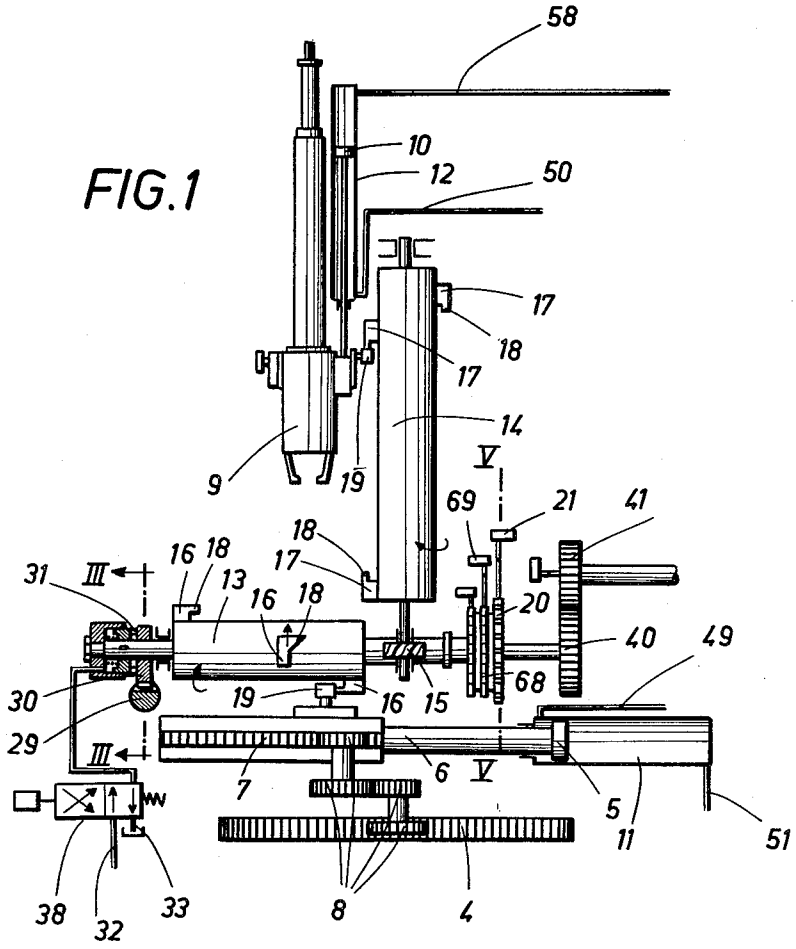
July 23, 1963 B. KRALOWETZ 3,098,402

FORGING MACHINE

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FIG.1



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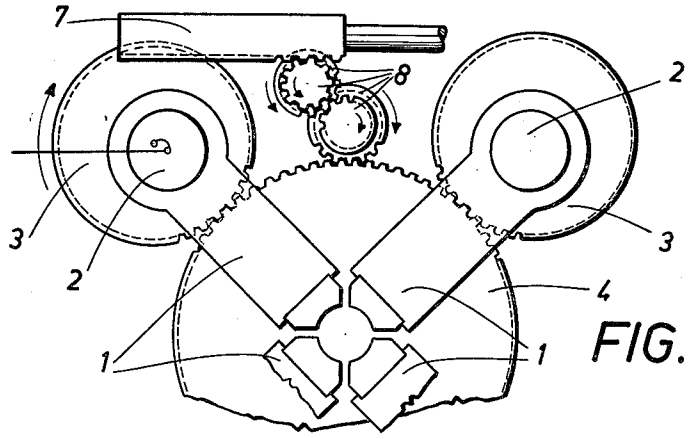


