Nov. 6, 1962 E. J. DE RIDDER ETAL 3,062,264

METHOD FOR STRAIGHTENING METALLIC EXTRUSIONS

Original Filed July 12, 1955 9 Sheets-Sheet 1

Fig. 1

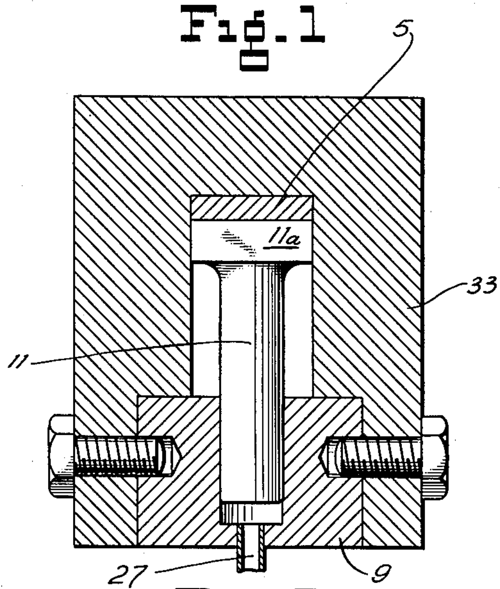

Fig. 2

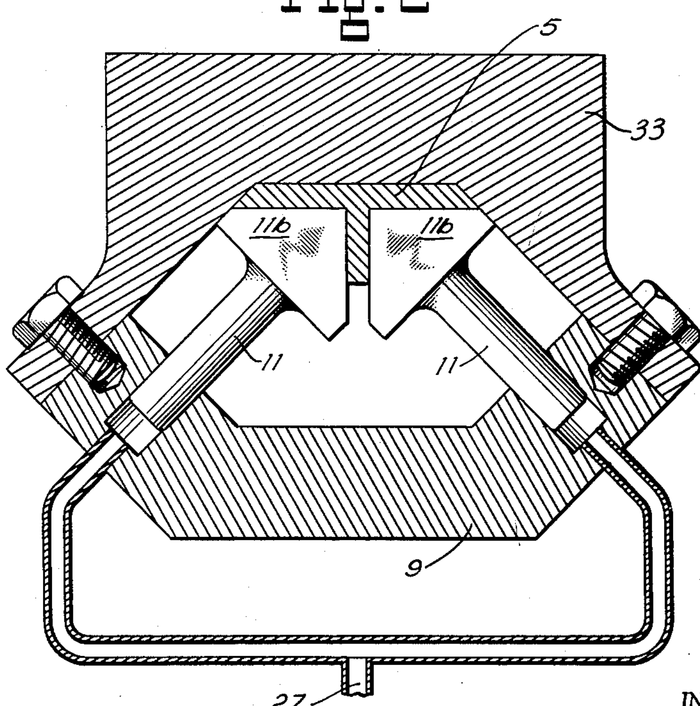

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Fig. 3

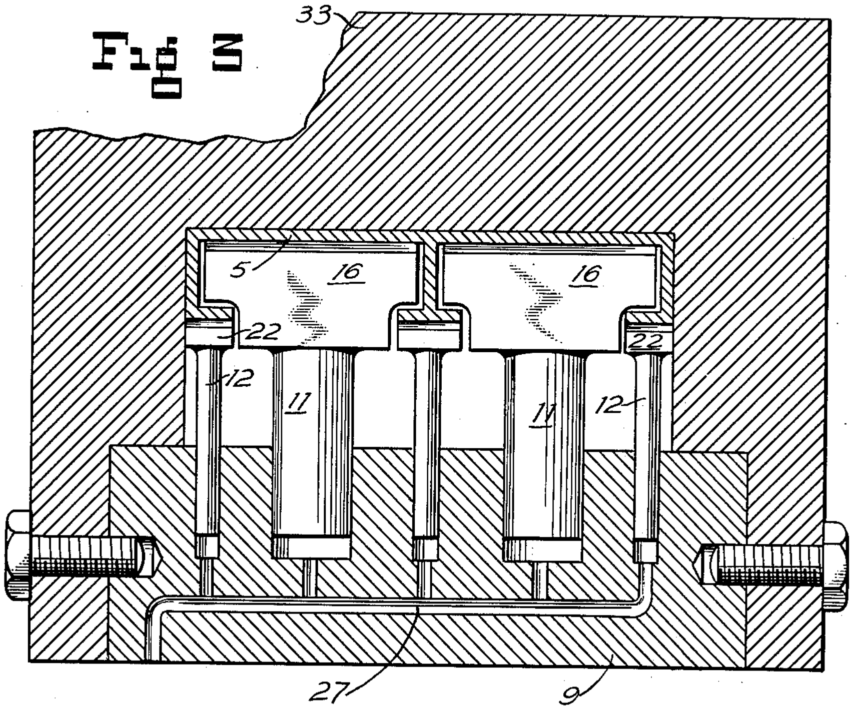

Fig. 25

