Dec. 21, 1965 B. KRALOWETZ 3,224,244

SWAGING MACHINE

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FIG.1

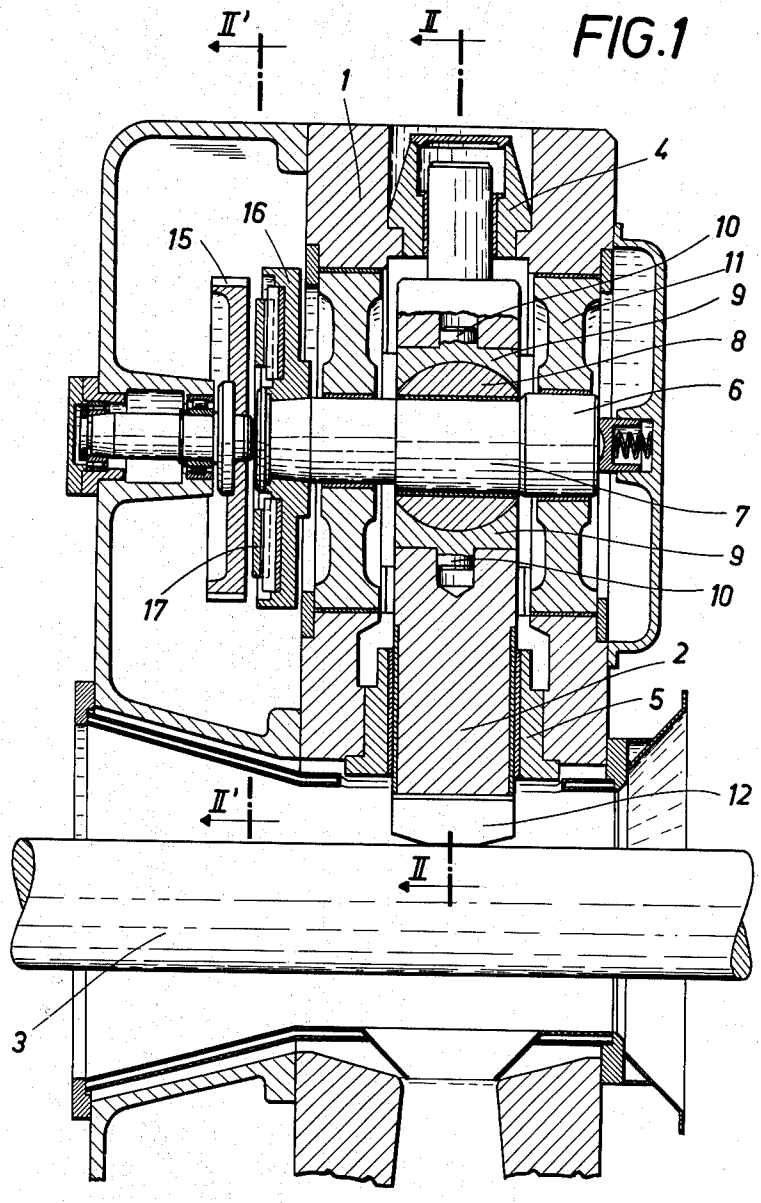

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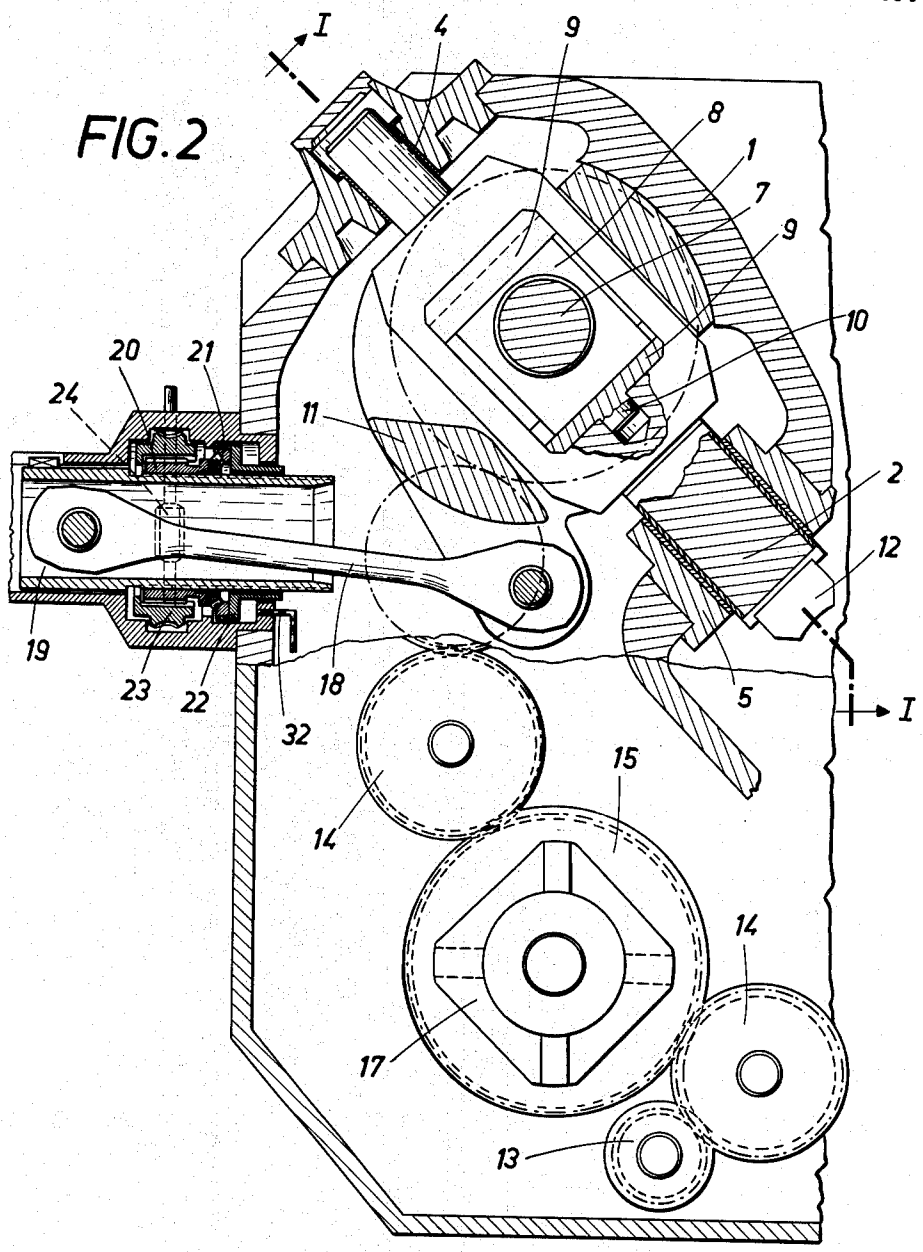
FIG. 2



