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[54] **FORGING MACHINE**

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[58] **Field of Search** 72/402, 453, 403, 404, 452, 72/450

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[57] **ABSTRACT**

A forging machine is disclosed having two pairs of opposed rams uniformly and angularly spaced around a workpiece feeding axis. Each ram has two working hydraulic actuator pistons for moving the ram in a working stroke, and a single retracting hydraulic actuator piston for retracting the ram. Two pump units are provided, one opposite the other, on opposite side of the machine. Each pump unit services two rams, one from each of the two pairs of rams, in order that the rams may be simultaneously driven in working and retracting strokes to forge a workpiece being fed along the workpiece feeding axis.

4 Claims, 2 Drawing Figures

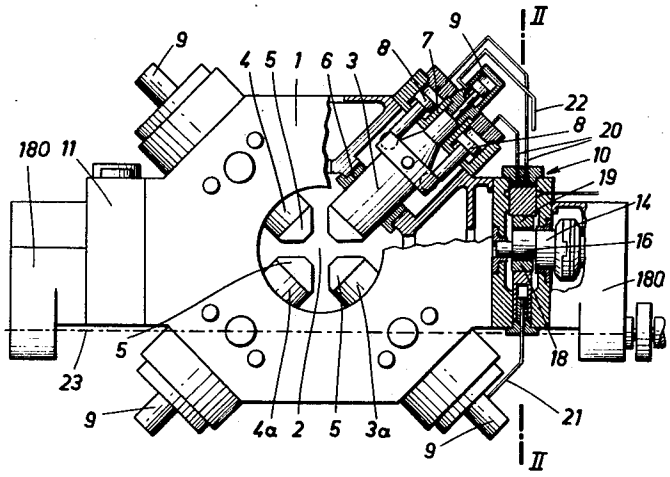
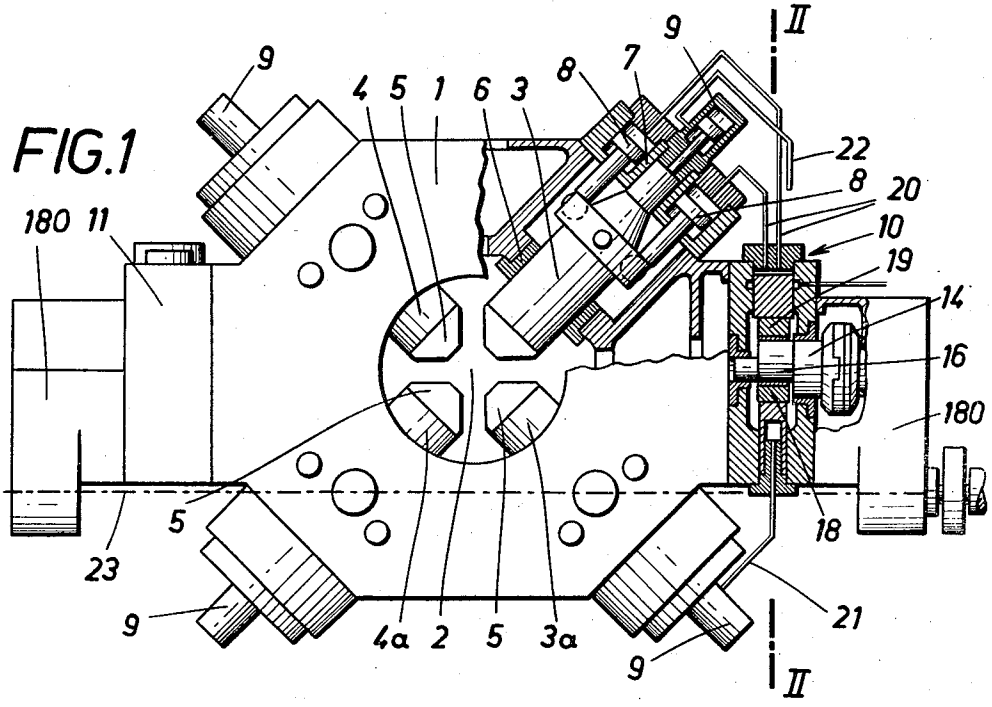