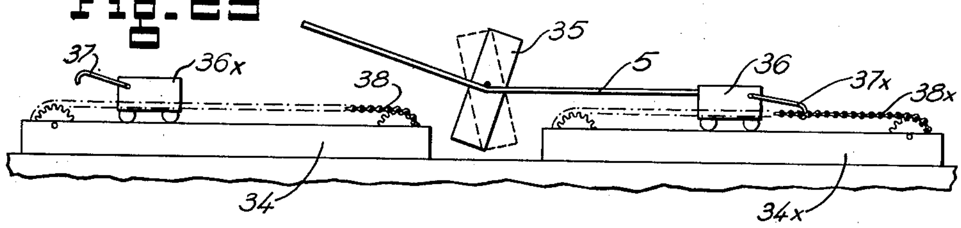

Fig. 26

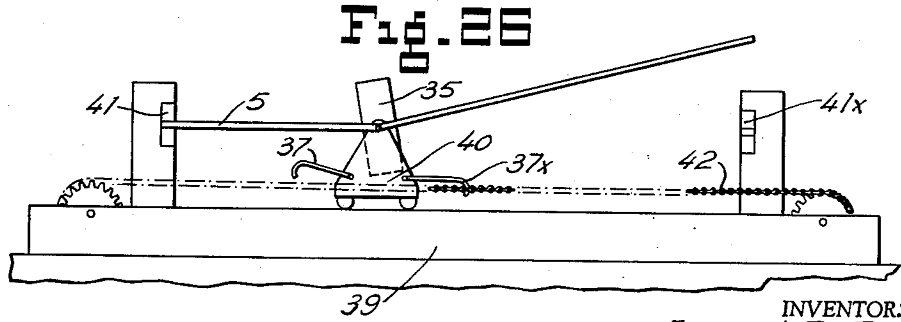

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Fig. 5

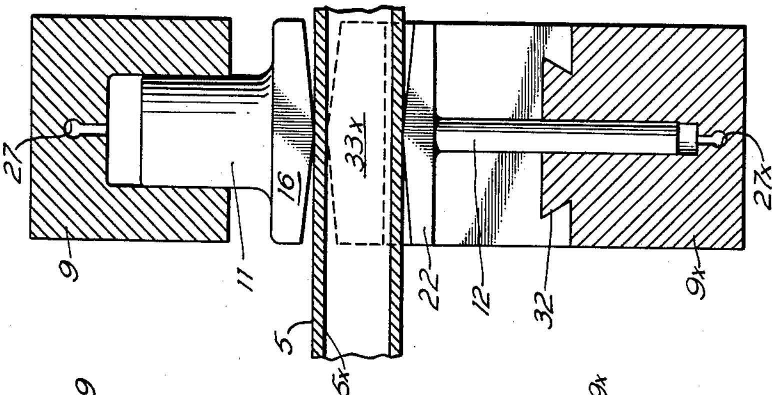

Fig. 4

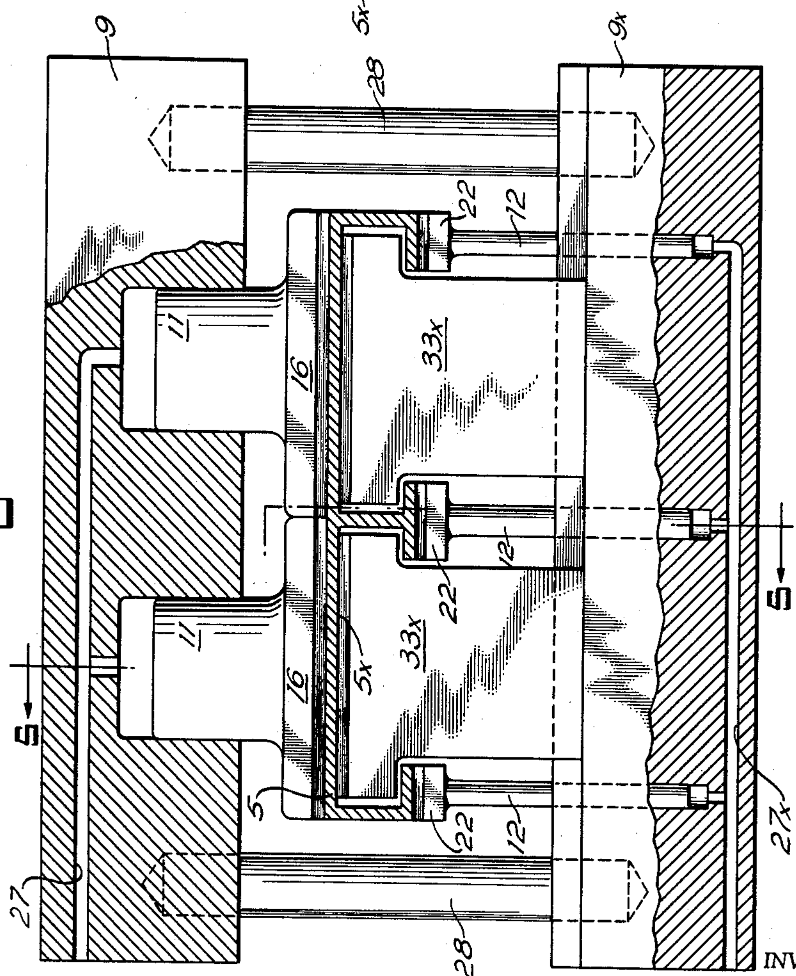

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Fig. 6

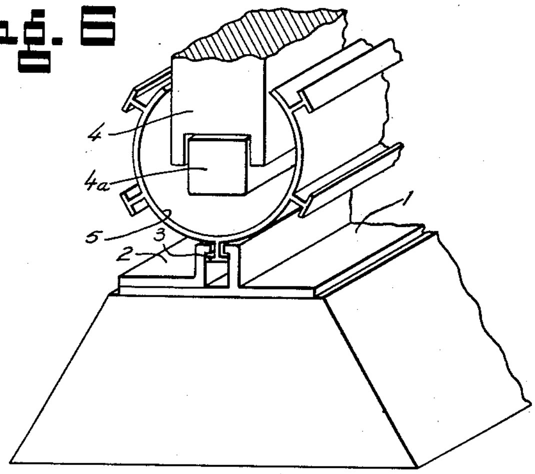