FIG. 2

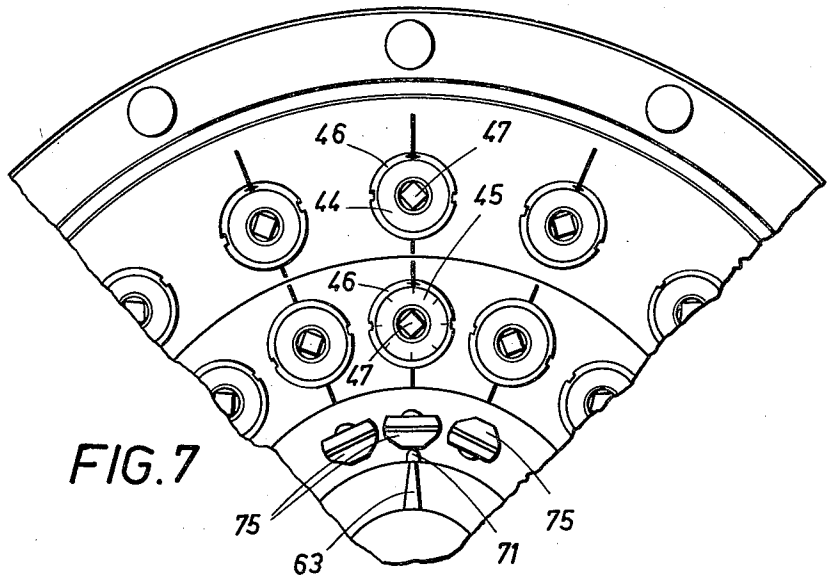


FIG. 7

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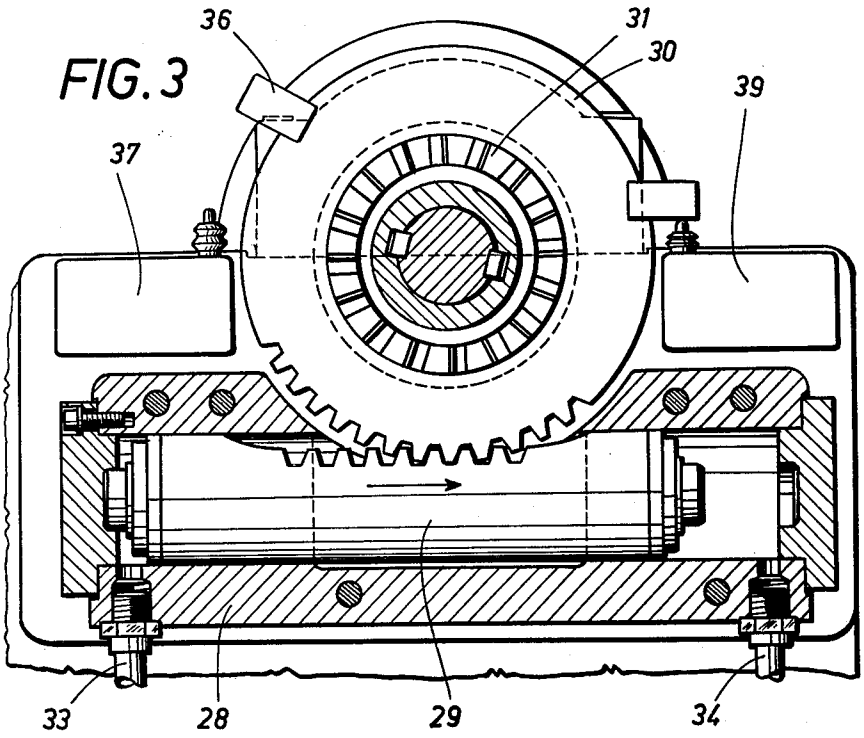
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FIG. 3



