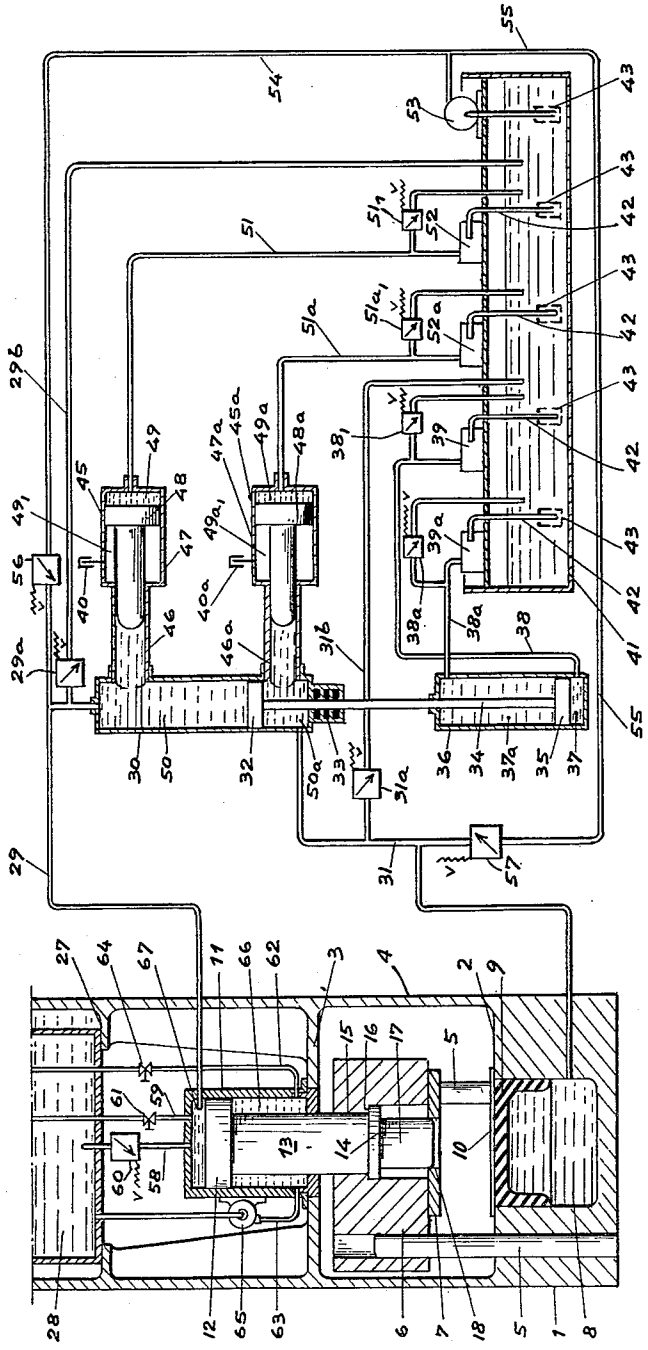
July 31, 1962 M. YOLIN 3,046,923

HYDRAULIC STAMPING PRESS WITH A DIE MADE OF RESILIENT MATERIAL

Filed July 22, 1959 2 Sheets-Sheet 1

Fig. 1.