Fig. 7

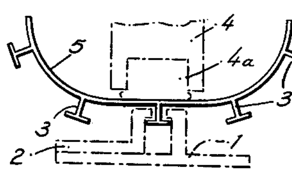


Fig. 8

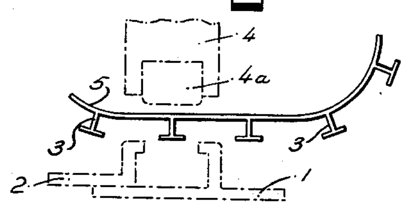


Fig. 9

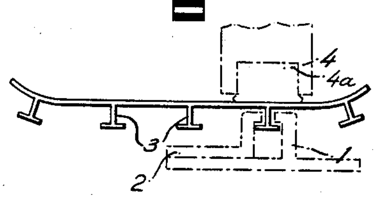


Fig. 10

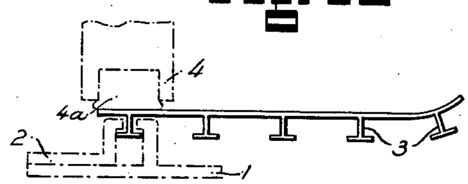
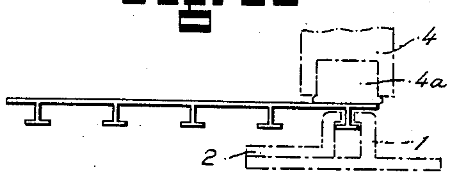


Fig. 11



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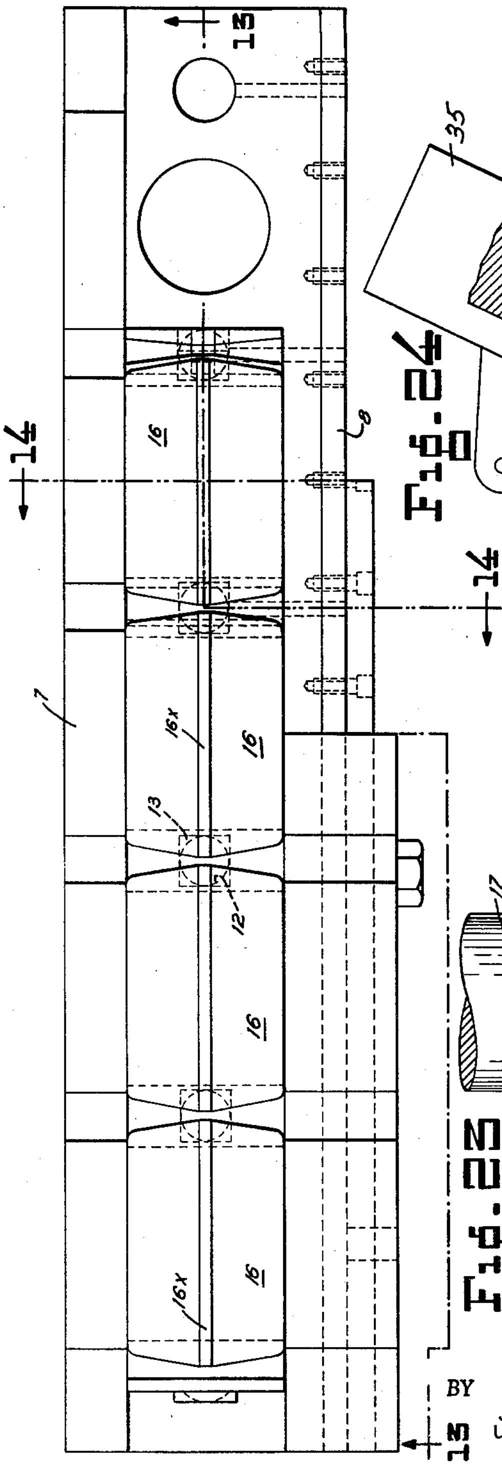

