals, it will be observed that a substantially collapsed roll core or central opening must be initially partially opened or started at one end in order to receive the spreading apparatus 20 of the invention. Here, an attachment to the basic spreading apparatus 20 is shown which permits initial starting of one end of a substantially collapsed core. A pair of longitudinally elongated arms 210, 212 are provided having rear ends 214 respectively pivotally connected to opposite sides of block 34 by pivot brackets 216. Arms 210, 212 have intermediate portions 218 which respectively engage the outer surfaces of shoes 54, 56. Arms 210, 212 extend forwardly of shoes 54, 56 and outer ends 42 of frame members 36, 38 and have outer end portions 220 which are in engagement when piston rod 26 is fully retracted and shoes 54, 56 thus are fully collapsed. Outer end portions 220 of arms 210, 212 have outer surfaces which are tapered forwardly toward a point, as shown. The pointed outer ends 222 of arms 210, 212 may thus be inserted into the opening 222 of a substantially collapsed roll core 224, as shown. Actuation of cylinder 22 to separate shoes 54, 56 will thus result in pivotal outward movement of outer ends 220 of arms 210, 212 as shown by arrows 226, resulting in partial expansion of opening 222 of the collapsed core 224. This process may be repeated with the outer ends 220 being progressively inserted further into the core 224 until the opening has been sufficiently enlarged to permit insertion of the shoes 54, 56 of the basic spreading apparatus 20. During spreading, shoes 54, 56 move forwardly, as shown in dashed lines, with respect to frame members 36 and 38.

Referring now to FIG. 16 in which like elements are again indicated by like reference numerals, another modification of the basic spreading apparatus 20 is shown for initially spreading or starting substantially flattened roll cores. Here, a pair of longitudinally elongated shoes 228, 230 are substituted for the shoes 54, 56 of the basic apparatus. Shoes 228, 230 have forward ends 232 which project forwardly of outer ends 42 of frame members 36, 38 and which may be pivoted into engagement when piston rod 26 is fully retracted and shoes 228, 230 are fully collapsed, as shown. Thus, it will be seen that shoes 228, 230, when pivoted forwardly with their ends 232 in engagement, define a point which may be inserted or driven into the end 222 of a substantially flattened roll core 224. In order to drive shoes 228, 230 into the end 222 of core 224 without damaging cylinder 22, a sleeve 234 is placed over cylinder 22 with its forward end 236 engaging block 34. Sleeve 234 has an impact-receiving projection 238 extending rearwardly therefrom which is adapted to be impacted by a mallet, as shown by the arrow 240, in order to drive the forward ends 232 of shoes 228, 230 into opening 222.

Referring now to FIG. 17, the basic spreading apparatus 20 of the invention may readily be adapted for use as a toe jack. Here, a pair of plate members 242 are respectively removably attached to the outer sides of frame members 36, 38, as by bolts 244, as shown. Plate members 242 respectively have outwardly extending flanges 246 formed thereon having transversely aligned, transversely spaced-apart, forwardly extending foot portions 248 formed thereon which extend forwardly of the outer ends 42 of frame members 36, 38. The outer ends of foot portions 248 may be beveled to form pointed edges, as at 250. Shoe 56 of basic spreader assembly 20 is replaced by shoe 252 having a flat toe portion 256 which extends forwardly between foot portions 248 in transverse alignment therewith when the shoes are fully collapsed. Toe portion 256 may likewise have its outer end 258 beveled to a pointed edge.

It will now be seen that in using the modified apparatus as a toe jack, with the shoes fully collapsed, and with foot portions 248 and toe portion 256 in engagement with a supporting surface, such as the floor, foot portions 248 and toe portion 256 are inserted under an object to be raised. Cylinder 22 is then actuated to spread the shoes resulting in lateral outward movement of toe portion 256 with respect to foot portions 248, as indicated by the dashed lines 256a. Toe portion 256 thus remains in engagement with the supporting surface while foot portions 248 raise the object resting thereon.

Referring finally to FIG. 18 in which like elements are still indicated by like reference numerals, here a modification of the basic spreading apparatus 20 is shown which adapts the apparatus for use as a clamp. The basic shoes 54, 56 are here replaced by a pair of elongated arms 260, 262 respectively pivotally connected intermediate their ends to links 58, 60 by pivot pins 68, 76. Rear ends 264 of arms 260, 262 are inwardly curved and engage the side edges 170, 171 of frame members 36, 38, being resiliently biased into engagement therewith by suitable springs 266, 268 respectively connecting the forward arm ends 264 to links 58, 60 as shown. The forward ends 270 of arms 260, 262 extend substantially forwardly of the outer ends 42 of frame members 36, 38, and have clamping elements 272 pivotally connected thereto, as at 274. Here, a double-acting cylinder 22 is required having another port 276 for admitting hydraulic fluid thereto under pressure for positively retracting piston rod 26.

