United States Patent

Marsch

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[54] **MACHINE AND METHOD FOR MAKING PULLEY GROOVES OR THE LIKE**

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[52] **U.S. Cl.** .....**72/58,** 72/61, 29/159 R

[51] **Int. Cl.**.....**B21d 26/04**

[58] **Field of Search**.....72/57, 58, 59, 60, 61, 62; 29/159

[56] **References Cited**

UNITED STATES PATENTS

2,743,691	5/1956	Cuq	29/421
2,006,691	7/1935	Giesler	72/58
2,919,740	1/1960	Poitras	72/59
2,929,345	3/1960	Zatyko, Sr.	72/58

FOREIGN PATENTS OR APPLICATIONS

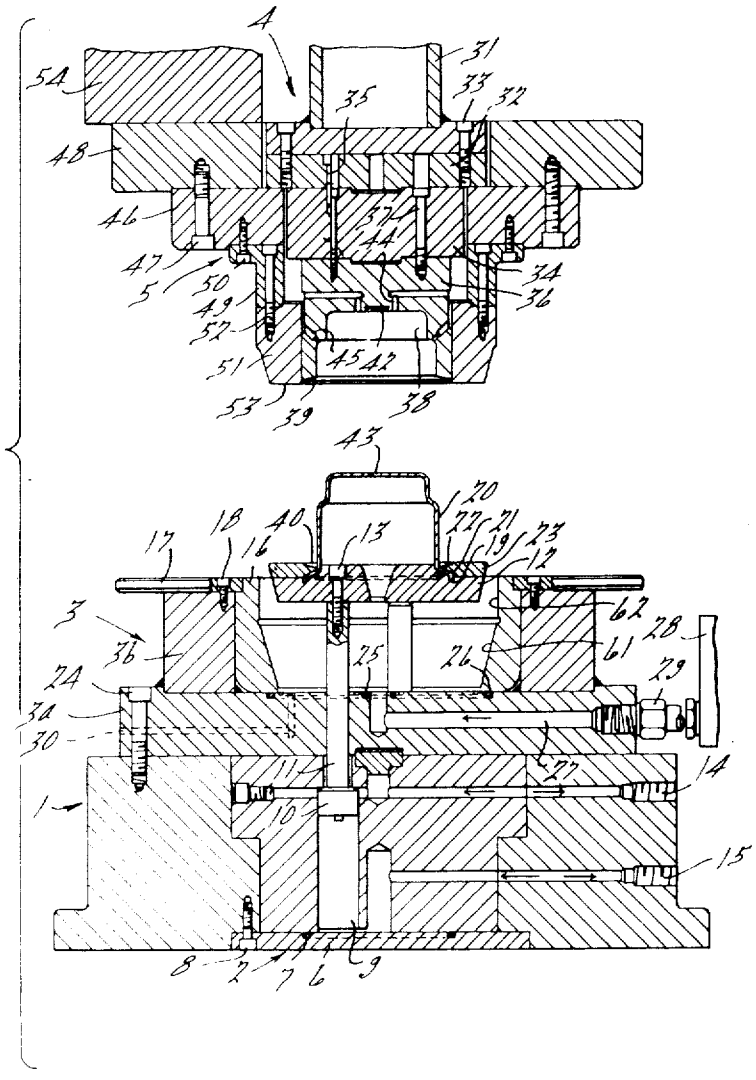
1,167,094	10/1969	Great Britain	72/57

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[57] **ABSTRACT**

Pulley grooves are formed in a cylindrical wall by a machine and method wherein mechanical force in an axial direction along with outwardly directed hydraulic pressure are applied to the wall to deform it into the desired radial groove shape.