Fig. 12

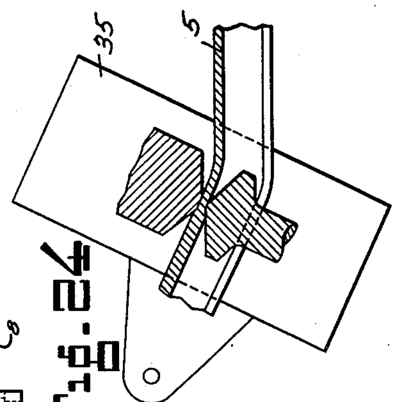

Fig. 24

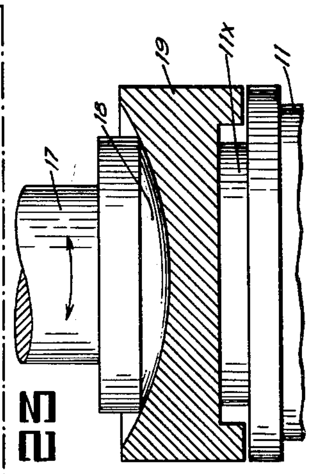

Fig. 23

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Fig. 12

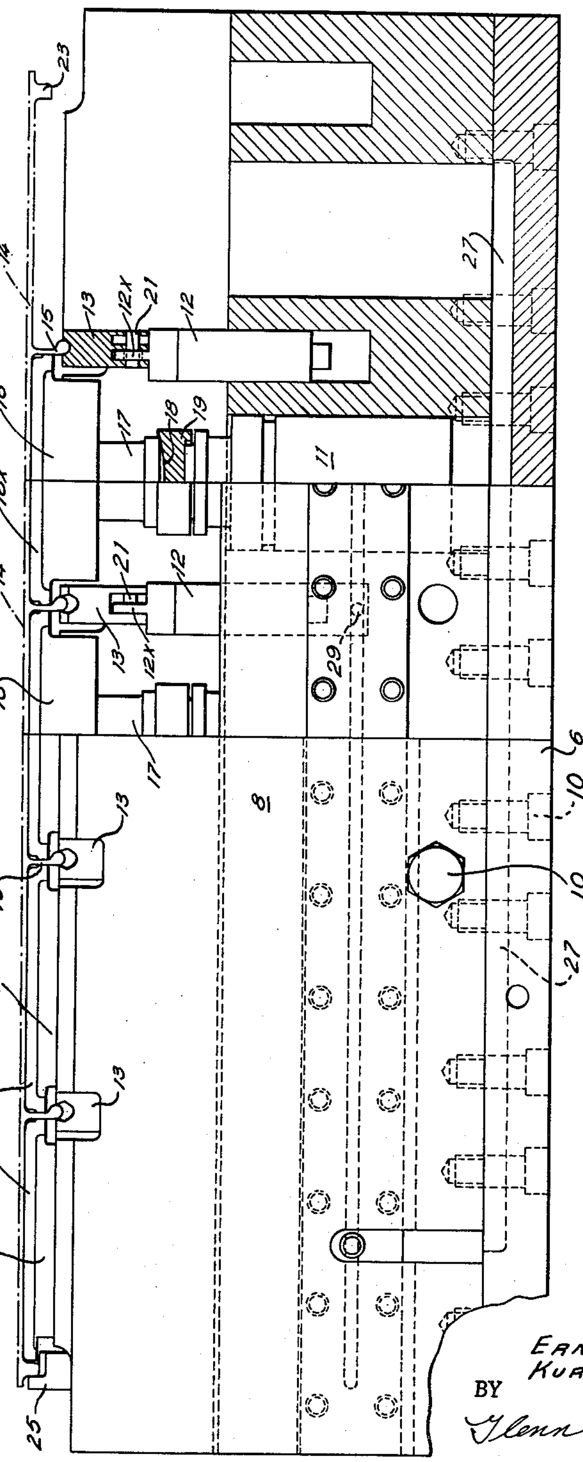

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Fig. 14

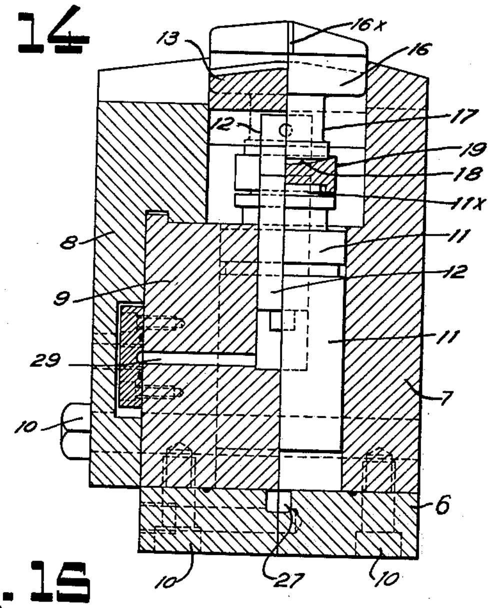

Fig. 15

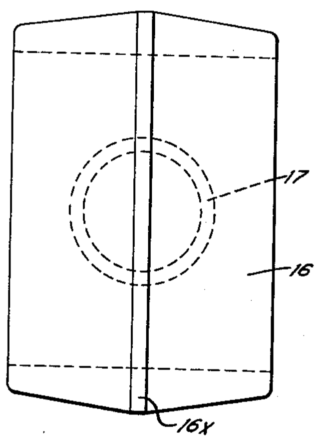

Fig. 17

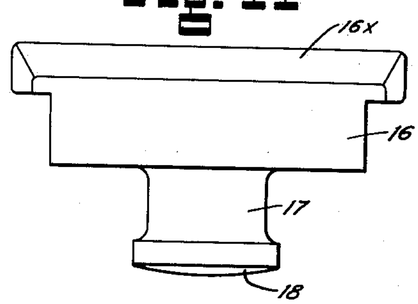

Fig. 18

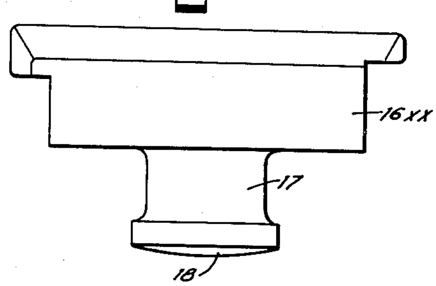

Fig. 16

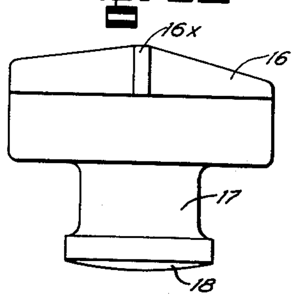

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Fig. 19

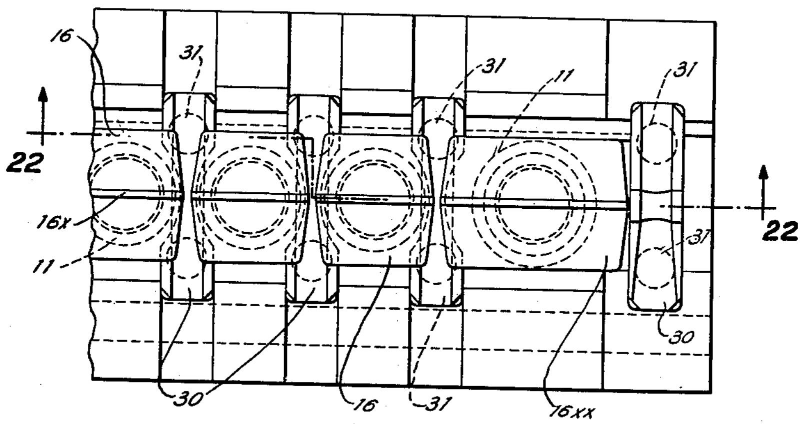
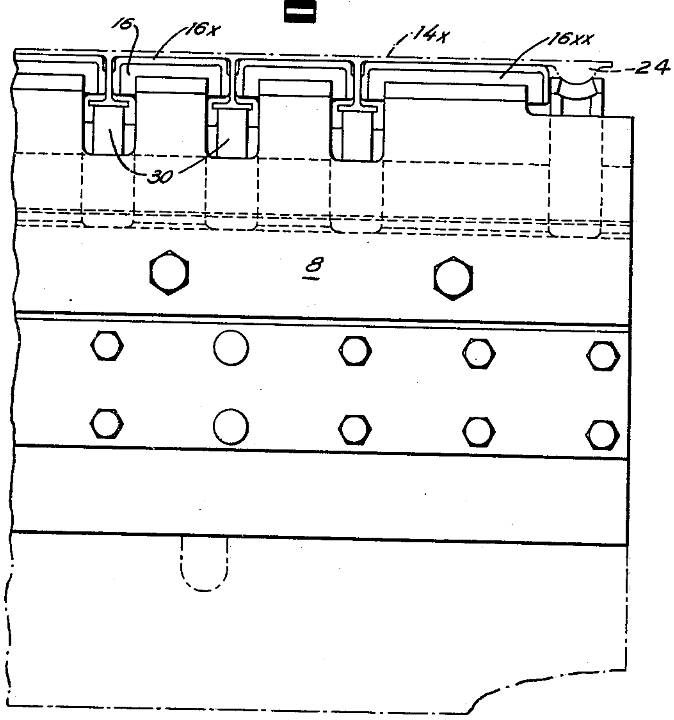


Fig. 20



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METHOD FOR STRAIGHTENING METALLIC EXTRUSIONS

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Fig. 21

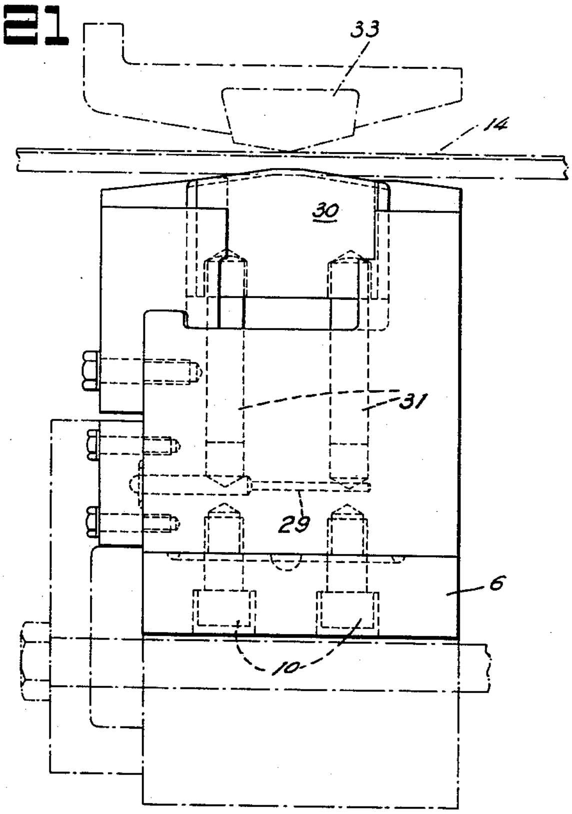
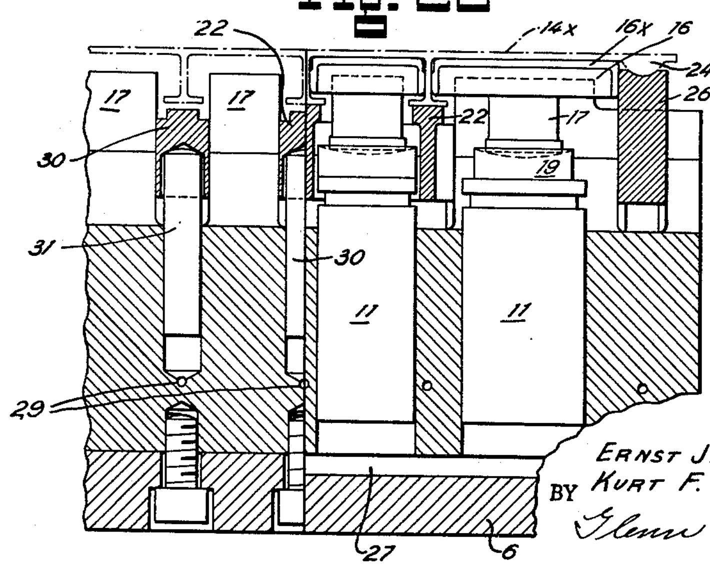


Fig. 22



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United States Patent Office

3,062,264

Patented Nov. 6, 1962

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3,062,264
METHOD FOR STRAIGHTENING METALLIC EXTRUSIONS

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Original application July 12, 1955, Ser. No. 521,557. Divided and this application Aug. 3, 1959, Ser. No. 831,409

14 Claims. (Cl. 153—32)

The present invention relates to a method and apparatus for producing untapered and/or tapered extrusions of many shape configurations straightened to very close tolerances in one or several draw operations.

This application is a division of our copending application, Serial No. 521,557, filed July 12, 1955 and now abandoned.

To straighten an untapered extrusion by drawing it through a draw die has been common practice for many years. In a steel disc an opening is cut which corresponds very correctly to the cross section of the extrusion and the shape is pulled through this die for straightening purposes.