It will now be seen that extension of piston rod 26 will result in pivotal outward movement of arms 260, 262 and separation of clamping elements 272, and that retraction of piston rod 26 will similarly result in pivotal inward movement of outer ends 270 of arms 260, 262 and closure of clamping elements 272 thereby to clamp an article, such as a length of pipe, therebetween.

While the basic spreading apparatus 20 of the invention has been illustrated and described in connection with the spreading of deformed rolls of sheet stock, it will be readily apparent that the apparatus may equally advantageously be employed for straightening kinks and dents in pipes, tubing, ducts and the like.

The spreading apparatus of the invention is fast acting. The above-referred-to specific embodiment having a maximum opening of 10¼ inches can be expanded from its minimum to its maximum extension in approximately 5 seconds, while a larger unit having a maximum opening of 17½ inches can be expanded to its maximum extension in approximately 13 seconds. Even greater speeds can be achieved by utilizing higher speed hydraulic pumps for pressurizing the cylinder 22.

While there have been described above the principles of this invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of the invention.

I claim:

1. Apparatus for exerting force in lateral directions with respect to a longitudinal axis comprising a fluid power cylinder having a piston rod coaxial with said axis, said piston rod having an outer end and being longitudinally movable between retracted and extended positions, a pair of elongated, transversely spaced, parallel frame members respectively having opposite ends, said frame members having first ends respectively secured to opposite sides of said cylinder and extending longitudinally forwardly therefrom on opposite sides of said piston rod in spaced, parallel relationship therewith, the other ends of said frame members extending longitudinally forwardly from said outer end of said piston rod when the same is in its extended position, a pair of force-exerting elements respectively on opposite sides of said frame members and movable laterally outwardly away from and inwardly toward said frame members, a first pair of links respectively having opposite ends, first means for pivotally connecting first ends of said first links to said outer end of said piston rod, the other ends of said first links being respectively pivotally connected to said elements, a second pair of links respectively

having opposite ends, a first end of each of said second links being pivotally connected to a respective first link, and second means for pivotally connecting the other ends of said second links to said frame members longitudinally forwardly of said outer end of said piston rod when the same is in its extended position, said first and second pairs of links forming a toggle whereby movement of said piston rod toward said extended position causes said toggle simultaneously to move said elements laterally outwardly in opposite directions away from said frame members and movement of said piston rod toward its retracted position causes said toggle simultaneously to move said elements laterally inwardly toward said frame members.

2. The apparatus of claim 1 wherein said first ends of said second links are respectively pivotally connected to said first links intermediate said ends thereof.

3. The apparatus of claim 2 wherein said second links are respectively curved toward said first means.

4. The apparatus of claim 1 further comprising a restraining member extending transversely between said frame members forwardly of and closely adjacent said other ends of said second links, said other ends of said second links being arcuately curved and bearing against said restraining member, said first means including a pivot member secured to said outer end of said piston rod and having said first ends of said first links pivotally connected thereto, said first and other ends of said first links being arcuately curved and respectively bearing against said pivot member and said elements.

5. The apparatus of claim 1 wherein said frame members respectively have top and bottom edges and oppositely facing outer surfaces, said elements being respectively movable outwardly from and inwardly toward said top and bottom edges, said elements respectively having a transverse width generally equal to the transverse spacing between said outer surfaces of said frame members.

6. The apparatus of claim 1 wherein said first ends of said first links are pivotally connected to said first means on a first common pivot axis which bisects said longitudinal axis, said other ends of said second links being pivotally connected to said second means on a second common pivot axis in spaced, parallel relationship with said first pivot axis and which bisects said longitudinal axis.

7. The apparatus of claim 6 wherein said first means comprises a pivot member secured to said outer end of said piston rod between said frame members and a first pivot pin on said first pivot axis for pivotally connecting said first ends of said first links to said pivot member, said second means comprising a second pivot pin on said second pivot axis extending transversely between said frame members and secured thereto, and further comprising a restraining member extending transversely between and secured to said frame members forwardly of said second pivot pin, said other ends of said second links being arcuately curved about said second pivot axis and bearing against a complementary surface of said restraining member, said first ends of said first links being arcuately curved about said first pivot axis and bearing against a complementary surface of said pivot member, said other ends of said first links being arcuately curved about their respective pivotal axes and respectively bearing against complementary surfaces of said elements.