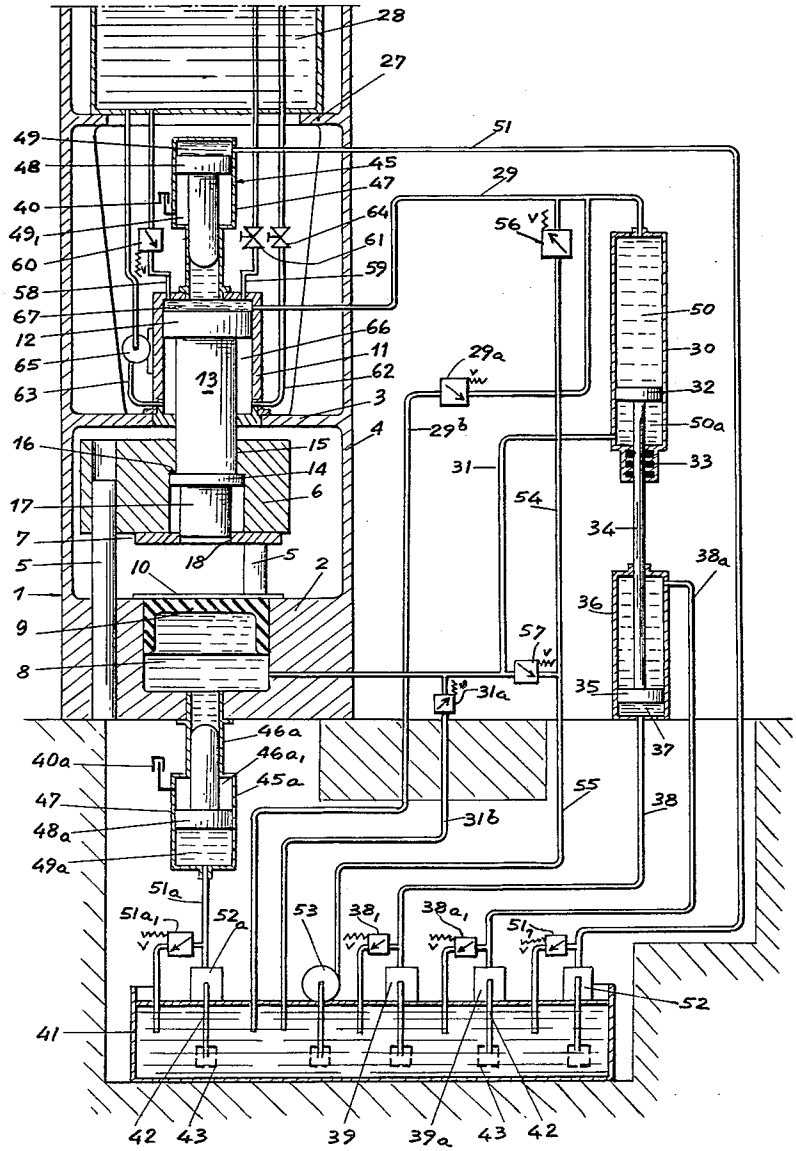
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Fig.2.



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HYDRAULIC STAMPING PRESS WITH A DIE MADE OF RESILIENT MATERIAL

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4 Claims. (Cl. 113—45)

The present invention relates to a hydraulic stamping press with a die made of resilient material of the type described for instance in U.S. Patent 2,696,183. In hydraulic presses of this type, the blank for stamping is seized between a blank-clip and a diaphragm hereinafter called the die and made of resilient material, flat when at rest, but deformable, and the stamping pressure is applied by a very high pressure delivery pump. Stamping takes place by thrusting a punch into the assembly formed by the blank and the deformable die. The force exerted on the punch is produced by the pressure of a fluid possibly delivered by a second pump with large delivery setting up a very high delivery pressure. These pumps are fragile and difficult to keep in order owing to the very high pressures that they must develop.

The hydraulic fluid, displaced in the die cavity by the driving in of the punch, being surplus, is discharged through a discharge valve and returned to the main tank, so that the piezometric energy of this fluid is lost and goes off in heat. This establishing of the hydraulic circuit necessitates the putting in of cooling members on the machine and has the disadvantage of losing a considerable part of the motive power.

The present invention obviates these disadvantages by creating a new hydraulic press in which the piezometric energy of the fluid displaced in the die cavity during the driving in of the punch is used for forming an important fractional part of the power put into operation for effecting the movement of said punch during its working stroke.

According to the invention, the stamping press comprises a die having a cavity filled with hydraulic fluid and covered by a diaphragm of resilient material, a slide and a rigid punch driven by a hydraulic jack cooperating with this die and is characterized in that the cavity of the die containing the hydraulic fluid and the jack chamber controlling the punch are respectively connected to two chambers of the same compensating cylinder, separated by a piston, and to two differential jacks enabling a primary tightening pressure of the part to the stamped to be set up in the cavity of the die and in the control chamber of the punch, said piston placed in the compensating cylinder being connected by a rod to a second piston sliding in the cylinder of another jack producing a secondary pressure effecting the stamping operation.