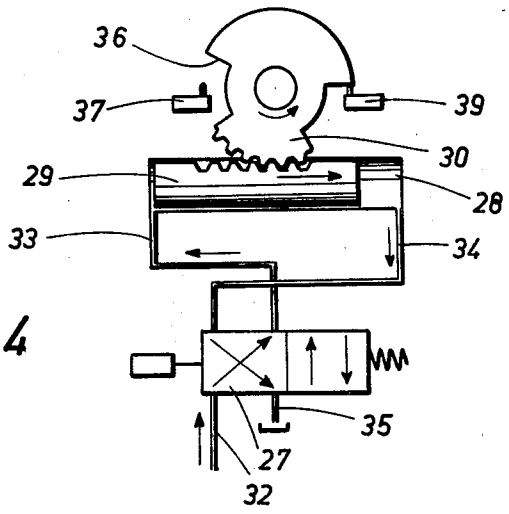


FIG. 4

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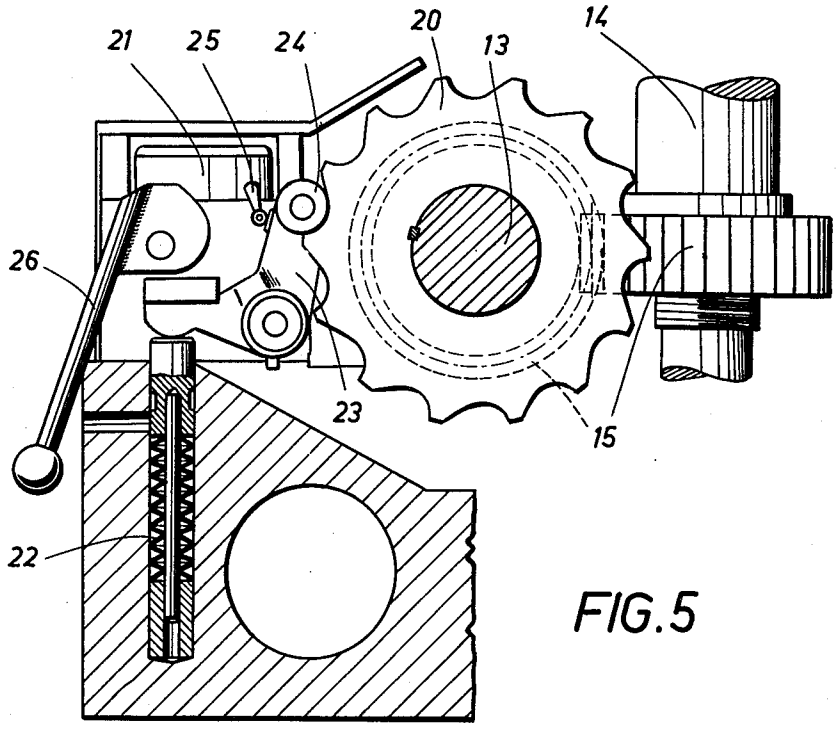


FIG. 5

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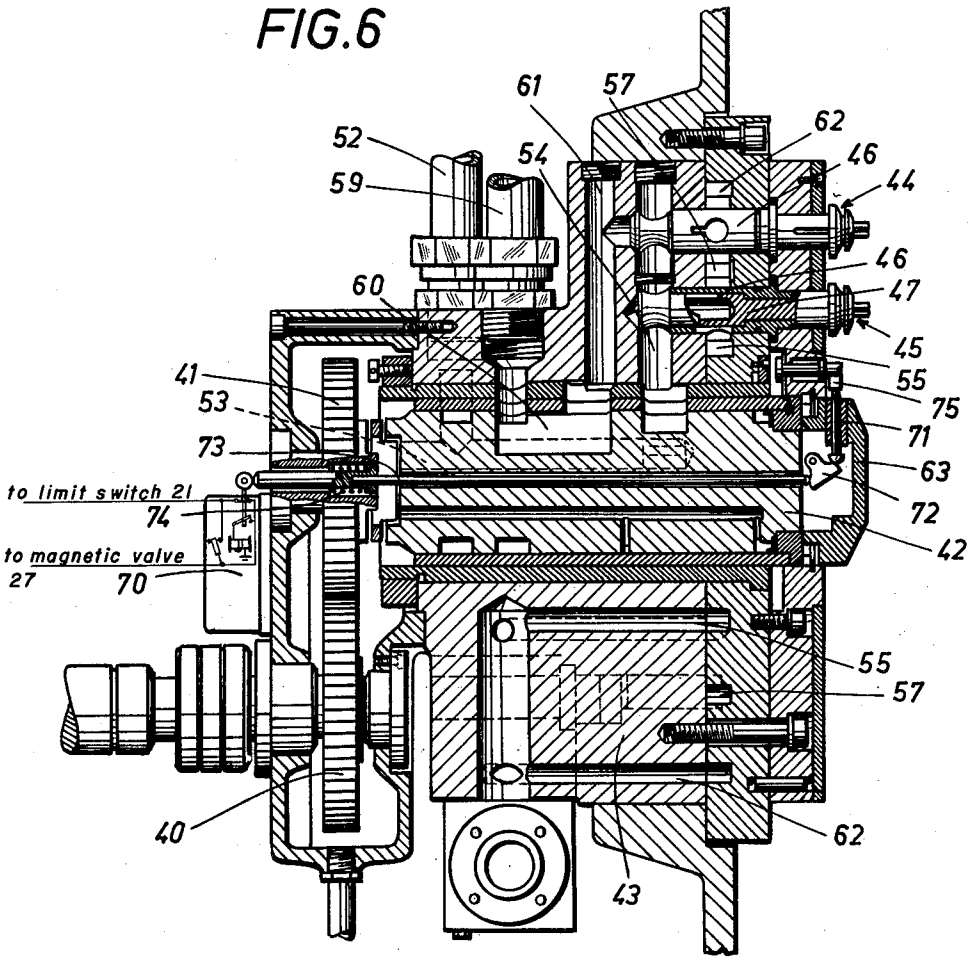
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FORGING MACHINE