7 Claims, 3 Drawing Figures



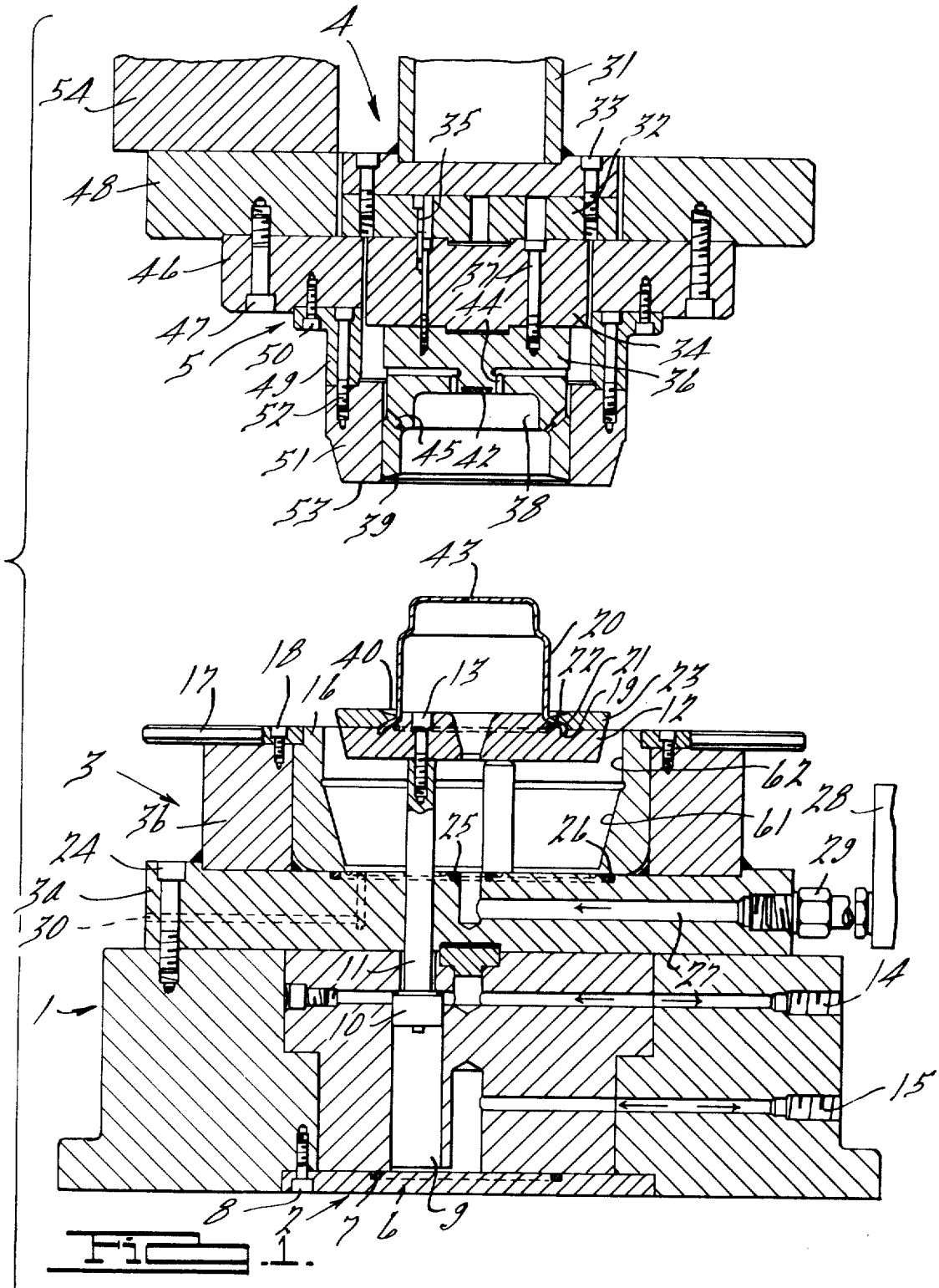