This method cannot be used if the extrusion is tapered having a thick wall thickness at one end and a thin one at the opposite end. It also cannot be used on wide extrusions having thin wall thicknesses and complex shape configurations since such rigid draw dies do not provide flexibility for variations in wall thicknesses caused by tolerances which are inevitable in the extrusion process. A characteristic of our method and apparatus is that each extrusion is longitudinally, and if necessary, repeatedly drawn through a specially formed hydraulic straightening die, in which movable die parts are mounted for varying the die opening according to wall thickness variations of the extrusion.

The apparatus and general method will be described with reference to the accompanying drawings, in which:

FIGURE 1 is a sectional view of a hydraulic die embodying the invention, for straightening a simple rectangular extrusion;

FIGURE 2 is a sectional view of a hydraulic die of the invention for straightening an extrusion in the form of a T section;

FIGURE 3 is a sectional view of a hydraulic die of the invention for straightening a wide integrally stiffened extrusion;

FIGURE 4 is a sectional view illustrating a modification of the hydraulic die for the extrusion shown in FIGURE 3;

FIGURE 5 is a cross section taken on line 5—5 of FIGURE 4;

FIGURE 6 is a schematic fragmentary perspective view showing a split tubular extrusion set up in a break-press, diagrammatically shown, for the first step of preliminary flattening of an integrally stiffened extrusion;

FIGURES 7 to 11, inclusive, are diagrammatic views showing the five pressure strokes and four position changes employed in the preliminary flattening of the extrusion of FIGURE 6;

FIGURE 12 is a plan view of our hydraulic die for straightening an integrally stiffened extrusion, and embodying the movable core members, the upper pressure shoe not being shown;

FIGURE 13 is a view taken on line 13—13 of FIGURE 12, a stiffened sheet undergoing straightening being shown, partly in dot and dash line at the top of the figure;

FIGURE 14 is a vertical section taken on the line 14—14, FIGURE 12;

FIGURE 15 is a plan view of one of the steel cores;

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FIGURE 16 is an end view of the core shown in FIGURE 15;

FIGURE 17 is a view in elevation showing the side of a steel core in the center or inner areas of our hydraulic die;

FIGURE 18 is a view similar to FIGURE 17 showing the form of steel core adapted for end positions of our hydraulic die;

FIGURE 19 is a plan view, partly broken away, showing an end area of our hydraulic die adapted for supporting elements of T-shape;

FIGURE 20 is a view in front elevation of the structure shown in FIGURE 19, part of a stiffened sheet with T-stiffening members being shown in position, and partly by dot and dash lines;

FIGURE 21 is a side elevation, partly in dot and dash lines showing the structure of FIGURES 19 and 20, with an overhead pressure shoe member in position;

FIGURE 22 is a longitudinal vertical section taken on the line 22—22, FIGURE 19, with a stiffened sheet, shown in dotted lines in position;

FIGURE 23 is an enlarged view in elevation, partly in section, showing members 11, 17, 18 and 19, the latter being in section;

FIGURE 24 is a schematic sectional view showing the mounting of the frame which holds all of the die elements, including the uppermost pressure head, for movement in inclined positions relatively to the stiffened sheet with the effect that the draw bench in any stretch of the planar element of the sheet will correspondingly stretch the headed stiffening elements;

FIGURE 25 is a schematic view of a double draw bench; and

FIGURE 26 is a schematic view of a double acting single draw bench.

Referring to the drawings, FIGURES 1–5 illustrate suitable apparatus embodying the present invention, and designed for straightening several types of metallic extrusions.

In FIGURE 1, a hydraulic die for straightening a simple rectangular extrusion is shown. This die comprises a main frame 33 which also serves as the upper die part. Bolted within frame 33 and at the bottom thereof is a cylinder block 9. Block 9 bears a cylinder in which is disposed a movable piston 11 having at its upper end the lower die part 11*a*. A port 27 is provided for the admission of hydraulic fluid to the cylinder. The rectangular metallic extrusion to be straightened by the die of FIGURE 1 is shown at 5.

Referring to FIGURE 2, there is shown a hydraulic die for straightening an extrusion in the form of a T section. In this die, cylinder block 9 bolted to the main frame 33 contains two cylinders, each bearing a piston 11. Each of pistons 11 provides at its upper end an angular lower die part 11*b* adapted to abut the two inner intersecting surfaces on one side of the T section 5. A suitable hydraulic system admits hydraulic fluid to the cylinders.

The hydraulic die of FIGURE 3 is designed for straightening a wide integrally stiffened extrusion. Here again, a frame 33 forming an upper die part has bolted therein a cylinder block 9. Cylinders are provided in block 9 for pistons 11 bearing the lower die pieces or cores 16, and also for pistons 12 which provide pressure heads 22 for supporting the leg portions of the extrusion. The two pairs of pistons are operated by hydraulic system 27.

Referring to FIGURES 4 and 5, a modification of the hydraulic die of FIGURE 3 is shown, particularly adapted for straightening extrusion 5 along its base line 5*x*. Here, the movable die parts 16 carried by pistons 11 press against the upper surface of the extrusion, the latter being supported on two base portions **33**_x_, which are vertically immovable. These latter base portions, however, may slide laterally of the direction of draw through the die, due to the dovetail construction at **32**. Cylinder blocks **9** and **9**_x_, bolted together by bolts **28**, are provided respectively for the piston members **11** and **12**. Two independent hydraulic systems, **27** and **27**_x_ operate the pistons.

Referring to FIGURES 6 to 11, a method of preliminarily flattening the integrally stiffened extrusion of the type shown in FIGURES 3–5 is illustrated. This method employs a break-press (FIGURE 6), which is as long as the length of the extrusion. This press comprises two movable sections **1** and **2**, which are adapted to engage the legs of the extrusion as shown in FIGURES 7–11. Fixed to the upper member **4** of the press is a strip of rubber indicated at **4**_a_. The extrusion **5** is placed in the press as shown in FIGURE 6, and is straightened in a succession of steps as indicated in FIGURES 7–11.