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SWAGING MACHINE

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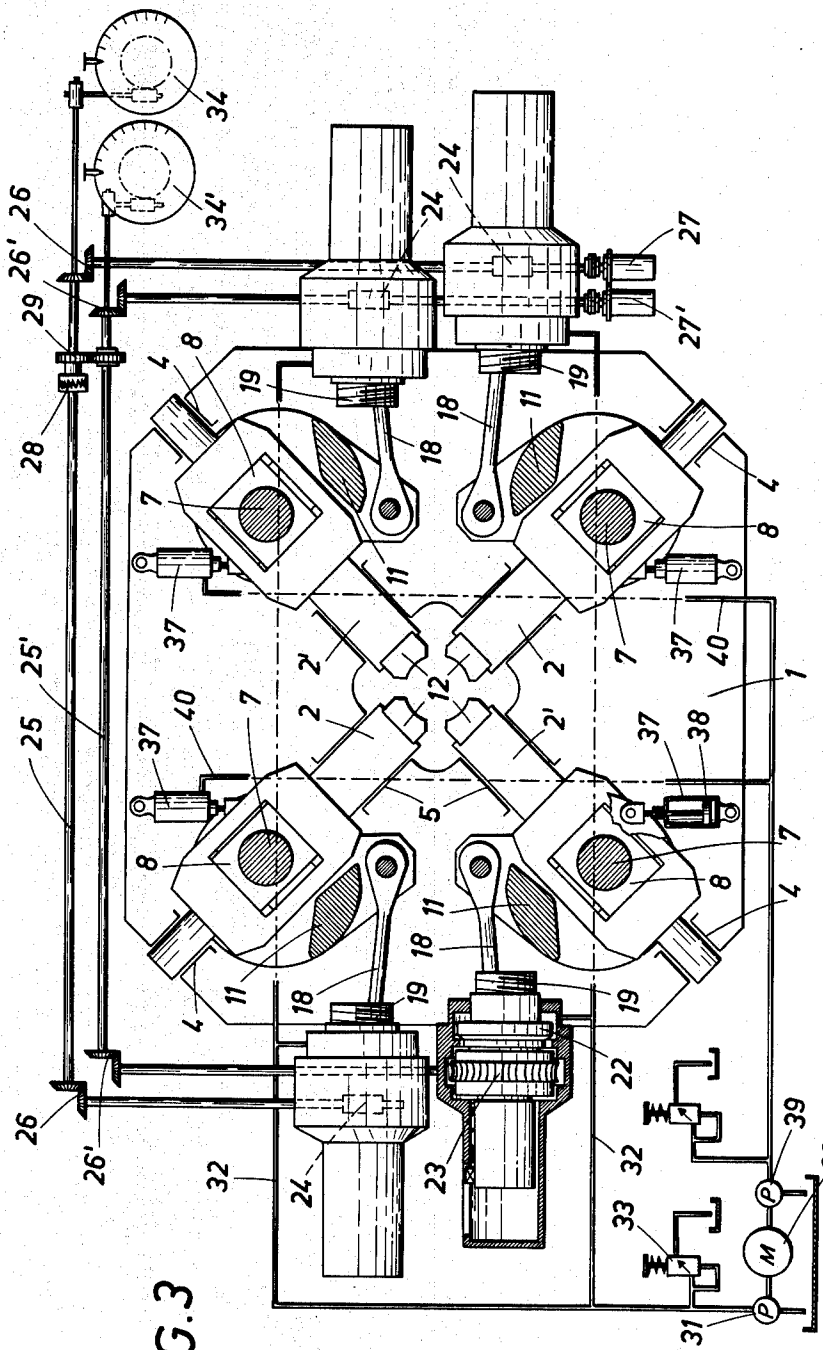

FIG. 3

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SWAGING MACHINE

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Claims priority, application Austria, May 20, 1963, A 4,045/63
7 Claims. (Cl. 72—402)

This invention relates to a swaging machine having preferably four hammers which are radially directed towards the axis of the workpiece and are driven by eccentrics and have driving shafts eccentrically mounted in cylindrical housings rotatably adjustably mounted in the swaging box, in which machine each adjusting housing is connected to a backing piston, which is displaceable in a cylinder and under the action of hydraulic pressure, which piston retains the housing against a rotation in the hammer-opening sense during the hammer blow until a swaging pressure has been reached which is determined by a suitably adjustable overpressure relief valve incorporated in the hydraulic system. Such a machine is described in Patent No. 3,165,012. If the swaging pressure becomes excessive by any mistake in operation, the overpressure relief valve permits of an escape of liquid, the backing piston is displaced so that the adjusting housing is rotated by the swaging pressure in the hammer-opening sense and detrimental reactions on the machine and its parts are prevented. In this way, a simple and reliable means for protection against overload is obtained. According to the above-mentioned patent, hydraulic pressure is applied to both ends of the backing pistons, and the latter serve also for an arbitrary rotation of the adjusting housings. This is the rotation which is required for varying the stroke position of the hammers according to the desired cross-sectional dimension of the workpiece. Hence, the backing piston must perform relatively large displacements so that large amounts of liquid are required in the cylinders of the backing pistons. It has now been found that the large number of hammer blows per unit of time, the compressibility of the liquid, and the elongation of the hydraulic conduits result in undesirable shakes or vibration so that the adjusting housings, the angular positions of which determine the penetration of the hammers into the workpiece, are not perfectly at rest during the operation. This will obviously have detrimental results regarding the result of the swaging operation. Besides, vibration and shakes result in a premature wear of the moving parts.