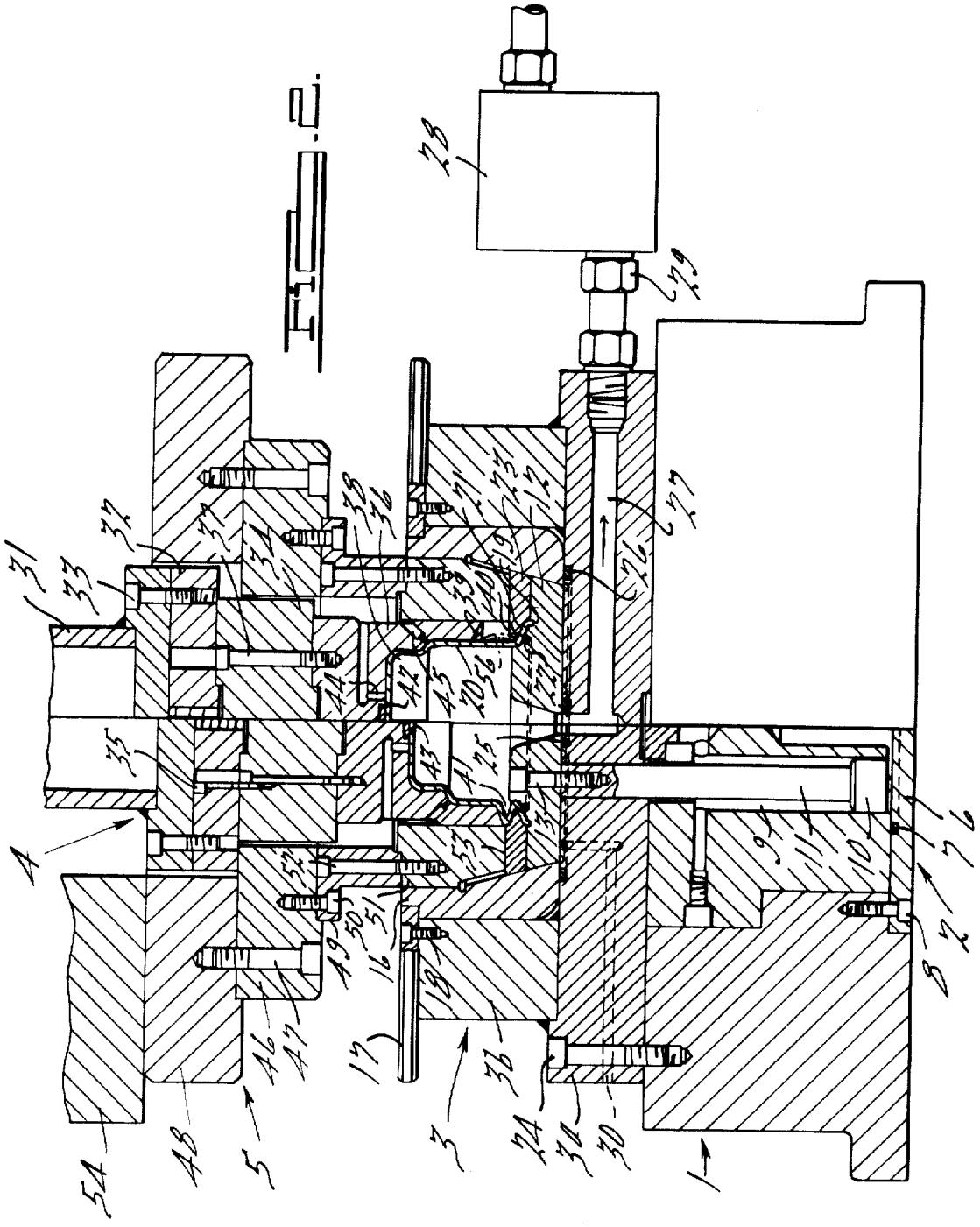