FIG.1



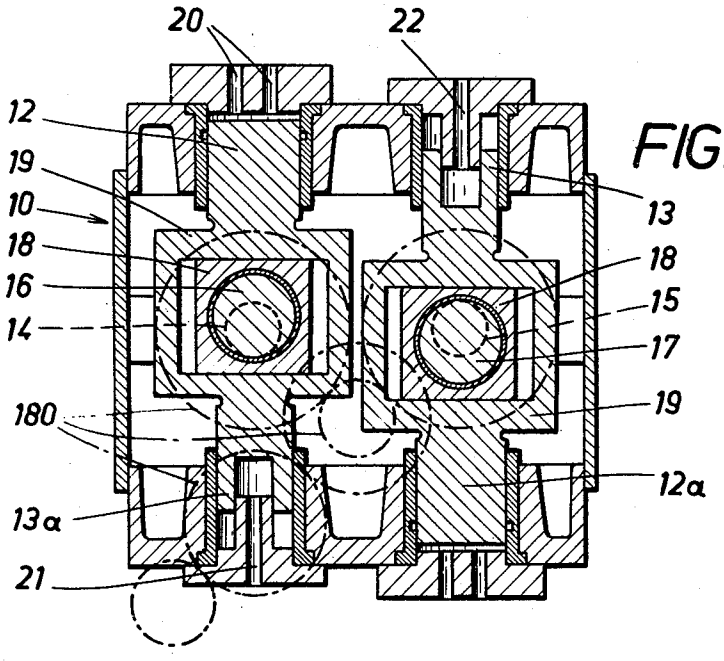


FIG.2

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FORGING MACHINE

This invention relates to a forging machine which comprises four forging rams which are angularly spaced 90° apart, or two mutually opposite forging rams, which rams extend and are displaceable radially with respect to the axis of the workpiece and at their end carry shaping tools and are movable by means of hydraulic actuators.

Such forging machines are mainly intended for shaping workpieces having large dimensions in cross-section and consisting of such materials that it is difficult to roll them directly from the ingot. The shaping of such workpieces gives rise to high torques so that the members of the drive means of the known and well-tried forging machines which are mechanically driven must be so large and strong that the manufacture of the machine would not be economical.

A forging machine is known in which the shaping tools are hydraulically driven. These tools are directly secured to the four forging rams formed by the pistons or piston rods of the hydraulic actuators and the working stroke is derived from four pump pistons, which are rigidly connected and disposed one beside the other and mounted on another reciprocating piston or the like and which are movable in cylinders communicating with those cylinder chambers of the actuators which are remote from the workpiece. Retracting actuators which are provided for retracting the shaping tools from the workpiece and are supplied with fluid under pressure from respective accumulators. That known machine has various disadvantages. Because the pump pistons associated with all four actuators are disposed adjacent to each other, some of the conduits which connect the pump cylinders and the cylinders of the actuators must be relatively long. Because the hydraulic fluid is compressible to some extent and the long conduits can elastically deform under the high pressures applied, oscillations or the like may arise in the hydraulic systems and may prevent an exact or dimensionally accurate forging operation. Besides, that known machine cannot be designed to have a closely arranged, compact structure. The hydraulic accumulators provided for the retracting actuators add to the structural expenditure. Besides, each of the forging rams which form also the pistons or piston rods of the hydraulic actuators is provided with only one sliding guide, which is disposed between he pistons and the workpiece. Because the lines of action of the forces which occur are not always exactly aligned with the axis of the piston or ram, a canting and at least an increased wear in the cylinders of the hydraulic actuators may result.

It is an object of the invention to eliminate these disadvantages and to provide a forging machine of the kind defined first hereinbefore, which machine is comparatively simple and compact in structure and in which oscillations or the like in the hydraulic systems are avoided as far as possible and no difficulties are involved in the guidance of the rams.