Referring to FIGURES 12, 13 and 14, there is provided what may be termed a cylinder block formed by a base member **6**, a vertical wall member **7**, an opposed and spaced vertical wall member **8**, and an internal block **9**, bolted together by the screws or bolts **10**.

The internal walls of members **7**, **8** and **9** are shaped so as to provide a set of cylinders to receive pistons **11** for acting upon the steel cores later to be described, and intermediate and smaller cylinders which receive pistons **12** which act upon pressure heads **13** for the stiffening legs of the extrusion. In FIGURE 13 one of the extrusions is shown in dot and dash lines at **14**, and the ends of the stiffening legs **15** are of the "bulb" type.

Each steel core is preferably formed with a wall which tapers at both sides of a flattened apex, and in FIGURES 15 and 16 the steel core is indicated at **16**, and its contact apex at **16**_x_. Depending from the core head is a rounded shank **17** having a convex base at **18**.

As shown in FIGURE 13, the convex base of each steel core rests in the concave top seat of an annular steel block **19** supported upon the upper end of a piston **11** for limited transverse movement. As will be seen from FIGURES 14 and 23, block **19** is formed with a recess which receives the head **11**_x_ of the piston **11**. The recess of the block **19** is formed with straight sides to conform with the sides of the head but is wider at two of its opposed sides to permit limited shift of block **19** transversely of the walls **7** and **8** of the assembly.

Between the steel cores **16** are positioned the pressure heads **13** for the legs of the stiffened extrusion **14**. Each pressure head **13** is supported upon the top of its appropriate piston **12** and may be detachably connected to the latter. In the form shown in FIGURE 13 an apertured lug **12**_x_ projects into a slot formed in the head **13**, a pin **21** holding the elements together. In the form shown in FIGURE 22 the pressure head is formed with two base recesses which receive two pistons. (See also **30** in FIGURE 19.) Either expedient may be employed, as desired.

It will be seen from FIGURE 13 that the pressure heads **13** have top recesses conforming with the bulb tips of the stiffened sheet legs **15**, whereas the pressure heads **22** of FIGURE 22 lack such recesses at their tops to conform with the T-legs of the stiffened sheet **14**_x_.

In some cases it may be desirable to employ an elongated pressure head for the stiffened sheet leg intermediate each pair of steel cores, and in FIGURES 19 and 20, each elongated pressure head **30** is acted upon by two pistons in cylinders indicated by dotted lines at **31**, FIGURES 19 and 21.

Inasmuch as the stiffened sheets may, at their sides in some cases, lack legs of the type shown in FIGURE 13 or the type shown in FIGURE 22, but may have merely the short bar-like leg **23** of FIGURE 13, or the rounded reinforcing member **24** of FIGURES 20 and 22, the pressure heads at the ends of the die assembly may have their tops correspondingly formed as indicated at **25**, left-hand end of FIGURE 13, or **26**, right-hand end of FIGURE 22. In such cases, the steel cores may be somewhat modified as shown in FIGURE 18 at **16**_xx_.

For admitting hydraulic pressures to each of the pistons **11** for the appropriate steel cores, the die wall assembly is formed with suitable ports leading to the base of each cylinder which encloses a piston **11**, one of said ports being shown at **27**, FIGURE 13, and similar ports are provided for the cylinders in which the smaller pistons **12** are actuated, as indicated for example at **29**, FIGURES 13 and 14, and in FIGURE 22.

Shown in FIGURE 25 is a schematic view of a double draw bench comprising draw benches **34** and **34**_x_. **35** is the hydraulic die which can be tilted, while **36** and **36**_x_ are the carriers for extrusion **5**. These carriers are connected by hooks **37** and **37**_x_, respectively, to pulling chains **38** and **38**_x_.

Referring to FIGURE 26, a schematic view of a double acting single draw bench **39** is shown. Die **35** is mounted on carrier **40**. Extrusion **5** is held by clamping devices **41** and **41**_x_, only one clamp being in action at a time. Here again, hooks **37** and **37**_x_ are provided, connecting the die carrier **40** to the pulling chain **42**, and only one hook is in action at a time.

In the operation of our draw die, a stiffened sheet **5** is placed in position relatively to the steel cores **16** and pressure head **33**, as indicated in the drawings. The front end of the sheet is gripped by clamps (not shown) of draw-bench carriage **36**, as illustrated in FIGURE 25, and the stiffened sheet is repeatedly drawn through the die in reversing cycles. By using a draw-bench carriage at opposite ends of the stiffened sheet with the usual draw-bench operating members including chains, the stiffened sheet may be drawn back and forth, as will be understood without further explanation.

Since in such operation, with the stiffened sheet **5** being pulled in a straight line, only the top portion of the extrusion is straightened, the legs and formed ends of the stiffened extrusion will not be stretched, and this will cause a longitudinal bow in the sheet. To avoid this bow, the die **35** may be set at an adjustable angle to the direction of draw, as indicated in FIGURE 24, schematically. In that figure, the angle is acute, and beyond that actually required, and for the purposes of illustration only. By means of such angles, the legs of the stiffened sheet are stretched.

By means of hydraulic pressure, the steel cores are pressed against the undersurface of the web or top portion of the extrusion, and therefore against the top die piece 33, FIGURES 21 and 24. The pressure heads which act upon the bottoms of the legs may be given a less hydraulic pressure than that exerted by the steel cores, and their action is to prevent lines of depression in the top of the extrusion which might occur between the steel cores in the absence of the said pressure head.