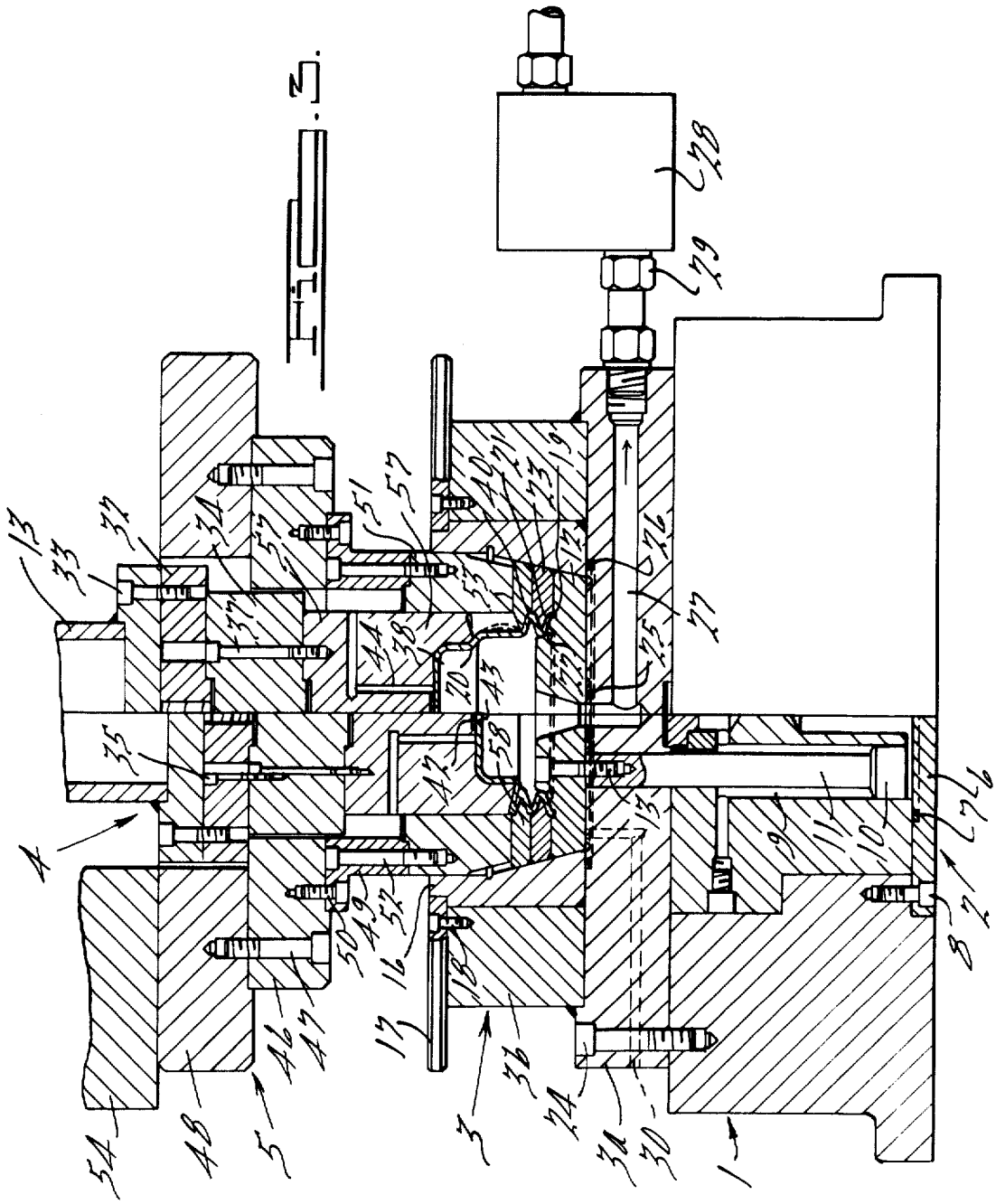