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FIG.6



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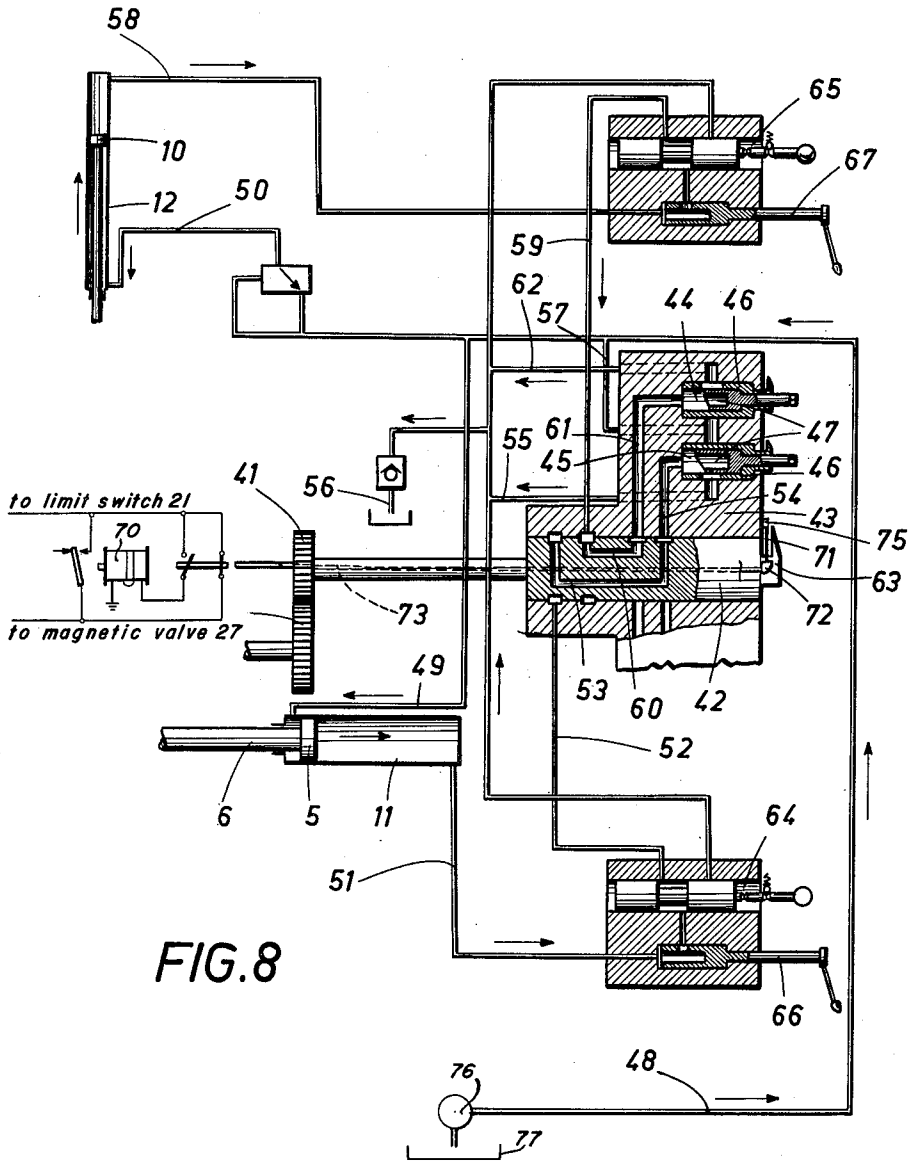