8. The apparatus of claim 1 wherein said elements respectively have outwardly facing surfaces, and further comprising a pair of shoes having means for respectively removably attaching the same to said surfaces of said elements, said shoes respectively having outer surfaces which are arcuately curved about said horizontal axis and defining a circle when said elements are moved outwardly by a predetermined amount.

9. The apparatus of claim 8 wherein each of said elements has forward and rear edges, each of said shoes having forward and rear edges, each of said attaching means comprising an outwardly extending flange on one of said shoe edges and an outwardly extending reentrant flange on the other of said shoe edges which removably receives one of said element edges.

10. The apparatus of claim 1 further comprising a second pair of force-exerting elements respectively on opposite sides of said frame members and spaced longitudinally forwardly from said first-mentioned pair of elements, said second pair of elements being movable laterally outwardly away from and inwardly toward said frame members, a third pair of links respectively having opposite ends, first ends of said third links being disposed forwardly of said second means, third means for pivotally connecting together said first ends of said third links, means for connecting said first means to said third means whereby longitudinal movement of said piston rod simultaneously longitudinally moves said first and third means, the other ends of said third links being respectively pivotally connected to said second pair of elements, a fourth pair of links respectively having opposite ends, a first end of each of said fourth links being pivotally connected to a respective third link, the fourth means for pivotally connecting said other ends of said fourth links to said frame members longitudinally forwardly of said third means, said third and fourth pairs of links forming a second toggle whereby movement of said piston rod toward said extended position causes said toggles simultaneously to move said first and second pairs of elements laterally outwardly in opposite directions away from said frame members and movement of said piston rod toward its retracted position causes said toggles simultaneously to move said first and second pairs of elements laterally inwardly toward said frame members.

11. The apparatus of claim 10 wherein said first means includes a pivot member secured to said outer end of said piston rod between said frame members and a first pivot pin pivotally connecting said first ends of said first links to said pivot member, said third means including a second pivot pin pivotally connecting said first ends of said third links; said connecting means including a pair of elongated connecting members respectively extending parallel with said frame members adjacent the outer sides thereof and having opposite ends, and means for respectively connecting said opposite ends of said connecting members to said pivot member and said second pivot pin.

12. The apparatus of claim 11 wherein said last-mentioned connecting means comprises a first pair of longitudinally elongated, transversely aligned slots respectively formed in said frame members, said first pivot pin having opposite ends respectively extending through said first slots and secured to said connecting members adjacent one end thereof, and a second pair of longitudinally elongated, transversely aligned slots respectively formed in said frame members forwardly of said first pair of slots, said second pivot pin having opposite ends respectively extending through said second slots and secured to said connecting members adjacent the other end thereof, said slots accommodating longitudinal movement of said pivot pins in response to longitudinal movement of said piston rod.

13. The apparatus of claim 12 wherein said third means further includes a second pivot member between said frame members and having said second pivot pin connected thereto, said last-mentioned connecting means comprising portions of said connecting members respectively adjacent said opposite ends thereof which extend over the respective frame members and are respectively secured to said first and second pivot members.

14. The apparatus of claim 1 wherein said frame members are transversely spaced apart in a first direction and said elements are transversely spaced apart in a second direction normal to said first direction, and further comprising a second pair of elongated, parallel frame members transversely spaced apart in said second direction and having opposite ends, means for securing first ends of said second frame members to said other ends of said first-mentioned frame members with said second frame members extending longitudinally forwardly therefrom, a second pair of force-exerting elements respectively on opposite sides of said second frame members transversely spaced apart in said first direction and spaced

longitudinally forwardly from said first-mentioned pair of elements, said second pair of elements being movable laterally outwardly away from and inwardly toward said second frame members, a third pair of links respectively having opposite ends, first ends of said third links being disposed between said second frame members, third means for pivotally connecting together said first ends of said third links, means for connecting said first means to said third means whereby longitudinal movement of said piston rod simultaneously longitudinally moves said first and third means, the other ends of said third links being respectively pivotally connected to said second pair of elements, a fourth pair of links respectively having opposite ends, a first end of each of said fourth links being pivotally connected to a respective third link, and fourth means for pivotally connecting said other ends of said fourth links to said second frame members longitudinally forwardly of said third means, said third and fourth pairs of links forming a second toggle whereby movement of said piston rod toward said extended position causes said toggles simultaneously to move said first and second pairs of elements laterally outwardly in opposite directions away from said first and second frame members, respectively, and movement of said piston rod toward its retracted position causes said toggles simultaneously to move said first and second pairs of elements laterally inwardly toward said first and second frame members, respectively.