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Fig. 1.





MACHINE AND METHOD FOR MAKING PULLEY GROOVES OR THE LIKE

RELATED APPLICATION

This application is based on West German Pat. application, Ser. No. P 19 25 686.1, filed May 20, 1969. Priority is claimed.

BRIEF SUMMARY OF THE INVENTION

It is the purpose of the invention to simplify and improve the techniques for forming radially extending flanges in cylindrical walls, such as pulley grooves in deep drawn sheet steel pulley constructions. The invention accomplishes this purpose by means of a method and machine in which the hollow cylindrical part to be deformed is supported and held while an axial force is applied to upset a portion of the cylindrical wall of the part so that it deforms outwardly in a radial direction. During the application of axial force internal hydraulic pressure is applied to assist in the deformation and shaping of the upset portion into the desired contour.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional view, partly broken away, of a machine embodying the invention showing the workpiece in clamped position prior to deformation;

FIG. 2 is a dual cross sectional view of the structure of FIG. 1 showing in the right half the initial forming position of the parts and in the left half the final forming position of the parts; and

FIG. 3 is a view similar to FIG. 2 showing the machine modified so that it can form two pulley grooves.

DESCRIPTION OF THE INVENTION

Subsequent processing of mechanically or hydraulically produced, deep drawn hollow sheet steel bodies, such as single-groove or multi-groove belt pulleys, has hitherto been feasible primarily by mechanical means in one or in several operations. In these mechanical processes of subsequent forming the cold forming operations on the surfaces of workpieces will lead to increased resistance because of compression of the material, which in turn may cause hairline cracks within the structure during subsequent processing, and permanent cracking at a later time.

It is therefore an object of this invention to avoid the existing drawbacks and risks inherent in the conventional methods by having the subsequent processing carried out in one single operation including hydraulic means. This problem is solved according to a preferred form of this invention, as follows: the open rim of the hollow body is superimposed on a plate corresponding to the shape of said rim and equipped with a centering device and a seal for said hollow body; then a split form ring is placed upon the lower part of said rim, and pressed against the centering plate and seal by a holding down device disposed concentrically with the hollow body; hydraulic fluid is then fed through the centering plate into the inside of the hollow body, the air present in said hollow body being purged from the same by a centered opening in the bottom of the hollow body. A forming die is superimposed on the hollow body, the lower part of which die envelops said hollow body and is shaped to the desired form, the air vent being sealed off. The further lowering of the die punch causes the hollow body to become shortened by upsetting; the increasing hydraulic pressure displacing exposed areas of the hollow body, from the inside to the outside, into the adjacent cavities of the die created during the downward movement of the press-die punch. The excess quantity of hydraulic fluid is carried back by a controlled pressure valve.

In a mechanical forming process from the inside to the outside a weakening of wall thicknesses may occur. However, the present method of subsequent forming from the inside to the outside does not result in any material modification of wall thicknesses because of the continued flow of those parts of the material of the hollow body that have not been subsequently formed.

The machine used in working out this method includes preferably a base plate with the elements of an ejector, the elements of the lower tool parts, those of the upper tool parts, and the holding down device. The ejector may be mounted into the base plate and may have three cylinder bores with pistons guided within the same, which pistons are connected to ejector rods on the free ends of which the centering plate is mounted. It is preferred to have the centering ring set into the lower tool part permanently connected with the base plate, and to hold the same in position by means of the cover plate. It is further preferred that the centering plate be equipped with a centering notch to receive the lower rim of the hollow body, the centering plate to be shaped corresponding to said lower rim of the hollow body. Furthermore a sealing ring may be lodged between the lower rim of the hollow body and the centering plate, whereas the divided form ring is concentrically superimposed upon the lower rim of the hollow body. It is also preferred to have the lower part of the inner enveloping surface of the centering ring cone shaped and the upper part of the same cylinder shaped; the centering plate and the forming ring with correspondingly conical outer surface to fit without play into the lower, cone shaped part of the centering ring.

The lower tool part is preferably represented by the plate and the ring welded pressure-tight on said plate, into which the hardened and ground centering ring is set with a fitting seat; the notches in the plate take up the two concentric sealing rings together with the groove for feeding and returning the hydraulic fluid; the outer end of said groove having a high-pressure control valve thread-connected. For the hydraulic fluid, feed and return grooves may be provided in the cylinder bores over and below the pistons of the ejector unit. It is preferred to have the die punch of the upper tool part guided without play within the guide ring of the holding-down appliance. A seal may be provided in the upper front of the cavity in the die punch, for the pressure-tight sealing of the opening provided in the bottom of the hollow body workpiece when the die punch settles on top of the hollow body after said hollow body has been filled with hydraulic fluid. Also, it is possible to provide drain grooves in the die punch.

The machine embodying the invention includes as major components the base plate **1** with the parts of the ejector **2**, the parts of the lower tool part **3**, the parts of the upper tool **4** and the holding down device **5**. The ejector **2** is set into the base plate **1** with the sealing plate **6** and sealing ring **7** with fixation screws **8** and has three cylinder bores **9** containing the guided pistons **10**. These pistons **10** are connected with ejector rods **11**, the free ends of which have the centering plate **12** fastened to them by the screws **13**. The pistons **10** are hydraulically or pneumatically controlled, by means of the channels **14**, **15** in which the respective flow direction of the control medium (the control valve is not shown in the illustration) is marked by arrows.