FIG.8

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United States Patent Office 3,098,402 Patented July 23, 1963

3,098,402

FORGING MACHINE

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Filed Mar. 14, 1961, Ser. No. 95,559
Claims priority, application Austria Mar. 18, 1960
9 Claims. (Cl. 78—20)

This invention relates to a forging machine which comprises hammers consisting of connecting rods and driven by eccentric shafts eccentrically mounted in angularly adjustable housings, and hydraulic working pistons for the longitudinal movement of the workpiece and for the angular adjustment of the bearing housings, which working pistons have associated with them two stepping rollers coupled for rotation in unison. The rollers are stepped forward at the end of the respective working piston movement and by such forward step act on a valve system for automatically controlling the working pistons. The eccentric shafts for driving the connecting rod-like hammers being eccentrically arranged in their bearing housings, the angular adjustment of these bearing housings will change the stroke position of the connecting rods and with it the respective depth of penetration of the hammers into the workpiece. The working piston which causes the angular adjustment of the bearing housings controls the radial dimensions of the workpiece whereas the other working piston, which causes the longitudinal movement of the workpiece controls the respective length dimensions.

Stop discs connected for rotation with the stepping rollers have previously been provided and stop members may be selectively secured to these discs. Each of these stop discs supports a valve by means of a feeler lever or the like. The valve is hydraulically urged against the disc. Depending on the height of the stop members, the valve will be displaced through different distances, This displacement of the valve will cause the application of hydraulic pressure to the working pistons in one sense or the other. As each angular movement of the stepping rollers causes another stop member to be moved to its operative position, the stepping roller will be rotated by the working piston at the end of its movement to change the valve system in such a manner that the desired sequence of operations will be obtained. It has now been found that the setting up of the stop discs for the desired sequence of operations, i.e., the selection and mounting of the required stop members and the change in the positions thereof, is a complicated, time-consuming operation which requires extreme attention and that relatively complex valve structures are required, particularly because it is not sufficient to effect a reversal of the movement, but a flow through a throttle may also be required.

It is an object of the invention to improve the forging machine described hereinbefore in this respect so that the setting up for a desired sequence of operations is simplified.

The valve system of the invention comprises a common rotary valve, to which a stepping movement is imparted by one of the stepping rolls, and pre-adjustable pairs of control valves corresponding in number to the positions of the stepping rollers and of the rotary valve. One of the control valves of each pair controls the application of hydraulic pressure to one working piston and the other control valve controls the application of hydraulic pressure to the other working piston, whereas the rotary valve connects in each of its positions the conduits of the cylinders of the working pistons to one pair of control valves. The control valves are arranged to connect said conduits to the pressure fluid supply conduit or to the drain conduit or for shutting off the cylinder conduits

entirely. Thus, in each position of the stepping rollers and rotary valve, another pair of control valves will determine the application of pressure to the working pistons and it is sufficient to move the control valves into the position which corresponds to the desired operation. Instead of the time-consuming setting up of two stop discs previously required, it is now sufficient to adjust two control valves for each position of the control roller and rotary valve in such a manner that the desired working piston movement will be effected. A simple inscription is sufficient to avoid errors in setting up and a special tool is not required for adjusting the valves.