According to one form of embodiment, the outlets of the differential jacks respectively emerge in each of the two chambers of the compensating cylinder on either side of the piston separating them.

According to an alternative embodiment, the two differential jacks are directly connected, one to the jack chamber controlling the punch, and the other to the cavity of the die; more particularly, the outlets from the differential jacks emerge in the ends, preferably axially, of the jack chamber controlling the punch and the cavity of the die, respectively.

Two forms of embodiment of the purpose of the invention are shown, by way of non-restrictive examples, in the attached drawings.

FIGURE 1 is a diagrammatical elevation-section, partial, of a hydraulic press and a drive unit illustrating one form of carrying out the invention.

FIGURE 2 is an elevation-section similar to FIGURE 1, showing an alternative.

In FIGURE 1, the press comprises a body or frame **1** delimiting a table **2** and a tray **3** held together by uprights **4**. The frame **1** supports guides **5**, three in number, for example, on which a slide **6** is slipped. This slide carries a blank-clip **7** for holding the part or blank **10** for stamping above the die which is made of a thick deformable diaphragm **9** of resilient material, covering a cavity **8** made in the body of the press starting from the table **2**. The die is mounted in such a manner that it cannot slide with respect to the wall of the cavity **8**. This cavity **8** is completely filled with oil or other incompressible liquid. Owing to the way in which it is made, the die **9** is deformable like a fluid, that is to say, it exerts an even and normal reaction on the surface of the object causing its deformation. The tray **3** supports a cylinder **11** hereinafter called stamping cylinder, comprising a piston **12** connected by a rod **13** and a flange **14** to the slide **6** in relation to which the piston rod **13** can be displaced during certain stages of the working of the press. The flange **14** forms a stop for raising the slide **6** and for this purpose bears against a shoulder **16** formed in a bore **15** made in the slide for positioning the rod **13**.

17 designates a stamping punch integral with the flange **14** and traversing the blank-clip **7** which has an opening **18** whose shape corresponds to that of the punch **17**.

Other than the members described above, the frame **1** holds a liquid tank **28** mounted on supports **27**.

The stamping cylinder **11** is connected at its upper part by piping **29**, to one of the ends of a cylinder **30** forming a part of an assembly generally called hereinafter compensating element. The other end of this cylinder **30** is connected to the cavity **8** of the die **9** by piping **31**. **29***a* and **31***a* designate anti-return adjustable pressure limiting check valves which respectively effect the communication of the pipings **29** and **31** by pipes **29***b* and **31***b* with a fluid tank **41**. These check valves, which are intended to prevent any harmful over-pressure in the pipings **29** and **31** are advantageously provided with members regulating their loading. The pressure compensating element having the cylinder **30** contains a piston **32** forming a separator. This cylinder further comprises, at its lower part, a labyrinth joint **33** in which a rod **34** is guided, said rod connecting the piston **32** to a piston **35** of a second cylinder **36**. This piston **35** delimits two chambers **37** and **37***a* in the cylinder **36** which are completely filled with liquid supplied, for moving the piston **35** in one direction or the other, by means of two pumps **39**, **39***a* respectively connected by piping **38** and **38***a* on the one hand, to the chambers **37** and **37***a*, and on the other hand, to the liquid tank **41**, by suction tubes **42**. The pipings **38** and **38***a* are, furthermore, connected to the tank **41** by adjustable check-values 38_1 and $38a_1$.

As shown in the drawing, the pumps **39**, **39***a*, as well as the other pumps which are described hereafter, comprise filters or strainers **43** in their suction tubes **42**.

In addition to the cylinder **30** the compensating element comprises two identical differential cylinder arrangements generally designed by references **45** and **45***a* and respectively comprising cylinders **46**, **46***a* in communication with the cylinder **30** on both sides of the separator piston **32** which delimits chambers **50** and **50***a*. These cylinders **46** and **46***a* extend axially with cylinders **47** and **47***a* of larger diameter and free pistons **48** and **48***a* having respectively portions the diameter of which correspond to the inner diameter of the cylinders **46**, **47** and **46***a*, **47***a* respectively are freely mounted inside said cylinder arrangements **45**, **45***a*. The portion of larger diameter of the pistons **48** and **48***a* delimit, with the end of the cylinders **47** and **47***a*, chambers **49** and **49***a* filled with liquid supplied by conduits **51** and **51***a* connected to the outlet of low delivery pump **52** and **52***a*, whose intake communicates with the tank **41**. Check-

valves 51_1 and $51a_1$, whose loading is adjustable, connects the conduits 51 and 51*a* to the tank 41.