It is object of the invention to provide an improvement in this respect. The invention resides essentially in that each adjusting housing and its backing piston, which is subjected to pressure only at one end, is connected to a mechanical adjusting gearing, which serves for an arbitrary rotation of the housing. Hence, the adjusting pistons serve only to enable a yielding of the entire mechanism for rotating the adjusting housings in the case of overload whereas the rotation of the adjusting housings for setting the depth corresponding to the desired cross-sectional dimension of the workpiece is effected by the mechanical adjusting gearings, which are not liable to be subjected to vibration and which are free of other disadvantages involved in hydraulic transmissions.

A particularly suitable design will be obtained if each adjusting gearing comprises a nut, which is held in axial direction by the backing piston and is rotatable by a gear wheel, preferably a worm wheel, and a non-rotatable screw, which is articulatedly connected to the adjusting housing, the nut being non-rotatably but axially slidably coupled to the gear wheel or worm wheel. A rotation of

the nut will obviously result in an axial displacement of the screw. If the screw is connected to the adjusting housing, e.g., by a connecting-rod, the adjusting housing will be rotated in accordance with the axial movement of the screw. A worm wheel or worm gearing has the advantage of being self-locking. In spite of the stationary bearing of the gear wheel or worm wheel, an axial displacement of the nut is possible because the nut is non-rotatably but axially slidably connected to its drive wheel. Such an axial displacement is necessary to enable the action of the backing piston in case of an overload.

In a machine which comprises four hammers, it is a feature of the invention that the adjusting gearings for the adjusting housings associated with each pair of two opposed hammers are adapted to be jointly driven and to be selectively coupled to the adjusting gearings associated with the other pair of hammers. Hence, the stroke position of each pair of opposed hammers will always be displaced simultaneously and to the same extent, whereas the adjustment of the other pair of hammers is independent of the adjustment of the first-mentioned pair, as is necessary for obtaining workpieces having a rectangular cross-section. When the adjusting gearings associated with all four hammers are coupled together, a joint adjustment will be obtained to obtain workpieces having a circular or square cross-section.

In a development of the invention, each adjusting housing is connected to an additional piston, which is subjected to hydraulic pressure at one end and tends to rotate the adjusting housing in the same direction as the swaging pressure, the hydraulic pressure acting on the backing piston being a multiple of the pressure acting on this additional piston. In view of the large number of hammer blows, the inevitable backlash in the bearings of the adjusting gearings and in the means connecting them to the adjusting housings would result in vibration in the adjusting gearings and consequently in an increased wear of the sliding or other movable parts. Hence, this backlash must be eliminated. This is effected by the additional piston, which exerts on the adjusting housing a torque, which is transmitted as a tensile force to the adjusting gearing and urges all moving parts into engagement in the direction of the swaging blow to be expected. In this way, the backlash between the moving parts is eliminated before the blow so that the actual hammer blow cannot result in a shock load on the gearing parts. The initial stress which is due to the additional piston has also the desirable result that the adjusting housing itself is urged against its bearing surface which is remote from the workpiece so that there will be no shocklike pressure action at this point during the hammer blow.