In the lower tool part **3**, including the plate **3***a* and the ring **3***b*, permanently united to the plate by pressure-tight welding a hardened and ground centering ring **16** is provided and held in position by the cover plate **17** and screws **18**. The centering plate **12** has a centering slot **19** to receive the lower rim of the workpiece **20**. In addition, the centering plate **12** is shaped to suit the lower rim **21** of the rimmed and cup-shaped, cylindrically walled, hollow body or workpiece **20**. Between the lower rim **21** of the hollow body **20** and the centering plate **12** the packing ring **22** is imbedded. The divided or split form ring **23** is concentrically superimposed upon the lower rim **21** of the hollow body **20**. The lower tool part **3** is solidly fastened to the base plate **1** by the anchoring screws **24**. The lower part **3** also houses the two concentrical packing rings **25**, **26** with the channel **27** for feed and return of the hydraulic fluid. The high-pressure controlled valve **28** is connected to the channel **27** with a thread connection **29**. Finally there is a drain **30** in lower part **3** to dispose of any excess liquid. The upper tool part **4** includes the die punch head **31** connected to a center-

ing plate 32 by means of the screws 33, to which centering plate 32 the intermediary plate 34 is fastened by means of screws 35. The intermediary plate 34 in turn carries the forming die punch 36 fastened by the screws 37. The interior of die punch 36 is suited to the outer shape of hollow body 20 as seen at 38. The lower front 39 of die punch 36 is shaped so as to form the desired cavity 41 as seen in FIG. 2, 3, as soon as the die punch 36 settles in the final position on form ring 23 of lower part 3, the lower front 39 combining with the recess 40 in said form ring 23 to make said cavity. A seal 42 is embedded in the upper front of cavity 38 in die punch 36, to seal off the opening 43 in the bottom of hollow body 20 as soon as die punch 36 settles on hollow body 20. This, too, is shown in FIG. 2, 3. Drain channels 44, 45 are provided in the upper front and enveloping surfaces of die punch 36 through hollow body 20 when die punch 36 goes downwards.

The upper tool part 4 with die punch head 31 and parts 32 through 35, as well as the die punch 36, are guided within the holding down unit 5 comprising several elements. The intermediary ring 46 of the holding down unit 5 is fastened to the head plate 48 by means of the screws 47. The intermediary ring 49 is fastened to the bottom of intermediary ring 46 by means of the screws 50, whereas the guide ring 51 for die punch 36 is fastened to the intermediary ring 49 by means of the screws 52. When the device is in its lowermost position the lower plane front 53 of guide ring 51 settles on the divided form ring 23 as shown in FIG. 2, 3. The pressure power required for axially moving the holding down unit 5 may be obtained by a pressure element 54 with mechanical, hydraulic, or pneumatic control. Suitable power means (not shown) are provided to reciprocate the die punch head 31. All power and pressure fluid means may be synchronized by suitable control means to provide for automatic sequencing and operation after initiation of a work cycle.

The functioning of the machine is the following: In the initial position as shown in FIG. 1, where the upper tool part 4 and the holding down unit 5 are in elevated position, the hollow body 20 may be inserted in centering plate 12, whereupon the divided form ring 23 is added. Then the control valve serving the control medium flowing through grooves 14, 15 is set so that the pistons 10 with ejector rods 11, centering plate 12, hollow body 20 and form ring 23 are set in a downward motion, parts 12 and 23 penetrating with their conical exterior surfaces into the interior of centering ring 16 and centering without play in the cone shaped lower part of said ring, as shown in FIG. 2, 3. Now the pressure fluid is fed into the cavity of hollow body 20 by way of the high-pressure control valve 28 through feed channel 27. After having purged the air through opening 43 in the bottom of hollow body 20 the hydraulic fluid likewise extrudes through said opening 43. Now the holding down unit 5 moves downwards until the lower front 53 of guide ring 51 settles on the surface of form ring 40 at a pressure sufficiently high to prevent the hydraulic fluid from extruding through the seal 22 when the hollow body 20 is subsequently deformed. Then the upper tool part 4 is likewise lowered, die punch 36 enveloping that part of hollow body 20 that is not to be deformed, whereas the deformable part of hollow body 20 and the space 55 needed therefore remain free.