This object is accomplished according to the invention in that each forging ram is provided with two spaced apart sliding guides and at least two hydraulic actuators for the working movement, which actuators are uniformly spaced around the axis of the ram, and an axial retracting hydraulic actuator, and the hydraulic

actuators of each pair of directly adjacent forging rams have associated with them a pump unit, which is secured to the machine housing and comprises two large piston pumps having a relatively large effective piston area, two small piston pumps and two eccentric shafts rotating in synchronism, each of said eccentric shafts being connected by an elliptic chuck or the like to a large piston pump and a small piston pump which is coaxial with and disposed opposite to said large piston pump, said large piston pumps supplying pressure fluid to said actuators for the working movement and said small piston pumps supplying pressure fluid to the retracting actuators. Because each forging ram is provided with two sliding guides which are spaced a suitable distance apart, all forces can be taken up satisfactorily and canting or the like can be avoided. Since the working movement is imparted to the rams by actuators which are uniformly spaced around the axis of the ram, no torque is developed by the forces transmitted from the actuators to the rams. As a pump unit is associated with each pair of directly adjacent forging rams and the actuators for these rams, said pump unit may be secured to the machine housing very close to the actuators so that the conduits which connect the pump cylinders to the cylinder chambers of the actuators are as short as possible, the liquid cushions are relatively small, and oscillations or the like in the hydraulic systems are substantially avoided. Besides, the forging machine has a simple, compact and clearly arranged structure. The working stroke is derived from the two large piston pumps which are connected to the actuators for the working movement of the rams whereas the small piston pumps serve to retract the pistons so that accumulators are not needed for this purpose. The retracting actuator may be coaxial with the associated ram because the retracting stroke requires only much smaller forces and the forging reaction forces need not be allowed in this stroke. As a larger piston pump and a smaller one are coaxially arranged opposite to each other and driven by the same eccentric, the pistons of these pumps will move in phase opposition so that the pressure stroke of one pump piston and the suction stroke of the other pump piston will be necessarily performed at the same time, the supply of pressure fluid to the actuators will be properly timed in a simple manner, and it is sufficient to supply pressure fluid to only one end of each piston of all actuators. The arrangement may be such that the larger of the two piston pumps driven by a common eccentric is associated with the actuator for the working movement of one forging ram and the smaller of these two pumps is associated with the retracting actuator of the adjacent forging ram so that the connecting conduits are further reduced in length. It will be understood that in machines comprising four forging rams the two pump units will be synchronized or have a common drive means.

A desirable and space-saving design of the pump unit will be obtained if the piston pumps thereof are arranged so that a larger piston pump and a smaller one are disposed one beside the other with parallel axes and the eccentrics of the two parallel eccentric shafts are relatively displaced 180° in phase so that the supply of pressure fluid to the actuators is properly timed.

An embodiment of the invention is shown by way of example in simplified or diagrammatic views in the accompanying drawing, in which

FIG. 1 is a partly sectional view showing an overall machine and FIG. 2 is an enlarged sectional view showing the pump unit and taken on line II—II in FIG. 1.

A forging housing 1 comprises four forging rams 3, 3*a*, 4, 4*a*, which carry shaping tools 5 at their ends. The rams extend radially with respect to a workpiece axis 2 and are angularly spaced 90° apart and inclined by an angle of 45° from the horizontal. Each of the forging rams 3, 3*a*, 4, 4*a* carries at its end face a shaping tool 5 and is provided with two sliding guides 6, 7 which are considerably spaced apart. The forging rams are held against rotation, of course. Each forging ram is connected to two hydraulic actuators 8, which are symmetrically disposed with respect to the axis of the ram. It will be understood that hydraulic actuators may be provided in a larger number and uniformly spaced around the axis of the ram. These actuators 8 impart to the forging rams 3, 3*a*, 4, 4*a* the working movement, i.e., the stroke of the ram toward the workpiece. The rams are retracted from the workpiece by retracting actuators 9. Pressure is supplied only to one end of each of the actuators 8 and 9.