Finally, according to the invention, each backing piston has associated with it a switch, which is operable by the backing piston when the latter is displaced under the action of an overload and serves for directly or indirectly energizing the motors for driving the adjusting gearings in the sense of a rotation of the adjusting gearings in a hammer-opening direction. This feature provides a further protection against overload. The displacement of the backing piston results first in a rotation of the adjusting housings in the hammer-opening sense. Then the operation of the switch starts the mechanical adjusting gearing in the same sense so that the hammers will be reliably opened to a sufficiently large extent.

An embodiment of the invention is shown by way of example on the accompanying drawing, in which

FIG. 1 is a fragmentary sectional view taken on line I—I of FIG. 2 and showing a part of a swaging machine,

FIG. 2 is a sectional view taken on lines II—II (upper half) and II'—II' (lower half) of FIG. 1, and

FIG. 3 is a diagrammatic view showing the entire machine.

Four hammers 2, 2' evenly spaced around the workpiece 3, which is centrally guided through the swaging box 1, are slidably mounted in the swaging box in fixed guides 4, 5 so as to be radially reciprocable with respect to the workpiece axis. The hammers 2 are driven by eccentrics 7 carried by shafts 6. The eccentrics 7 are embraced by a cylindrical sliding block 8, which is slidable transversely to the hammer axis in appropriately shaped shell members 9. The shell members 9 have central pins 10 mounted in the hammer 2 for a limited pivotal movement about the hammer axis. A rotation of the driving shafts 6 will reciprocate the hammers 2 in the radial direction of the workpiece 3 while the sliding blocks 8 perform a corresponding transverse movement. The driving shafts 6 are eccentrically mounted in cylindrical housings 11, which are capable of rotary adjustment in the swaging box 1. Owing to this eccentricity, a rotation of the adjusting housing 11 will change the distance from the driving shafts 6 to the workpiece axis. This enables an arbitrary adjustment of the stroke position of the hammers 2 and the penetration of the dies 12, secured to the hammers, into the workpiece.

The eccentric shafts 6 of all four hammers are driven by a common motor (not shown) by means of a belt drive or the like, a gear wheel 13, idler wheels 14, and spur gears 15, each of which is associated with one shaft 6. Owing to the change of the position of the shafts 6 by the rotation of the adjusting housings 11, the spur gears 15 cannot be rigidly coupled to the shafts 6. Each spur gear 15 and a flywheel 16 carried on the shaft 6 are designed to form the two coupling discs of a cross-keyed coupling (Oldham's coupling), the cross-keyed disc 17 of which has grooves on both sides whereas the spur gear 15 and the flywheel 16 carrying the sliding blocks engaging these grooves.

Each adjusting housing 11 is connected by a connecting rod 18 to a tubular screw 19, which is held against rotation. The screw is threaded into a nut 20, which bears by means of an axial bearing 21 on a piston 22, which is subjected to hydraulic pressure at one end, according to FIG. 2 on the right. The nut 20 is non-rotatably, but axially slidably coupled to a worm wheel 23, which meshes with a worm 24. The worms associated with each pair of diametrically oppoiste hammers 2 are jointly driven from a common hydraulic motor 27 by means of shafts 25 and angle gearings 26. The worms associated with the hammers 2' are jointly driven from a motor 27' by means of shafts 25' and angle gearings 26'. These two drive branches may be coupled together by means of a clutch 28 and two spur gears 29 (FIG. 3).

A pump 31 driven by a motor 30 serves for applying hydraulic pressure to the four backing pistons 22, and is connected by conduits 32 to the respective cylinder chambers. The backing pressure is determined by an adjustable overpressure relief valve 33. If the permissible-swaging pressure is exceeded, e.g., as a result of an excessive penetration of the dies 12 into the workpiece 3 or an insufficient swaging temperature, the force transmitted to the pistons 22 by the connecting rod 18, the screw 19 and the nut 20 will be increased. The hydraulic pressure will then rise beyond the value set at the valve 33 so that this valve opens and releases oil. Now the backing piston and with it the entire adjusting gearing can be displaced in such a manner that the adjusting housing rotates in the hammer-opening sense.