This is the position shown in the right half of the sectional view in FIG. 2. In this position the drain opening 43 in the bottom of hollow body 20 is also sealed off by the joint 42 in the front surface of die punch 36. The residual air and liquid volumes are allowed to escape through channels 44 and 45. Then the entire upper tool part 4 continues its downward motion, upsetting the hollow body 20 and increasing its internal pressure until its free enveloping surface is bulged outwards at 56 into the free cavity 55. The decrease of the interior cavity of the hollow body displaces more fluid than is required for the bulge 56 (shown in an interrupted line in FIG. 2) and the excess amount of hydraulic fluid is allowed to escape through groove 27 and the high pressure valve 28 which latter is set at the pressure level required for the forming operation in point.

The upper tool part 4 is further lowered until it arrives in the end position shown in the left sectional half of FIG. 2 where the desired cavity 41 is obtained. At the close of this forming operation the inner cavity of hollow body 20 is relieved of pressure through the high-pressure control valve 28; upper tool part 4 and holding down unit 5 return to their respective initial positions. The pistons 10 with ejector rods 11 are raised and the divided form ring 23 is removed. Now the pulley body 20 in its final shape with a pulley groove therein may be taken out of the machine.

The difference between the structures of FIG. 2 and 3 lies in the feature that in FIG. 3 a second forming operation follows the first one so that two pulley grooves are pressed into the cylindrical wall of workpiece 20. This is done by inserting another die punch 57 to replace die punch 36 in FIG. 1, 2. In addition, a second divided form ring 58 is superimposed on divided form ring 23. By replacing the die punches consecutively, and by inserting additional form rings, several additional forming operations may be carried out. These consecutive deformations may be identical or different from one another.

The general method for the subsequent pulley groove formation in the hollow sheet steel deep drawn body includes, therefore, the following features: the open rim of the hollow body 20 is placed upon a plate 12 the shape of which is adapted to the rim 21 and is equipped with a centering slot 19 and a seal 22 for said hollow body; subsequently a divided form ring 23 is pushed upon the lower part of the rim and is pressed against the centering plate and seal by means of a holding down unit 5 mounted concentrically with the hollow body; then the hydraulic fluid enters through opening 59 in the centering plate into the interior of the hollow body, purging the air present in said hollow body through a centered opening 43 in the bottom of said hollow body; finally a die punch 4 is applied on top of the hollow body, which die punch envelops the hollow body with its lower part which is shaped to form the die in this process; when lowered the die punch seals off the air vent and when further lowered it shortens the hollow body through upsetting against the hydraulic pressure, the mounting hydraulic pressure displacing exposed parts of the hollow body from the inside to the outside into the cavities 55 of the die neighboring the hollow body which cavities are created by the further lowering of the die punch; the excess fluid being discharged through a pressure control valve 18.

The machine of the invention preferably includes the parts mentioned in the preceding paragraph and is preferably further related with other features as follows:

1. the base plate 1 carries the elements of the ejector unit 2 and the lower tool part 3.

2. the ejector unit 2 is enclosed in the base plate 1 and has three cylindrical bores 9 with pistons 10 guided within said bores, the pistons being connected to ejector rods 11, the free ends of which carry the centering plate 12.

3. the lower tool part 3 is permanently fastened to the base plate 1 and has an inserted centering ring 16 held in position by the cover plate 17.

4. a packing ring 22 is embedded between the lower rim 21 of the workpiece 20 and the centering plate 12 and the divided form ring 23 is concentrically applied on top of the lower rim 21 of the body 20.

5. the lower part of the internal enveloping surface 61 for the centering ring 16 has a conical shape whereas its upper part 62 is cylindrical and the centering plate 12 and the form ring 23 with corresponding conical outer surfaces fit without play into the lower conical part of the centering ring as does the guide ring 51 for punch 36.

6. the lower tool part 3 includes the plate 3*a* and the ring 3b permanently united with the plate by pressure tight welding and provide a seat for the ring 16, the plate 3*a* carrying the two concentric packing rings 25 and 26 and having a channel 27 for hydraulic fluid with a threaded connection 29 for the high pressure control valve 28.

7. the ejector unit 2 has channels 14 and 15 for the feed and return of pressure fluid to the cylinder bores 9 for pistons 10.

8. the die punch **36** of upper tool part **4** is guided without play in the guide ring **51** of the hold down unit **5**.

9. a seal **42** is embedded in the upper front of the cavity **38** of die punch **36** to provide pressure tight sealing of opening **43** in the bottom of body **20** when the die punch settles on top of the hollow body **20** at the end of the filling operation of the body.

10. the die punch has drain grooves **44** and **45**.

Modifications may be made in the structure shown without departing from the spirit and scope of the invention.

I claim:

1. A machine to form a radially extending deformation in a cylindrical wall of a hollow sheet metal workpiece of cup-shape with a bottom end and an open end comprising a base including a centering ring, a centering plate located within the centering ring, first means supporting the plate on the base for controlled movement along the axis of the plate, said plate including means to receive and support said open end of a workpiece to be deformed, a form ring carried by the centering plate and embracing a portion of a workpiece supported on the centering plate, said machine including an upper tool part having a hold-down section for hold down engagement with the form ring, a die and forming punch mounted within the holddown section and movable axially relative to the hold-down section, said punch being hollow and fitting over the outside and engaging the bottom end of said cup-shaped workpiece, second means for axially moving the hold-down section, third means for axially moving the die punch, said die punch having a radial surface cooperating with the forming ring to provide a cavity adjacent the cylindrical wall of the workpiece and to shape the radial deformation that is to be formed therein, and fourth means for supplying pressure fluid to the interior of the workpiece to expand a portion thereof into said cavity including communicating passages in the base and in the centering plate.

2. A machine as set forth in claim **1** wherein the die punch and fourth means are constructed to apply axial force to the workpiece after the workpiece is filled with pressure fluid.

3. A machine as set forth in claim **2** wherein said workpiece has a vent opening, and wherein the die punch is constructed and arranged to vent said workpiece vent opening prior to application of axial force and to seal the workpiece vent opening upon application of axial force by the punch to the workpiece.

4. A machine as set forth in claim **1** wherein said centering ring, hold-down section, centering plate, and forming ring have engaging conical surfaces, said forming ring being split and cammed in place by said centering ring.

5. A machine as set forth in claim **1** wherein said base includes a sealing ring for the pressure fluid passages engaged by said centering plate when held down by the hold-down section.

6. A machine as set forth in claim **1** wherein said first means includes pressure fluid operated ejector rods and pistons within the base and secured to the centering plate.

7. A machine to form a radially extending deformation in a cylindrical wall of a hollow sheet metal workpiece comprising a base including a centering ring, a centering plate located within the centering ring, first means supporting the plate on the base for controlled movement along the axis of the plate, said plate including means to receive a workpiece to be deformed, a form ring carried by the centering plate and embracing a portion of a workpiece supported on the centering plate, said machine including an upper tool part having a hold-down section for hold down engagement with the form ring, a die and forming punch mounted within the hold-down section and movable axially relative to the hold-down section, second means for axially moving the hold-down section, third means for axially moving the die punch, said die punch having a surface cooperating with the forming ring to provide a cavity adjacent the cylindrical wall of the workpiece to shape the radial deformation that is to be formed therein and means for supplying pressure fluid to the interior of the workpiece to expand a portion thereof into said cavity including communicating passages in the base and in the centering plate, said die punch being constructed and arranged to apply axial force to the workpiece after the workpiece is filled with pressure fluid, said workpiece being cup-shaped with an annular rim at its open end, the bottom end of the workpiece having an opening therein, said centering plate being shaped to receive said rim, said form ring fitting on top of said rim, said die punch including vent passages communicating with said workpiece opening to vent said workpiece prior to application of axial force, said die punch including sealing means for closing said workpiece opening upon application of axial force by the punch to the workpiece when said die punch contacts the bottom end of the workpiece.

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