15. The apparatus of claim 14 wherein said first means includes a pivot member secured to said outer end of said piston rod between said first frame members and a first pivot pin pivotally connecting said first ends of said first links to said first pivot member, said third means including a second pivot member between said second frame members and a second pivot pin pivotally connecting said first ends of said third links to said second pivot member, said connecting means comprising a pair of elongated connecting members respectively extending parallel with said first frame members adjacent the outer sides thereof and having opposite ends, portions of said connecting members adjacent first ends thereof extending over the respective first frame members and being respectively secured to said first pivot members, the other ends of said connecting members being secured to said second pivot member.

16. The apparatus of claim 1 further comprising a pair of elongated arms respectively having opposite ends, said arms respectively having first ends and intermediate portions transversely spaced apart on opposite sides of said frame members, means for respectively pivotally connecting said first ends of said arms to said frame members adjacent said first ends thereof, said elements respectively engaging said intermediate portions of said arms, said arms respectively having outer force-exerting ends extending forwardly of said other ends of said frame members, said outer ends of said arms engaging when said piston rod is in its retracted position and said elements are in their innermost positions, said outward movement of said elements in response to extension of said piston rod causing said arms to pivot outwardly thereby separating said outer ends of said arms.

17. The apparatus of claim 16 wherein said outer ends of said arms are tapered forwardly toward a point whereby said outer ends when so engaged may be inserted in the end of a collapsed roll of sheet material thereby to spread the same upon said separation of said outer ends.

18. The apparatus of claim 1 wherein said elements respectively comprise longitudinally elongated shoe members having opposite ends, said shoe members respectively having outer ends longitudinally spaced forwardly from said other ends of said frame members, said pivotal connections of said shoe members to said first links permitting said shoe members to pivot so that said outer ends are in engagement when said piston rod is in its retracted position.

19. The apparatus of claim 18 wherein said outer ends of said shoe members when so engaged define a point adapted for insertion in the end of a deformed roll of sheet material

thereby to spread the same upon extension of said piston rod, and further comprising means attached to said cylinder adapted to be impacted thereby to drive said point into said roll end.

20. The apparatus of claim 1 further comprising a pair of foot members respectively attached to said other ends of said frame members, said foot members respectively having flat portions projecting longitudinally forwardly from said other ends, said foot portions being transversely spaced apart and lying in a common plane spaced laterally outwardly in one direction from said frame members, the respective one of said elements having a flat toe portion projecting longitudinally forwardly therefrom, said toe portion being disposed between said foot portions and lying in said plane when said piston rod is in said retracted position whereby extension of said piston rod causes said toe portion to move laterally outwardly in said one direction away from said plane and foot portions.

21. The apparatus of claim 1 wherein each of said elements comprises a longitudinally elongated arm having opposite ends, a first end of each of said arms being inwardly curved and engaging said frame members, the other end of each of said arms projecting forwardly of said other ends of said frame members, and further comprising spring means for biasing said first ends of said arms into engagement with said frame members, and a pair of clamping elements respectively pivotally connected to said other ends of said arms whereby extension of said piston rod causes lateral separation of said clamping elements and retraction of said piston rod causes lateral movement of said clamping elements toward each other thereby to clamp an article therebetween.

22. Apparatus for exerting force in lateral directions with

respect to a longitudinal axis comprising a pair of force-exerting elements respectively on opposite sides of said axis and movable laterally outwardly away from and inwardly toward said axis, a toggle having first and second pairs of links, first means for pivotally connecting each pair of links to a respective element, a linear power actuator having a fixed member carrying a reciprocable rod member coaxial with said axis and longitudinally movable between retracted and extended positions, second means for pivotally connecting one link of each pair to said rod member, third means for pivotally interconnecting the other links of each pair at a point on said axis spaced forwardly of said rod member when the same is in its extended position, and fourth means rigidly connecting said third means to said fixed member whereby movement of said rod member toward said extended position thereof causes said toggle simultaneously to move said elements laterally outwardly in opposite directions away from said axis and movement of said rod member toward its retracted position causes said toggle simultaneously to move said elements laterally inwardly toward said axis.

23. The apparatus of claim 22 wherein said fourth means comprises a frame secured to said fixed member and extending longitudinally forwardly therefrom, said third means pivotally connecting said other links to said frame.

24. The apparatus of claim 23 wherein said frame includes a pair of elongated, transversely spaced portion extending longitudinally forwardly from said fixed member on opposite sides of said rod member in spaced, parallel relationship therewith.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,635,440

Dated January 18, 1972

Inventor(s) James J. VanGompel

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE SPECIFICATION

Column 5, line 34, change "with" to --within--

Column 6, line 50, change "20-2" to --respectively--

IN THE CLAIMS

Claim 24, line 26, column 14, change "portion" to --portions--

Signed and sealed this 29th day of August 1972.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents