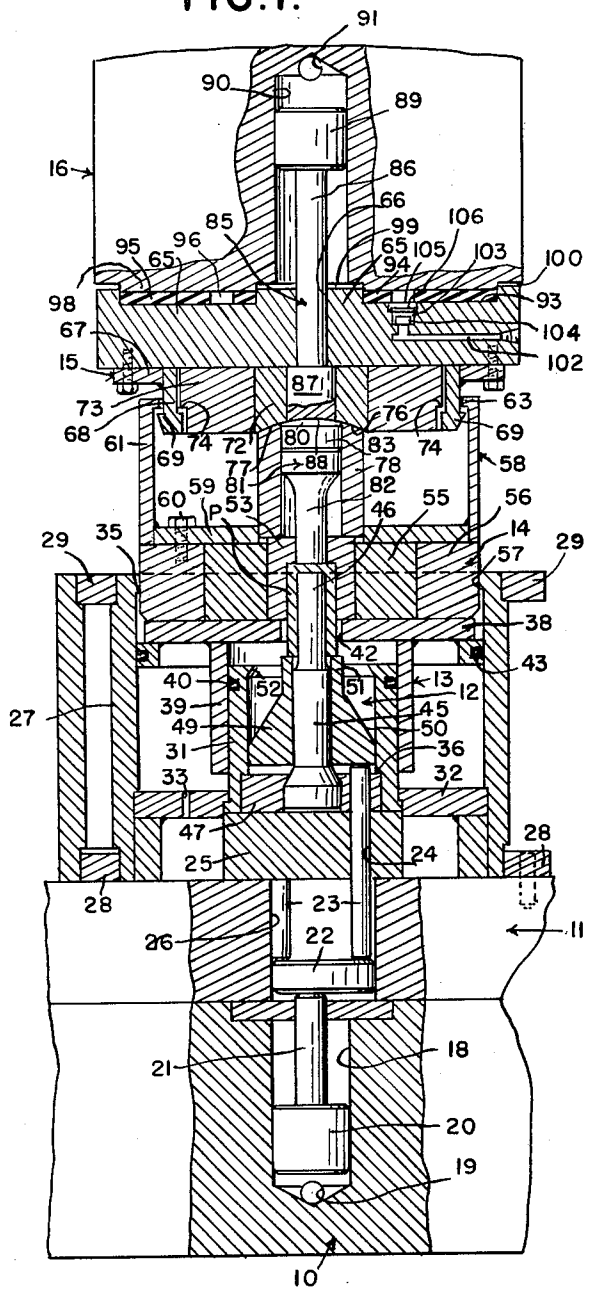
June 23, 1964 G. L. ANDERSEN 3,138,257

PRODUCTION DIE

Filed March 7, 1960 2 Sheets-Sheet 1

FIG. 1.



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PRODUCTION DIE

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FIG. 3.

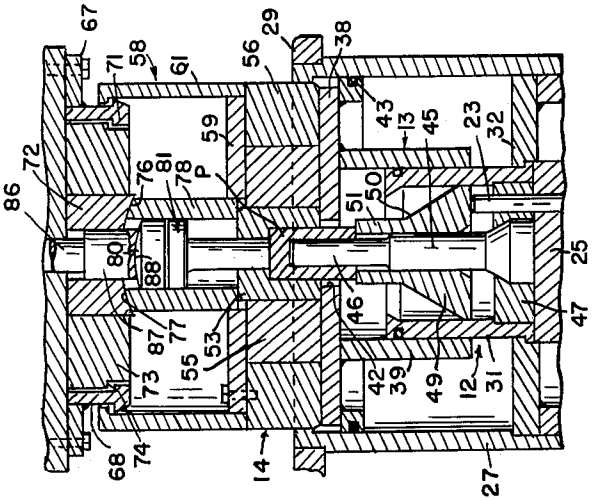
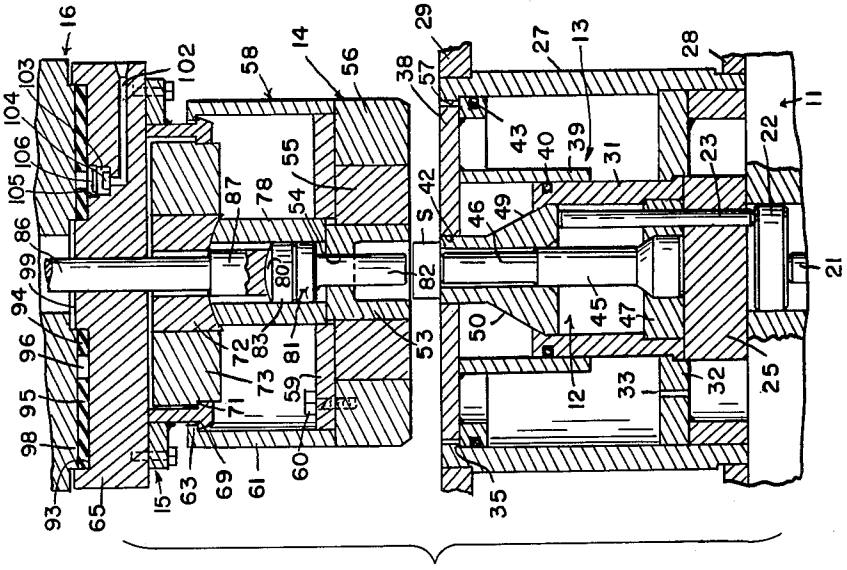


FIG. 2.



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PRODUCTION DIE

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14 Claims. (Cl. 207—6)

The present invention relates to improvements in a production die for the cold forming of hollow and like shaped metal parts.

It is an object of the invention to provide die structure including relatively movable punch and die units or sub-assemblies mounted, respectively, upon lower and upper die shoe or bolster units, in which novel and improved leveling means are provided to insure an accurate alignment of coacting punch and die units, and the accurate maintenance of such alignment during the relative axial movement of the punch and die units relative to one another. For this purpose, the invention contemplates the provision of a flat horizontal leveler and aligning plate adapted to be engaged flatwise by the die unit as the latter is advanced downwardly by an upper die shoe and bolster assembly, and a fixed leveler plate guide and restraining unit, onto which a tubular bottom extension or sleeve of the leveler plate is axially telescoped with a very close and accurate clearance.

Another object is to provide production die structure of the sort described, in which a novel die unit composed of an accurately formed die insert, reinforced and confined by surrounding shrink rings, is releasably coupled to the upper die shoe unit by an improved form of slack coupling.

Another object is to provide die structure of this sort, in which the upper die unit includes a tubular insert transmitting axial force to the formed die insert of the die unit, this insert being driven downwardly by an upper die shoe which engages it at a spheroidal meeting surface, so that self aligning action as between the die-driving insert and the upper die shoe unit takes place closely adjacent the die parts, rather than remote from the same, as in previous structures of a generally comparable nature.

A further object, in regard to the die aligning and level unit referred to above, is to provide means whereby the leveler plate of this unit is brought to a position in which it is flush with the top of a work transfer plane, as well as the top of a stationary punch which coacts with the die, at the commencement of the forming operation, when a metal slug or blank is positioned coaxially above the punch. This is accomplished by subjecting the leveler plate to a moderate pneumatic pressure to force the same upwardly, with means to engage a transfer plate of the equipment to limit its movement to the said flush position.

A further important object of the invention is to provide, in association with the upper die shoe and bolster of the structure, an improved pneumatic shock absorber arrangement involving the trapping of air under pressure between coaxial, horizontally spaced rings of incompressible but elastically deformable material, as the upper bolster operates and engages the upper die shoe. This shock absorber action affords a nearly constant acceleration of the motion of the upper die structure as the rings are elastically forced in the radial direction into the space therebetween.

Generally, it is an object to provide an improved production die which, by reason of the improved, accurately guided and aligned leveler plate action, eliminates the need to lengthen the fixed punch of the die in order to provide for the proper locating of the work piece or slug relative to the die, coupled with the confining and bracing action of shrink rings on the shaped die insert, enables the punch and die insert to be formed of less expensive materials than has heretofore been possible.

The foregoing as well as other objects will become more apparent as this description proceeds, especially when considered in connection with the accompanying drawings illustrating preferred embodiments of the invention, wherein:

FIG. 1 is a fragmentary view in vertical axial section through a production die in accordance with the invention, as the die is normally assembled with other die forming assemblies (not shown), illustrating punch and die parts and their positional relationship at the time the cold forming of a metal object is completed; and

FIGS. 2 and 3 are fragmentary views in section similar to FIG. 1, respectively showing the parts at the commencement of the cold forming operation and at an intermediate stage in the operation.

Referring to FIG. 1, the die structure in general comprises a lower die shoe bolster **10**, upon which a lower die shoe **11** is mounted in a conventional manner; a stationary punch and alignment sub-assembly, generally designated **12**; a leveler plate sub-assembly, generally designated **13** which coaxially telescopes accurately on a part of the alignment sub-assembly **12**; a die unit or sub-assembly **14**, including slack coupling provisions to be described; an upper die shoe assembly **15**; and an upper die shoe bolster **16**, by which the die shoe **15** is driven through improved pneumatic shock absorber provisions, to be described.

The lower bolster **10** is, in conventional manner, formed to provide a hydraulic cylinder **18**, to which hydraulic pressure liquid may be supplied, as through a conduit **19** at its bottom, at a relatively moderate pressure of, say 40 pounds per square inch, or a relatively high pressure of about 2000 pounds per square inch, under the control of suitable valve provisions (not shown). A sealed piston **20** works vertically in cylinder **18** under this pressure, its plunger **21** being guided adjacent the top of bolster **10** and projecting thereabove. Plunger **21** engages beneath the center of a three-armed spider **22**, the arms of which in turn engage beneath three knockout or stripper pins **23**. These pins are guided for vertical action in bores **24** of a stationary punch back-up plate or block **25** of the alignment unit or sub-assembly **12**, and their action will be hereinafter referred to. The spider **22** is vertically guided in the lower die shoe **11**, preferably in a correspondingly shaped opening or bore **26** opening through the die shoe.

The alignment unit **12** comprises a cylindrical alignment tube **27**, which is supported on the top of die shoe **11** and is fixed accurately in relation to the latter by means of an annular locator plate **28** doweled into the die shoe. The alignment tube **27** is further confined adjacent its top in an opening in a fixed horizontal transfer plate **29** of the equipment.

Alignment unit or sub-assembly **12** further comprises a cylindrical tubular leveler plate guide **31**, mounted on the back-up plate or block **25**, coaxially of the lower hydraulic cylinder **18**. Guide **31** is of considerable length along its upright axis to provide a stable guiding action for the leveler plate unit **13** in a manner to be described; and it is braced adjacent its bottom within the alignment tube **27** by a fixed horizontal platform **32**. Platform **32** is provided with one or more openings therethrough, as indicated at **33**, and the annular space surrounding the back-up plate **25** may serve as a manifold through which compressed air at a mild pressure of about 20 pounds per square inch is supplied to the annular space between alignment tube **27** and the tubular leveler plate guide **31**, for a purpose to be described.

It is to be noted that the upper extremity of alignment tube **27** is formed to provide a radially inwardly extending annular shoulder **35** for upwardly limiting the motion of

the leveler plate unit **13**, for a purpose also to be described. Otherwise, the parts of the fixed tubular alignment sub-assembly **12** are shouldered, for example as indicated at **36**, to constitute the same a functionally unitary structure.

The leveler plate assembly or unit **13** comprises a horizontal flat leveler plate **38** of circular outline having a cylindrical, axially elongated annular guide sleeve **39** welded or otherwise secured in dependent relation to its bottom surfaces, in centered relation to the plate **38**. The sleeve **39** has a close tolerance axially telescoping engagement about the tubular leveler plate guide **31**, and overlaps the same a distance in an axial direction, as the parts slide axially relative to one another, which approximates or is substantially of the order of their diameter at the sliding surfaces. A suitable seal **40** is provided between these parts, and it will be appreciated that the leveler plate unit **13** is thereby guided in its vertical movement with accuracy and stability, due to the close tolerance fit and long axial overlap of sleeve **39** and guide **31**.

Leveler plate **38** is provided with an axial bore **42** therethrough; and an annular sealing ring **43** is peripherally welded about the bottom of plate **38**, this seal encircling the inner wall of the fixed alignment tube **27** and thus further assisting in guiding plate unit **13** in the latter. A further function of the sealing ring is to upwardly engage against the shoulder **35** of the alignment tube **27** and thereby limit upward movement of plate **38** to a position in which its top surface is flush with that of the alignment tube and the transfer plate **29** in which the alignment tube is received. See FIG. 2.

The reference numeral **45** generally designates the fixed upright punch of the die structure. It is, of course, shaped in accordance with the cross section of the hollow or cup-shaped product P to be produced, which may be assumed to be cylindrical, so that the punch **45** is therefore of this cross sectional outline. It is shown as being of diminished diameter at its upper portion **46**. Punch **45** is bottomed upon the back-up plate **25**, and is confined in place by a punch retainer block **47**, through bores in which the stripper pins **23** extend.

The inner wall of the leveler plate guide sleeve **31** serves to guide an outer punch guide or stripper member **49**, which has a close sliding fit with the larger diameter portion of punch **45**. Its lower portion **50** is frusto-conical, from which portion it extends upwardly in a cylindrical cross section at **51**, which section is machined for relatively close sliding fit in the bore **42** of the leveler plate **38** when stripper **49** is elevated as shown in solid line in FIG. 2. It is elevated to this position, to which it is limited by engagement of its frusto-conical bottom **50** with a mating surface **52** at the top of tubular guide **31**, by the moderate pressure of about 40 pounds per square inch in hydraulic cylinder **18** mentioned above. This is done through the agency of the spider **22** and stripper pins **23**. The product P is stripped ultimately from punch **45** under the aforementioned hydraulic pressure of 2000 pounds per square inch on piston or plunger **20** in cylinder **18**. The product is similarly stripped from an upper die insert (to be described) under a corresponding downward hydraulic force exerted in the upper die shoe and bolster units **15**, **16**, as will be described.

The moving die unit **14** comprises a central die insert **53** of tungsten carbide or high speed steel which is internally shaped in an inverted cup-like cross section, in accordance with the desired shape of the ultimate product P. Insert **53** has an axial clearance opening or bore **54** through its top, and is externally of slightly upwardly and outwardly tapered, circular outline. An inner, relatively thick shrink ring **55** surrounds the insert **53**, having a correspondingly tapered and mating inner perimeter, the insert and inner shrink ring **55** having a driven fit at these slightly tapered surfaces. An outer shrink ring **56** surrounds and has a shrink fit about inner ring **55**, the outer shrink ring having a sliding fit in the top opening **57** of alignment tube **27** of alignment sub-assembly **12**, above the shoulder **35** of that tube.

The die unit **14** has affixed thereto, and actually serving as a part thereof, an annular slack coupling device, generally designated **58**. This may consist of an annular plate or disk **59** secured by bolts **60** or the like to the outer shrink ring **56** of the die unit, and an upstanding cylindrical wall **61** welded about disk **59**. The latter has an axial inner bore **62**, for a purpose to be described. The slack coupling wall **61** is provided at its top with an inwardly directed, bayonet type connecting shoulder **63**, through the agency of which the coupling assembly **58** and die unit **14** may be lifted upon upward retraction of the upper die shoe assembly **15**.

The upper die shoe assembly includes a steel upper die shoe proper **65** having a central bore **66** coaxial with the other punch and die parts. An annular locating clamp **67** is bolted or otherwise secured, preferably releasably, to the lower surface of the die shoe **65**, this clamp surrounding and serving as a mount for an inner bayonet type connecting ring **68**, to which it is welded or otherwise fixedly secured. Ring **68** is externally provided with a suitable bayonet type formation **69** for coaction with the shoulder **63** of slack coupling **58** in elevating the die unit **14** upon a retractile stroke of upper die shoe **65**. The nature of such releasable, bayonet-type provisions are well known and understood by those skilled in the art, it being contemplated that a rotation of the coupling about the bayonet ring **68** will enable the coupling and die unit **14** to be separated from the upper die shoe. This loose type of connection permits proper and desired alignment of the die shoe parts with the die unit **14** and connecting provisions, through self-aligning provisions at the die components themselves, rather than at some remote location.

Bayonet ring **68** is also provided with an inwardly directed annular shoulder **71** about its bottom, for engagement with upper die parts on such retractile stroke, while permitting self alignment of such parts with the remaining die structure. These parts include a central annular anvil ring insert **72** which has a ring **73** surrounding and shrunk fit thereto to constitute a unitary anvil device. Shrink ring **73** is provided with an outwardly directed shoulder **74** for coaction with the inturned shoulder **71** of the bayonet ring **68** in lifting the anvil device.

This type loose or slack coupling, as combined with the accurate and stable guiding of leveler plate **38** by sleeve **39** and guide **31** for a true axial movement at 90° to the press gibs, enables an improved self alignment of force transmitting surfaces adjacent the die, thus to preserve a true axiality of force relative to punch **45**, so that the latter is not subjected to any transverse force at all tending to cant it in operating on the workpiece or slug. The surfaces include a mildly spheroidal annular bottom surface **76** on the anvil ring insert **72**, concave in nature and a mating convex spheroidal surface **77** on a tubular insert support **78** coaxial therewith. This support **78** extends downwardly into the bore **62** of the plate or disk **59** of slack coupling **58**, where it has axial thrust transmitting engagement with the die insert **53** of die unit **14**, outwardly overlapping in the radial sense a corresponding area of the inner shrink ring **55** of the die unit.

The anvil insert ring **72** also has mating thrust engagement with the coaxial convex spheroidal surface **80** of a two-piece knockout pin **81** mounted for sliding movement within the bore of the insert support **78**. This pin is constituted by a lower nose portion **82** which is received in the upwardly opening bore **54** of die insert **53**, being downwardly tapered for this purpose, and an upper anvil portion **83** in flatwise engagement with the top of the nose portion **82** and having the anvil surface **80** formed thereon.

The reference numeral **85** generally designates a knockout assembly, including a pin or plunger **86** slidably received in the bore **66** of upper die shoe **65**, and provided with an enlarged lower cylindrical portion **87** which slides

within the anvil insert ring 72. The portion 87 has a concave spheroidal bottom surface 88 in mating and self-aligning engagement with the convex surface 80 of knockout pin 81.

At its upper end the plunger 86 carries a piston 89 of enlarged diameter which slides in a hydraulic cylinder 90 formed in the upper bolster 16. The top portion of cylinder 90 is adapted to be placed in communication, as through a conduit 91, with a source of hydraulic pressure which, as in the case of the hydraulic supply for the bottom cylinder 18, may be selectively controlled through suitable pressure and flow control valve provisions (not shown) to furnish a mild pressure of, say, 40 pounds per square inch, for initially bringing the lower portion 87 of knockout pin or plunger 85 to the position of FIGS. 1 and 2, or a relatively heavy pressure of about 2000 pounds per square inch for later downward stripping of the product P from the die insert 53.

The die structure is completed by provisions for affording a shock absorber action at the upper bolster, which it will be understood is bolted or otherwise secured to the ram (not shown) of a press whose base or platen is constituted by the lower bolster 10, and for thus enabling a nearly constant shock free acceleration in the downward cold forming phase of the operation of the upper die unit 14. To this end, the upper surface of upper die shoe 65 is formed to provide an annular recess 93 coaxially surrounding the axis of the die parts, the function of which recess is that of an annular pressure cylinder. Within the cylinder recess there are disposed two concentric, inner and outer shock absorber rings 94, 95, respectively, with an annular expansion space 96 left therebetween. The rings 94, 95 are, in accordance with the invention, fabricated of polyurethane or like incompressible but elastically distortable material, so that upon mechanical axial compression the inner ring 94 may distort radially outwardly and expand toward the space 96, the outer ring correspondingly distorting and expanding inwardly toward this space.

The bottom surface of the upper bolster 16 is provided with an annular piston formation 98 which fits axially with a close radial tolerance into the annular cylinder 93 of upper die shoe 65, when the parts are in operative, force transmitting position. The bottom surface of piston formation 98 engages flatwise the upper surface of the shock absorber rings 94, 95. It should be specially noted that an axial clearance space 99 is left between the bottom bolster surface and the top die shoe surface in the area inwardly of the piston formation 98 on the upper bolster, which space 99 is greater in the axial sense than the annular clearance space 100 between the bolster and die shoe outwardly of the piston formation. The purpose of this relationship will appear.

Upper die shoe 65 is further provided with a radial passage 102 opening upwardly into a chamber 103, in which a simple check valve 104 is disposed. Die shoe 65 is counterbored at 105 above the chamber 103 to receive a fluid-permeable cover 106. The passage 102 is thus communicated for the one-way application of air pressure to the annular space 96 between shock absorber rings 94 and 95. The passage is suitably connected with a source of supply (not shown) of air at a pressure of about 80 pounds per square inch, this pressure being maintained within the space 96 even when axial force is not being transmitted to the die parts.

In operation, now referring to FIGS. 2 and 3 in conjunction with FIG. 1, it will be assumed that the parts are in the neutral position shown in FIG. 2, with the leveler plate 38 of leveler unit 13 flush with the upper surface of the transfer plate 29. It has been brought upwardly to this position by the application of a mild 20 p.s.i. pneumatic pressure through the passage 33 in the platform 32 of alignment unit 12, so that the leveler plate unit or sub-assembly 13, as accurately guided by the sleeve 31 of the alignment unit 12, and by its sealing ring 43, is elevated to the FIG. 2 position. The engagement of the ring 43 with the shoulder 35 on alignment tube 27 stops the plate 38 in this accurately aligned and flush position. It will be noted that in this position the top of leveler plate 38 is also flush with the top of punch 45; and that the stripper member 49 surrounding the punch has also been elevated to the same level, through the agency of the pins 23 therebeneath, the spider 22 and the piston 20, which is raised under the approximate 40 p.s.i. hydraulic pressure in cylinder 18.

In this initial condition of FIG. 2, the die unit 14 is elevated substantially above the plane of the transfer table and leveler plate 38, in order to enable the metal blank or slug, designated S in FIG. 2, to be placed in position by the transfer mechanism (not shown). The upper, two-part knockout pin 81 is at this time located within the forming recess of the die insert 53. The upper bolster 16, die shoe 65 and bayonet connecting ring 68 are now lowered, lowering die unit 14 through the connecting slack coupling 58.

The die insert 53 and shrink rings 55, 66 of die unit 14 contact the leveler plate 38 about ⅛ inch in advance of the commencement of forming of the blank or slug S. Force applied to knockout pin 81 under moderate, 40 p.s.i. pressure from above has brought the pin into the bore 54 of die insert 53, where it engages the top of the blank as shown in FIG. 3. During the actual forming operation under ram force, both the upper knockout pin 81 and the lower stripper member 49 remain under the original pressure of but 40 p.s.i. The greater pressure of, say, 2000 p.s.i. is later applied in stripping.

Two things happen as the die unit 14 descends, prior to the building up of true forming force between die insert 53, the slug S and the fixed punch 45. The bottom surface of unit 14 comes into flush, flatwise engagement with the top of leveler plate 38, and the outer shrink ring 56 of die unit 14 pilots telescopingly into the top of the fixed alignment tube 27.

The first of these almost simultaneously occurring actions results in a tilting shift of the die unit, at the convex rounded surface 77 of the support 78 fixedly connected to the unit, relative to the concave rounded surface 76 of the anvil ring insert 72. Thus, should there be a need for it, the die unit 14 is corrected angularly by positive reference to the stably guided leveler plate 38, the mating rounded surfaces 76, 77 sliding relatively and in continuing contact with one another over their meeting areas.

The second action of the parts, in the telescoping entry of shrink ring 56 into alignment tube 27, results in a bodily lateral shift of unit 14 in one direction or another so that, if it is off-center, the unit 14 and its die insert 53 are returned to true coaxiality with punch 45, the surfaces 76, 77 maintaining their mated engagement.

The loose couplings at coupling wall shoulder 63, ring formation 69 and shrink ring shoulder 74 freely permit these actions.

As the upper bolster 16 descends under ram force, the tubular insert support 78 initially engaging die insert 53, the polyurethane shock absorber rings 94, 95 in the cylinder 93 between the bolster and upper die shoe 65 are axially compressed strongly, causing them to move radially into the space 96, and developing up to 1500 p.s.i. cushioning pressure between the piston formation 98 and cylinder 93, which builds up to 4000 p.s.i. pressure as the stroke progresses.

As mechanical force continues to be transmitted to die insert 53 through the self-aligning anvil insert 72 and insert support 78, the metal of the slug S is caused to flow downwardly into the axial and radial space between the rigidly sustained lower punch 45 and the die insert 53, as shown in FIG. 3, the stripper member 49 the while moving downwardly in the leveler plate bore, since it is supported by only 40 p.s.i. pressure at this time, until it reaches the position shown in FIG. 1 of the drawings. The leveler plate unit 13 similarly travels downwardly in

telescoping relation over the top portion 51 of stripper member 49 and over the tubular guide 31, being sustained by the light hydraulic pressure therebeneath, and at this time forming is complete.

The upper ram-supported parts are now withdrawn and 2000 p.s.i. hydraulic pressure is applied to both the top and bottom cylinders 90, 18, respectively, to strip the formed product from punch 45 and die insert 53.

Accurate self-alignment, through joint coaction of the leveler plate 38, the telescoped die unit 14, the mating spheroidal surfaces 76, 77, and the loose action of the slack coupling 58 is made possible. A true axial force is developed on each die stroke, once the force transmitting and force receiving members initially become aligned, along the line of the axis of fixed punch 45, by the long and stable guiding action exerted along that line by plate 38 through its depending sleeve 39 and fixed tubular guide 31.

This combination of the accurately guided floating leveler plate 38, spheroidal thrust transmitting surfaces and slack coupling has the advantages of permitting a very quick change of forming tools, of enabling the equipment to handle an off-center extrusion with good concentricity, of transferring wear to the gibs which guide the moving press part without effect on the operation of the tools, and of enabling efficient operation in the event of non-parallel bolster plates.

Due to the different clearances between the upper bolster 16 and upper die shoe 65, i.e., at 99 and 100, the desired pneumatic shock absorber action is permitted to develop at the polyurethane rings 94, 95 prior to mechanical engagement of bolster with the die shoe 65 about its peripheral zone at 100. Therefore, the die shoe may flex elastically and develop any required tonnage prior to and after such engagement. The air trapped in the space between the polyurethane rings 94, 95 gives a nearly constant axial acceleration as the rings distort into the space 96 therebetween. A full load cushion is provided by the elastic material for normal loads, plus a flexing deformability of the die shoe in the event of overload. High pressure shock is eliminated.

In this manner, shock loading is avoided, which permits the use of low cobalt content (3% to 8%) tungsten carbide, as compared with the usual 16%–24% content, and permitting the development of 800,000 pounds per square inch pressure.

The drawings and the foregoing specification constitute a description of the improved production die in such full, clar, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. Production die equipment comprising press force applying means, a pair of coaxial, relatively movable die units engageable in the axial direction thereof with a piece to be formed in a relative forming movement of said units under force applied thereto by said means in said direction, one of said units having a rounded force receiving surface, a force applying member having a rounded surface adapted for coaxial mating and self-aligning engagement with said first named rounded surface to exert forming force from the latter on said piece in said axial direction, means providing a loose coupling connection of said press force applying means with said force applying member and said die unit capable of permitting a tilting shift of said rounded surfaces relative to and in mated engagement with one another, and of permitting a lateral shift of said die unit relative to said press force applying means, and means acting on said unit to produce said respective shifts through said loose coupling connection at the outset of a forming stroke, said last named means comprising a leveling surface having means rigidly guiding the same for accurate axial movement along the axis of the other die unit, said one die unit having a surface other than its rounded surface which engages said leveling surface to occasion said relative tilting shift at said rounded surfaces, and a fixed guide member slidingly engaging said one die unit to occasion said relative lateral shift of the latter.

2. Production die equipment in accordance with claim 1, in which said loose coupling connection means includes means providing loose couplings respectively between said press force applying means and said force applying member, and between said force applying means and said one die unit.

3. Production die equipment in accordance with claim 1, in which said loose coupling connection means includes means providing loose couplings respectively between said press force applying means and said force applying member, and between said force applying means and said one die unit, the last named coupling being one enabling a ready separation of said one die unit from said press force applying means by a simple relative movement of the same other than the relative motion due to the loose coupling thereof.

4. Production die equipment in accordance with claim 1, in which said fixed guide member has an annular opening coaxial with said other die unit and telescopingly receiving said one die unit with sliding clearance to maintain said die units coaxial in the forming stroke, said leveling surface moving axially within said opening.

5. Production die equipment in accordance with claim 1, in which said fixed guide member has an annular opening coaxial with said other die unit and telescopingly receiving said one die unit with sliding clearance to maintain said die units coaxial in the forming stroke, said leveling surface moving axially within said opening.

6. Production die equipment in accordance with claim 1, in which said fixed guide member has an annular opening coaxial with said other die unit and telescopingly receiving said one die unit with sliding clearance to maintain said die units coaxial in the forming stroke, said leveling surface moving axially within said opening, said leveling surface being provided with an elongated tubular sleeve element of substantial length extending axially therefrom in the direction away from said one die unit, and an axially elongated fixed guide element externally telescoped slidingly by said sleeve element over a substantial axial length to guide said sleeve element and leveling surface.

7. Production die equipment in accordance with claim 1, in which said fixed guide member has an annular opening coaxial with said other die unit and telescopingly receiving said one die unit with sliding clearance to maintain said die units coaxial in the forming stroke, said leveling surface moving axially within said opening, said leveling surface being provided with an elongated tubular sleeve element of substantial length extending axially therefrom in the direction away from said one die unit, and an axially elongated fixed guide element externally telescoped slidingly by said sleeve element over a substantial axial length to guide said sleeve element and leveling surface.

8. Production die equipment comprising press force applying means, a pair of coaxial, relatively movable die units engageable in the axial direction thereof with a piece to be formed in a relative forming movement of said units under force applied thereto by said means in said direction, one of said units having a rounded force receiving surface, a force applying member having a rounded surface adapted for coaxial mating and self-aligning engagement with said first named rounded surface to exert forming force from the latter on said piece in said axial direction, means providing a loose coupling connection of said press force applying means with said force applying member and said die unit capable of permitting a tilting shift of said rounded surfaces relative to and in mated engagement with one another, and of permitting a lateral shift of said die unit relative to said press force applying means, and means acting on

said unit to produce said respective shifts through said loose coupling connection at the outset of a forming stroke, said loose coupling connection means including means providing loose couplings respectively between said press force applying means and said force applying member, and between said force applying means and said one die unit.

9. Production die equipment comprising press force applying means, a pair of coaxial, relatively movable die units engageable in the axial direction thereof with a piece to be formed in a relative forming movement of said units under force applied thereto by said means in said direction, one of said units having a rounded force receiving surface, a force applying member having a rounded surface adapted for coaxial mating and self-aligning engagement with said first named rounded surface to exert forming force from the latter on said piece in said axial direction, means providing a loose coupling connection of said press force applying means with said force applying member and said die unit capable of permitting a tilting shift of said rounded surfaces relative to and in mated engagement with one another, and of permitting a lateral shift of said die unit relative to said press force applying means, and means acting on said unit to produce said respective shifts through said loose coupling connection at the outset of a forming stroke, said last named means comprising a leveling surface having means rigidly guiding the same for accurate axial movement along the axis of the other die unit, said one die unit having a surface other than its rounded surface which engages said leveling surface to occasion said relative tilting shift at said rounded surfaces, said loose coupling connection means including means providing loose couplings respectively between said press force applying means and said force applying member, and between said force applying means and said one die unit.

10. Production die equipment comprising press force applying means, a pair of coaxial, relatively movable die units engageable in the axial direction thereof with a piece to be formed in a relative forming movement of said units under force applied thereto by said means in said direction, one of said units having a rounded force receiving surface, a force applying member having a rounded surface adapted for coaxial mating and self-aligning engagement with said first named rounded surface to exert forming force from the latter on said piece in said axial direction, means providing a loose coupling connection of said press force applying means with said force applying member and said die unit capable of permitting a tilting shift of said rounded surfaces relative to and in mated engagement with one another, and of permitting a lateral shift of said die unit relative to said press force applying means, and means acting on said unit to produce said respective shifts through said loose coupling connection at the outset of a forming stroke, said last named means comprising a fixed guide member slidingly engaging said one die unit to occasion said relative lateral shift of the latter, said loose coupling connection means including means providing loose couplings respectively between said press force applying means and said force applying member, and between said force applying means and said one die unit.

11. Production die equipment comprising press force applying means, a pair of coaxial, relatively movable die units engageable in the axial direction thereof with a piece to be formed in a relative forming movement of said units under force applied thereto by said means in said direction, one of said units having a rounded force receiving surface, a force applying member having a rounded surface adapted for coaxial mating and self-aligning engagement with said first named rounded surface to exert forming force from the latter on said piece in said axial direction, means providing a loose coupling connection of said press force applying means with said force applying member and said die unit capable of permitting a tilting shift of said rounded surfaces relative to and in mated engagement with one another, and of permitting a lateral shift of said die unit relative to said press force applying means, and means acting on said unit to produce said respective shifts through said loose coupling connection at the outset of a forming stroke, said loose coupling connection means including means providing loose couplings respectively between said press force applying means and said force applying member, and between said force applying means and said one die unit, the last named coupling being one enabling a ready separation of said one die unit from said press force applying means by a simple relative movement of the same other than the relative motion due to the loose coupling thereof.

12. Production die equipment comprising a pair of coaxial, relatively movable die units engageable in an axial direction in the relative movement thereof, one of said units comprising an axially movable forming member, means to apply forming pressure to said forming member, including a pair of pressure members engaging one another in an axial direction, a bolster to move one of said pressure members axially, and means providing a fluid pressure shock absorbing and force transmitting connection between said bolster and the last named pressure member, including axially telescoping piston and cylinder means connected respectivley to the latter and the bolster, and a pair of concentric elastically deformable rings spaced radially from one another in said cylinder means and engaged in an axial direction and compressed by the cylinder means.

13. Production die equipment comprising a pair of coaxial, relatively movable die units engageable in an axial direction in the relative movement thereof, one of said units comprising an axially movable forming member, means to apply forming pressure to said forming member, including a pair of pressure members engaging one another in an axial direction and having coaxial mating, engaging and self-aligning rounded surfaces, a bolster to move one of said pressure members axially, and lost motion means providing a fluid pressure shock absorbing and force transmitting connection between said bolster and the last named pressure member, including axially telescoping piston and cylinder means connected respectively to the latter and the bolster, a pair of concentric elastically deformable rings spaced radially from one another in said cylinder means and engaged in an axial direction and compressed by the cylinder means, and a lost motion connection between said one pressure member and said bolster to permit self-aligning of said pressure members at said surfaces for the transmission of truly axial force to said die units.

14. Production die equipment comprising a pair of coaxial, relatively movable die units engageable in an axial direction in the relative movement thereof, one of said units comprising an axially movable forming member, means to apply forming pressure to said forming member, including a pair of pressure members engaging one another in an axial direction and having coaxial mating, engaging and self-aligning rounded surfaces, a bolster to move one of said pressure members axially, and lost motion means providing a fluid pressure shock absorbing and force transmitting connection between said bolster and the last named pressure member, including axially telescoping piston and cylinder means connected respectively to the latter and the bolster, a pair of concentric elastically deformable rings spaced radially from one another in said cylinder means and engaged in an axial direction and compressed by the cylinder means, and a lost motion connection between said one pressure member and said bolster to permit self-aligning of said pressure members at said surfaces for the transmission of truly axial force to said die units, one of said die units having a readily releasable connection to said bolster in addition to said lost motion connection.

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