As can be seen from the foregoing, the pressure in the cylinders 46 and 46*a* of the differential cylinder arrangements 45 and 45*a* is respectively equal to the pressure prevailing in the chambers 50 and 50*a* of the cylinder 30, whereas the pressures prevailing in the chambers 49 and 49*a* are only a fraction of the above-mentioned pressures, owing to the difference in section of the cylinders 46, 47, on the one hand, and 46*a*, 47*a* on the other. So that the working of the differential cylinder arrangements 45, 45*a* is not disturbed, the cavities 49_1 and $49a_1$ which they respectively delimit communicate with the atmosphere by discharge conduits 40, 40*a*.

53 designates a pump of relatively high delivery, fed from the tank 41 and intended to supply liquid to the conduits 54 and 55 respectively communicating with the pipings 29 and 31. Check-valves 56 and 57 are mounted on the conduits 54 and 55 above the intersection of the latter with the pipings 29 and 31. The pump 53 is intended to supply liquid to the cavity 8 of the die and to the chamber 67 of the stamping cylinder 11 controlling the down-stroke of the punch so that said cavity and jack are properly filled. This pump may be a low pressure pump and is used only for the starting of the machine.

The chamber 67 of the cylinder 11 is put into communication with the auxiliary tank 28 by means of two conduits 58 and 59, each being respectively provided with an inlet check-valve 60 and a valve or cock 61. The lower chamber 66 of the stamping cylinder 11 is also connected to the auxiliary tank 28 by conduits 62 and 63, a valve or cock 64 being branched on the conduit 62 and a delivery pump 65 being branched on the conduit 63. It is quite obvious that other regulating members for the circulation of the fluid can be used.

When the cock 64 is closed, the liquid contained in the lower chamber 66 of the stamping cylinder 11 prevents the premature descent of the slide 6 and punch 17, which forms a locking of the slide in the high position. This locking is complemented by mechanical locking means.

The filling of the machine with oil or any other liquid is first of all effected by means of the pump 53 in communication with the upper chamber 67, of the cylinder 11, the chambers 50 and 50*a* of the cylinder 30, and the cylinders 46 and 46*a* which has the effect of bringing the pistons 48 and 48*a* to their starting position. The pump 53 also effects the filling of the cavity 8 of the die 9, of part 50*a* of the compensator 30 and the cylinder 46*a*. The delivery pump 65 simultaneously causes the filling of the lower chamber 66 of the cylinder 11, which has the effect of making the piston 12 rise to its top position (starting position), and the pressure pumps 39, 39*a*, 52 and 52*a* enable the respective filling of the cavities 37, 37*a*, 49 and 49*a* of the second cylinder 36 and of the cylinder arrangement 45 and 45*a*. The calibration or loading of the check-valve 38*a* is selected so that the piston 35 connected by the rod 34 to the piston 32 reduces the cavity 37 to a minimum (starting position). During the filling of the above referred to cylinders and cavities, the check-valves 51_1 and $51a_1$ and the cock 61 are open.

In the first stage of the working operation, the slide is unlocked, the cock 64 is then opened to enable the slide 6 to descend by gravity along the guides 5 to its low position where it is locked again. The slide driving the piston 12 by means of the rod 13, causes the intake of the liquid coming from the auxiliary tank 28 into the top part of the cylinder 11, since the valve 60 is open under the effect of this attraction. The oil contained in the lower chamber 66 of the cylinder 11 is driven into the auxiliary tank 28, through the duct 62 of which the cock 64 has been opened at the same time that the mechanical unlocking of the slide occurred. The descent of the piston 12 causes the slide 6 and the punch 17 to bear against the blank 10.