The actuators 8, 9 for each pair of directly adjacent forging rams 3, 3*a* or 4, 4*a* are associated with a pump unit 10, 11, which is secured to the side of the machine housing 1. Each of these units 10, 11 comprises two large piston pumps 12, 12*a*, which have a relatively large piston area, two small piston pumps 13, 13*a*, and two parallel eccentric shafts 14, 15, whose eccentrics 16, 17 are displaced 180° in phase but may be driven in synchronism by a common spur gear train 18. The eccentrics 16, 17 are surrounded by links 18 of elliptic chucks having spiders 19, in which the links are slidable and which are directly connected to the pump pistons so that each revolution of the eccentric shafts results in an up-and-down motion of the pistons of the pumps 12, 13*a* and 12*a*, 13, respectively. The cylinder chamber of the piston pump 12 is connected by two conduits 20 to the actuators 8 for the ram 3. The cylinder chamber of the piston pump 13*a* is connected by a conduit 21 to the retracting actuator 9 for the ram 3*a*. A conduit 22 extends from the retracting actuator 9 for the ram 3 to the piston pump 13. The piston pump 12*a* supplies pressure fluid to the hydraulic actuators 8 for imparting a working movement to the ram 3*a*. Hence, the working movement of the rams 3, 3*a* is derived from the large piston pumps 12, 13*a* and the retracting movements of these rams are derived from the small piston pumps 13, 13*a*. The arrangement is such that the conduits from the piston pumps to the hydraulic actuators are as short as possible and the supply of pressure fluid to these actuators is properly timed. Similarly, the pump unit 11 supplies pressure fluid to the hydraulic actuators for the rams 4, 4a. The two units 10, 11 are operated in synchronism or have a common drive shaft 23.

Because the rams 3, 3*a*, 4, 4*a* have guided in accordance with the invention in the sliding guides 6, 7, any transverse or tilting or twisting forces which may be due to an eccentric action of force on the shaping tools 5 are withhold from the sensitive actuators 8. Only when the forging rams perform a transverse movement owing to the inevitable play in the guide are the corresponding pistons slightly canted; this canting can be taken into account by a cambered shape of the pistons and the provision of a floating seal preventing a leakage of oil at the piston rod. With this arrangement, the machine will operate reliably even when the sliding guides 6, 7 have suffered substantial wear. All hydraulic means are desirably disposed outside the range in which they would be subjected to the action of heat from the incandescent workpiece. Finally, the sliding guides for the rams may be lubricated with heavy-bodied oil independently of the hydraulic system. The forging machine need not essentially comprise four forging rams because only two forging rams, which are disposed diametrically opposite to each other, may be sufficient in some cases.

What is claimed is:

1. A forging machine, which comprises

a machine housing defining a feeding path for a workpiece, which feeding path has an axis,

one to two pairs of forging rams, which are uniformly angularly spaced around said axis and extend and are displaceable radially with respect to said axis to perform a working stroke toward said axis and a retracting stroke away from said axis, each of said rams having an inner end which faces said axis and carries a shaping tool, the rams of each pair being directly angularly adjacent to each other,

a plurality of pairs of sliding guides, the sliding guides of each of said pairs thereof being arranged to guide one of said rams in the longitudinal direction thereof and being spaced apart in said longitudinal direction,

a plurality of sets of working hydraulic actuators, each of which sets is associated with one of said rams and comprises a plurality of actuators uniformly angularly spaced around the associated ram and operable to impart said working stroke thereto,

a plurality of retracting hydraulic actuators, each of which is associated with one of said rams and operable to impart said retracting stroke to said ram, and

pump means comprising for each of said pairs of rams a pump unit, which is secured to said machine housing laterally of said axis and comprises two large piston pumps, two small piston pumps having a smaller piston area than said large piston pumps, each of said large piston pumps being coaxial with and disposed opposite to one of said small piston pumps, and two eccentric shafts, each of which is operatively connected to one of said large piston pumps and to the small piston pump which is coaxial with and disposed opposite to said one large piston pump,

said machine further comprising

drive means operable to rotate said two eccentric shafts of each of said pump units in synchronism, and

conduit means for supplying pressure fluid from each of said large piston pumps to said working actuators associated with one of said rams of the associated pair, and from each of said small pumps to said retracting actuator associated with one of said rams of the associated pair.

2. A forging machine as set forth in claim 1, which comprises two of said pairs of rams and in which said rams are angularly spaced 90° apart.

3. A forging machine as set forth in claim 1, in which each of said eccentric shafts is operatively connected by an elliptic chuck to the piston pumps associated therewith.

4. A forging machine as set forth in claim 1, in which the piston pumps in each pump unit are arranged so that one of said large piston pumps and one of said small piston pumps are disposed one beside the other with parallel axes,

said two eccentric shafts are parallel,

each of said eccentric shafts carries an eccentric, and

said eccentrics on the two eccentric shafts of each pump units are relatively disposed 180° in phase.

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