An arbitrary rotation of the adjusting housings 11 may be effected by the motors 27, 27', which drive the worms 24 and with them the worm wheels 23 in one sense of rotation or the other so that the tubular screws 19 are axially displaced in one direction or the other and the adjusting housings are rotated by means of the connecting-rods 18 to approach the hammers to or remove them from the workpiece. The amount of this adjustment may be read from circular scales 34, 34'. The energization and de-energization of the hydraulic motors 27, 27' may be selectively effected by hand by an operator in view of the information obtained by reading the scales.

Each adjusting housing 11 is engaged by another piston 38, which is guided in a cylinder 37 and subjected to pressure at one end. Pressure is applied to one end of these pistons 38 by a pump 39 through conduits 40. The pistons 40 tend to rotate the adjusting housing in the same sense as the forging pressure. Hence, they exert on the connecting-rods 18 a tensile force which eliminates the backlash throughout the adjusting gearings and urges their movable part inherently into engagement. The resultant which is due to the piston force and to the tensile force in the connecting-rod balancing the piston force will urge the adjusting housing against its bearing surface remote from the housing so that the bearing backlash and any impact when the hammers impinge upon the workpiece will also be eliminated at this point.

What is claimed is:

1. A swaging machine, which comprises a swaging box defining a path along which a workpiece is movable in the direction of its longitudinal axis, a plurality of cylindrical adjusting housings mounted in said swaging box and angularly adjustable in hammer-opening and hammer-closing directions, a plurality of hammer drive shafts, each of which is eccentrically and rotatably mounted in one of said housings, a plurality of eccentrics, each of which is carried by one of said shafts, a plurality of hammers, which are mounted in said box and movable toward and away from said path in a direction which is radial to said path, said eccentrics being operable by said shafts to drive said hammers toward said path for a hammer blow and away from said path, said hammers being adapted to be adjusted away from and toward said path by an angular adjustment of said adjusting housings in said hammer-opening and hammer-closing directions, respectively, a plurality of backing cylinders, a plurality of backing pistons, each of which is slidable in one of said cylinders and connected to one of said housings, a hydraulic system for supplying liquid under pressure to each of said cylinders at one end of said piston therein to enable said piston to resist an angular movement of said adjusting housings in the hammer-opening direction under the action of a hammer blow, said hydraulic system comprising an overpressure relief valve arranged to release liquid from said cylinders when the pressure applied to said relief valve exceeds a predetermined value, said machine further comprising a plurality of mechanical adjusting gearings, each of which is operatively connected to one of said housings and operable to effect an angular adjustment of said housing when this is desired.

2. A swaging machine as set forth in claim 1, which comprises four of said hammers.

3. A swaging machine as set forth in claim 1, in which said overpressure relief valve is adjustable with respect to said predetermined pressure.

4. A swaging machine as set forth in claim 1, in which each of said adjusting gearings comprises a non-rotatable screw, which is articulatedly connected to the respective adjusting housing, a gear wheel, and a nut, which is non-rotatably and axially slidably connected to said gear wheel for rotation thereby, said nut being axially held by the backing piston operatively connected to the respective adjusting housing.

5. A swaging machine as set forth in claim 4, in which said gear wheel consists of a worm wheel.

6. A swaging machine as set forth in claim 1, in which said hammers are arranged in two pairs of diametrically opposed hammers and which comprises first drive means for jointly driving the adjusting gearings connected to the housing one of said pairs, second drive means for jointly driving the adjusting gearings connected to the housings of the other of said pairs, and means for selectively coupling said first and second drive means.

7. A swaging machine as set forth in claim 1, which comprises a plurality of additional pistons adapted to be subjected to liquid under pressure at one end, each of said additional pistons being connected to one of said adjusting housings and tending to rotate said adjusting housing in the hammer-opening direction under the action of said liquid under pressure, said hydraulic system being arranged to supply liquid under pressure to said one end of each of said additional pistons and to subject said one end of each of said backing pistons to a liquid pressure which is a multiple of the liquid pressure to which said one end of each of said additional pistons is subjected.

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