The second working stage consists, after the descent of the slide and its mechanical locking with the body at the lower position to produce the pressing of the blank 10 under hydraulic pressure so that said blank is conveniently maintained for the following operations. For this, the delivery pressure of the pumps 52 and 52*a*, which are started at that time is applied in the chambers 49, 49*a* of the cylinders 47 and 47*a* on the pistons 48 and 48*a*. The value of this pressure is determined by the loading of the valves 51_1 and $51a_1$.

The pressure transmitted to the liquid contained in the chambers 50 and 50*a* of the compensating cylinder 30 by the pistons 48 and 48*a* is amplified, because the surface of the pistons 48, 48*a* on which the pressure is exerted from above is greater than the surface of the parts of these pistons placed in the cylinders 46, 46*a*. Seeing that the chamber 50 of the cylinder 30 is in communication with the upper chamber 67 of the stamping cylinder 11, the pressure in this cylinder is the same as that prevailing in said chamber 50. Likewise, the pressure of the liquid of the chamber 50*a* of the cylinder 30 is transmitted to the liquid contained in the cavity 8 of the die, thus causing the pressing of the blank 10 between the blank-clip 7 carried by the slide 6 locked in its lower position and the resilient die 9. The pressure being also applied to the punch 17, it follows that the latter is also pressed against the blank with a pressure at least equal to that applied between the die 9 and the blank-clip 7 and in fact higher due to the difference between the area of the piston 12 and of the punch 17. It results of these conditions that the punch is firmly applied against the blank the pressure it applies being directed according to the direction in which the stamping is to be made. Simultaneously with the starting of the pump 51_1, $51a_1$, the check-valves 29*a* and 31*a* have been loaded to the required pressure which corresponds to the maximum pressure which is to be developed during the following operation of stamping.

The third work stage which forms the stamping itself is effected by starting the pump 39 and by acting on the adjustment of the valves 38_1 and $38a_1$ in the sense for which the pressure is increased in the chamber 37 of the second cylinder 36 and decreased in the chamber 37*a*, i.e. the valve $38a_1$ is opened and the valve 38_1 loaded at a suitable pressure. This action has the effect of causing the displacement of the piston 35 and hence the separator piston 32 of the cylinder 30. The liquid delivered from the chamber 50 of the cylinder is brought into the upper chamber 67 of the stamping cylinder 11 and owing to the off-balance of pressures resulting between the chamber 67, on the one hand, and the cavity 8 of the die, on the other which communicates with the chamber 50*a*, it follows that the piston 12 is moved downwards while bringing down the punch 17. As the punch progressively descends, the blank 10 and the resilient die 9 are deformed, which causes the discharge from the cavity 8 of a quantity of liquid appreciably equal to the volume of the part stamped. This discharged liquid is brought by the piping 31 into the chamber 50*a* of the cylinder 30. From this working, it results that the stamping of the blank 10 is practically carried out without loss of power, the necessary power for producing the deformation itself of the blank 10 being provided by the dynamic action of the piston 35.

Seeing that the volume of liquid that is required to be introduced during the stamping stage into the chamber 67 is always greater than the volume of liquid delivered from the cavity 8, the pistons 48 and 48*a* are displaced to a corresponding extent for decanting a sufficient quantity of liquid to effect compensation. This displacement of the differential pistons 48 and 48*a* takes place up to the moment when they are brought to a balancing position, which depends on the calibrated pressure of the flap-

valves, 29*a* and 31*a* (calibrated pressure determined in function of the shape to be imparted to the parts for stamping) and the volume of liquid to compensate between the cavity 8 of the die and the upper chamber 67 of the stamping cylinder 11.