The steel cores have a somewhat lesser width than the spacing between the legs of the stiffened sheet, and the base of each steel core is enabled to shift angularly because of its concave base and the convex seat provided therefor in the steel block **19**, FIGURE 23, as is shown greatly exaggerated in FIGURE 24. Also the steel block may shift bodily with the steel core and relatively to the head **11**_x_ of the piston **11**. Thus irregularities at the under face of the stiffened sheet and in the sides of the legs thereof will not cause shearing action by the steel cores, but rather they will have an ironing and somewhat kneading action at areas of irregularity, the top portion of the extrusion being straightened within close tolerances.

The hydraulic die of our invention has special application for stretching tapered extrusions. Extrusions need to be straightened after formation and this can be done with apparatus embodying this invention. Thereafter, extrusions usually need to be heat-treated to eliminate non-uniform residual stresses. Such heat treatment, however, frequently distorts the extrusion to such an extent that it needs to be stretched to straighten the same. Tapered extrusions cannot be stretched in the dies of the prior art because the cross sectional area of the thin end of the extrusion is too small to permit sufficient stress for stretching the portions of thicker cross-sectional area. When using the hydraulic die of our invention, however, this problem is overcome. While pulling the extrusion through the die, the local stretching effect shifts progressively along the length of the extrusion, as is shown greatly exaggerated in FIGURE 24. The thick end of the tapered extrusion is pulled first through the die, the hydraulic pressure is decreased according to the decreasing cross-sectional area of the extrusion, and the danger of overstressing at the thin end of the extrusion is eliminated.

We claim:

1. A method for straightening a metallic extrusion, comprising drawing a portion of said extrusion between opposed rigid parts of a draw die, applying hydraulic pressure during the draw to at least one part of said die to yieldably force said part generally perpendicularly against said extrusion portion, and maintaining the die surfaces engaged at an acute angle with said extrusion portion to the direction of the draw and thereby stretching other selected portions of the extrusion.

2. A method for straightening and stretching a metallic extrusion which is tapered in thickness in the longitudinal direction, comprising drawing said extrusion through a draw die, applying hydraulic pressure to at least one part of said die, to yieldably force said part into pressing contact with the extrusion and produce a clamping action sufficient to stretch the extrusion during the draw, and varying the hydraulic pressure during the draw in accordance wtih the thickness and metallurgical properties of the extrusion.

3. A method for straightening a metallic extrusion, comprising drawing said extrusion through a draw die while applying hydraulic pressure to a part of said die to yieldably force said part into pressing contact with an area of the extrusion, heat treating said extrusion to eliminate non-uniform residual stresses, and again drawing said extrusion through said draw die, thereby eliminating distortions caused by the heat treatment.

4. A method for straightening an integrally stiffened curvilinear extrusion, comprising preflattening said extrusion, drawing the preflattened shape through a draw die, and applying hydraulic pressure to a part of said die to yieldably force said part into pressing contact with an area of the extrusion.

5. A method for stretching a longitudinally tapered extrusion, comprising drawing said extrusion in a single direction, thick end first, applying hydraulic pressure to at least one part of said die to yieldably force said part into pressing contact with the extrusion and produce a clamping action sufficient to stretch the extrusion during the draw, and decreasing the hydraulic pressure according to the decreasing cross-sectional area of the extrusion.

6. The method of straightening a sheet-like metallic extrusion, the steps comprising: effecting relative drawing movement between the extrusion and a draw die having opposed rigid surfaces engaged with the opposite faces of the extrusion, the die surfaces engaged with one face of the extrusion being divided, transversely of the direction of the relative movement, into a plurality of separate and independent parts; and yieldably maintaining each part independently of the others in straightening engagement with the extrusion by fluid pressure.

7. The method defined in claim 6 including the step of supporting each die part for rocking movement about an axis extending parallel to the direction of the relative movement.

8. The method of straightening a sheet-like metallic extrusion having a plurality of parallel integral stiffening flanges on one side thereof comprising: effecting relative drawing movement, in the direction of the flanges between the extrusion and a draw die having rigid opposed surfaces engaged with the opposite faces of the extrusion, while tilting the die in the direction of said relative drawing movement to effect a bend in the extrusion at its areas of engagement with the die in order to stretch the flanges sufficiently to compensate for any stretch in the sheet-like portions of the extrusion effected by the drawing action of the die thereon.

9. The method of straightening a sheet-like metallic extrusion having a plurality of parallel integral stiffening flanges on one side thereof, the steps comprising: effecting relative drawing movement, in the direction of the flanges, between the extrusion and a draw die having separate rigid surfaces engaged with the edges of the flanges and opposed rigid surfaces engaged with the opposite faces of the extrusion, the die surface engaged with one of the faces being divided, transversely of the direction of said drawing movement, into a plurality of separate and independent parts; and yieldably and independently maintaining each separate surface and each part in straightening engagement with the extrusion by fluid pressure.

10. The method defined in claim 9 in which the pressure maintained on the separate surfaces is less than that maintained on the parts.

11. The method defined in claim 9 including the step of supporting each part for rocking movement about an axis extending parallel to the direction of the drawing movement.

12. The method defined in claim 9 in which the die surface engaged with the flanged face of the extrusion is divided into a plurality of parts separated by the flanges, and including the step of supporting each separated part for limited movement transversely of the direction of the drawing movement.

13. The method defined in claim 12 including the additional step of supporting each separated part for rocking movement about an axis extending parallel to the direction of the drawing movement.

14. The method of straightening and stretching a metallic extrusion tapered in the direction of its formation, the steps comprising: effecting relative drawing movement between the extrusion, in the direction of its taper, and a draw die while yieldably maintaining a part of the die in straightening engagement with the extrusion by fluid pressure which effects a clamping action sufficient to stretch the extrusion during the draw; and varying the fluid pressure during the movement in accordance with the variation in thickness of the extrusion.

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