A fourth work stage consists of extracting the stamped part without deforming it and returning the working members to their initial position. To this end, at the end of the stamping stage, the valves 31*a* and $51a_1$ are open, which has the effect of causing the discharge of the cavity 8 of the die and consequently suppressing the effort exerted on the part surrounding the punch. The cock 61 is then opened and the discharge valves 29*a* and 51_1 are released for lowering the pressure in the chambers 67 and 50. Finally, the slide is unlocked and the pump 65 is put into action for supplying the lower chamber 66 of the stamping cylinder 11 so as to cause the piston 12 to rise, and consequently, that of the punch, then the slide. The rise of the slide only occurring from the moment when the flange 14 is brought into contact with the shoulder 16, it follows that the stamped part is automatically extracted from the punch, then released when the slide begins to be raised. Simultaneously, a part of the liquid contained in the chamber 67 is returned into the chamber 50 of the cylinder 30, which has the effect of displacing the separator piston 32 until the moment when it again assumes its starting position. The excess liquid is discharged into the tank 28. At the same time, the liquid delivered by the pump 39*a* also started keeps the chamber 37*a* of the cylinder 36 completely filled and the pump 53 effects the return to the waiting position of the remainder of the hydraulic circuit.

Seeing that all the elements of the circuit comprise pressure limiting adjustable check-valves, the pumps can operate continuously without risk of wear and tear. As can be seen, at least some of the pumps can be replaced by one or more pressure accumulating devices placed selectively in circuit by distributing members. Likewise, the hydraulic circuit, described in detail in the foregoing, can also equip a hydraulic press with a die of resilient material for which the arrangement of the die and jack equipped with a punch would be inverted.

FIG. 2 shows an alternative embodiment in which the same constitutive elements of the press having the same reference numerals are arranged in a different manner.

The differential cylinder 45 is directly mounted on the stamping cylinder 11, so that the cylinder 46 is in communication with the upper chamber 67. Likewise, the differential cylinder 45*a* is so mounted that the cylinder 46*a* is in communication with the cavity 8 of the die. Consequently, these differential cylinders directly control the pressures of liquid contained in the chamber 67 of the stamping cylinder 11 and in the cavity 8 of the die 9.

As in the preceding example, the chambers 50 and 50*a*, delimited on either side of the piston 32 in the cylinder 30, are put into communication with the chamber 67 and the cavity 8 by the conduits 29 and 31. As in the previous case, the conduits 29 and 31 are connected by adjustable check-valves 29*a* and 31*a* to the tank 41.

The invention is not restricted to the examples of embodiment, shown and described in detail, for various modifications can be applied to them without going outside of its scope.

I claim:

1. An hydraulic forming press having a die-cavity filled with liquid, a resilient diaphragm closing said cavity and constituting a die-element, a punch located in front of said die for cooperation therewith, a piston connected to said punch for actuation thereof, a stamping cylinder into which said piston is slidably mounted to delimit an actuating chamber and a releasing chamber, means for supplying said operating chamber with liquid under low pressure bringing said punch in contact with a blank placed to bear on said diaphragm, a slide connected to said punch to have a free limited movement with respect to the latter, a blank-clip carried by said slide to bear on said blank when said operating chamber is filled with liquid, an hydraulic cylinder arrangement interconnecting said die-cavity and said actuating chamber of the stamping cylinder, hydraulic pressure generating means associated to said cylinder arrangement to evolve therein a static pressure thus applied simultaneously into said actuating chamber and into said die-cavity, a separator piston slidably mounted inside said cylinder arrangement, said separator piston constituting a movable partition inserted between said die-cavity and said actuating chamber and means for actuating said separator piston to increase the pressure into said actuating chamber with respect to the static pressure established into said die-cavity.

2. An hydraulic forming press having a die-cavity filled with liquid, a resilient diaphragm closing said cavity and constituting a die element, a punch located above said die for cooperation therewith. a piston rigidly connected to said punch for actuation thereof, a stamping cylinder into which said piston is slidably mounted to delimit an actuating chamber and a releasing chamber, means for supplying said operating chamber with liquid under low pressure to bring said punch in contact with a blank lying on said diaphragm, means for supplying said releasing chamber with liquid to cause the rising of the punch, said punch having a protruding flange integral with a piston rod connecting said piston of the stamping cylinder and said punch, a slide freely mounted on said piston rod, bearing against said flange and extending substantially in alignment with the lowest portion of said punch, guide members carried by the press to guide said slide vertically, a blank-clip fixedly mounted beneath said slide, said blank-clip having a central hole correspondingly shaped to said punch engaged inside said hole, said blank-clip bearing onto said diaphragm when said operating chamber of the stamping cylinder is filled with liquid, an hydraulic cylinder arrangement interconnecting said die-cavity and said actuating chamber of the stamping cylinder, hydraulic pressure generating means associated to said cylinder arrangement to evolve therein a static pressure thus applied simultaneously into said actuating chamber and into said die cavity, a separator piston slidably mounted inside said cylinder arrangement, said separator piston constituting a movable partition inserted between said die-cavity and said actuating chamber and means for actuating said separator piston to increase the pressure into said actuating chamber with respect to the static pressure established into said die-cavity.

3. An hydraulic forming press having a die-cavity filled with liquid, a resilient diaphragm closing said cavity and constituting a die element, a punch located in front of said die for cooperation therewith, a piston connected to said punch for actuating thereof, a stamping cylinder into which said piston is slidably mounted to delimit an actuating chamber and a releasing chamber, means for supplying said operating chamber with liquid under low pressure bringing said punch in contact with a blank lying on said diaphragm, a slide connected to said punch to have a free limited movement with respect to the latter, a blank-clip carried by said slide to bear on said blank when said operating chamber is filled with liquid, a cylinder arrangement completely filled with liquid interconnecting said operating chamber and said die-cavity, said cylinder arrangement having a cylinder of constant diameter connected near its both ends with two differential cylinders having respectively a portion of small diameter in communication with said cylinder of constant diameter and a portion of larger diameter extending axially with respect to said portion of small diameter, free pistons having portions corresponding to said differential cylinders freely mounted therein, a liquid adjustable pressure supplying pump arrangement connected to the portion of larger diameter of each one of the differential cylinders to evolve inside the cylinder of constant diam-

eter and in the die-cavity and in the actuating chamber interconnected to said cylinder of constant diameter a static pressure causing the blank to be pressed by the diaphragm against the blank-clip and the punch to be pressed against said blank, a separator piston mounted inside said cylinder of constant diameter between said differential cylinders, delimiting upper and lower chambers therein, a control cylinder mounted in alignment with said cylinder of constant diameter, said control cylinder having a piston carrying a piston rod for connection with said separator piston and delimiting two chambers inside said control cylinder, a second reversible adjustable pressure supplying pump arrangement connected to said chambers of the control cylinder to cause moving of said piston of the control cylinder whereby said separator piston of the cylinder of constant diameter is correspondingly moved thus causing the pressure in said upper chamber of the cylinder of constant diameter to increase and consequently the pressure in said operating chamber of the stamping cylinder to increase whereby stamping of the blank-clip occurs and further whereby liquid is transferred from said die-cavity to said lower chamber of the cylinder of constant diameter.

4. An hydraulic forming press having a die-cavity filled with liquid, a resilient diaphragm closing said cavity and constituting a die element, a punch located in front of said die for cooperation therewith, a piston connected to said punch for actuation thereof, a stamping cylinder into which said piston is slidably mounted to delimit an actuating chamber and a releasing chamber, means for supplying said operating chamber with liquid under low pressure bringing said punch in contact with a blank lying on said diaphragm, a slide connected to said punch

to have a free limited movement with respect to the latter, a blank-clip carried by said slide to bear on said blank when said operating chamber is filled with liquid, two differential cylinders, having respectively a cylinder of small diameter and a cylinder of larger diameter located in alignment one with respect to the other and enclosing a free piston having two distinct portions rigidly connected together and corresponding to each one of said cylinders, said differential cylinders being respectively in communication by their small cylinders to said actuating chamber and to said die-cavity, a liquid adjustable pressure supplying pump arrangement connected to the cylinder of larger diameter of each differential cylinder to evolve inside said actuating chamber and die-cavity an amplified static pressure, a cylinder of constant diameter completely filled with liquid having at both ends ducts for interconnecting together said die-cavity and said actuating chamber, thus causing the static pressure to be equalized, a separator piston mounted inside said cylinder of constant diameter, a controlling cylinder mounted in alignment with said cylinder of constant diameter and enclosing an operating cylinder and a piston rod for connection with said piston of the cylinder of constant diameter and a liquid variable pressure supplying pump arrangement connected to said controlling cylinder.

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