In order to enable a pre-setting not only of the direction of movement but also of the speed of the working pistons, a throttle may be associated with each control valve. The control valve and throttle are preferably combined in a unit. The control valves are preferably plug valves and an independently rotatable throttle member is coaxially mounted in the valve plug. Depending on the position of the throttle, the working piston movement is accelerated or delayed so that the entire sequence of operations can be pre-set with the aid of the throttles. Since the plug valves and the throttle members are coaxially mounted, the adjustment is limited to two rotary movements which can be performed quickly and without difficulty.

The control valves may be accommodated in a common block and disposed in two concentric circles around the rotary valve, the valves of each pair lying preferably in a common radial plane. This will result in a clearly arranged and space-saving design. The central valve may be provided with a pointer which will indicate the operating pair of control valves. It is possible to change the operations while the machine is running. This would not have been possible, of course, with the known stop discs.

A particular simplification of the entire hydraulic system can be achieved if only the cover-side conduits of the working piston cylinders pass through the rotary valve and control valves whereas pressure is permanently applied in a known manner to the rod side of the working pistons. In this case it is sufficient to effect changes in connections on the cover side of the cylinders and the design of the control valves and the rotary valve can be simplified. Nevertheless the working pistons can be moved in both directions because the effective piston area is smaller on the rod side than on the cover side.

For the angular movement of the stepping rollers, there is provided a separate hydraulic piston drive, which is controlled by a magnetic valve. The magnetic valve is energized by a limit switch operable by a cam wheel which rotates with the control rollers. The working pistons cause only a short rotation of the rollers for generating a control impulse at the end of the piston movement. This results in a substantial simplification as compared to known devices . As soon as one of the working pistons impinges on one of the stepping roller stops, the stepping rollers are rotated by a small amount. This rotation is sufficient, however, to operate the limit switch, which will then displace the magnetic valve so that the piston drive is operated to rotate the stepping rollers. The displaceable part of the piston drive may be a rack in mesh with a pinion, which by a ratchet coupling is coupled to one of the stepping rollers. At the end of the rotation of the stepping rollers this pinion will operate an additional limit switch for resetting the magnetic valve.

When the forging cycles available are not fully utilized so that the work is completed before the stepping rollers return to their initial position provision must be made that the rotation of the stepping rollers is continued to the initial position even though there is no impulse-generating working piston movement. To this end, a second disc,

which is provided with detachable cams and rotates with the stepping rollers, and an additional limit switch operated by the detachable cams are provided for displacing the magnetic valve. The operation of this limit switch due to an appropriate cam position will cause a displacement of the magnetic valve to rotate the stepping roller so that the stepping movement is continued without action of the working pistons.

A movement of one working piston is usually followed by another working piston movement, due to the further rotation of the stepping rollers. It may be desirable to work for a longer time without a longitudinal movement of the workpiece and with the hammers set to the same depth, e.g., for an exact forging of collars. In such case, the succession of the working piston movements must be delayed. This is only possible if the further stepping of the stepping rollers and of the rotary valve at the end of the preceding working piston movement is delayed. The invention therefore provides a time limit relay for the magnetic valve, which relay is selectively operable in each position of the stepping rollers and rotary valve. A feller pin is preferably slidably mounted in the rotary valve and is urged radially outwardly by a spring against rotatable stops by spring force. According to the stop position the pin acts by means of a linkage on a limit switch of the time limit relay. Thus, any desired interval between the forging cycles may be preset by rotation of stops at the block which encloses the rotary valve, the control valves and the throttles.

An illustrative embodiment of the invention is shown in the accompanying drawings, in which

FIG. 1 is an elevation view of the entire machine;

FIG. 2 is a top plan view of the hammer drive;

FIG. 3 a sectional view taken on line III—III of FIG. 1 and showing the piston drive for rotating the stepping rollers on a larger scale;

FIG. 4 is a diagram of the corresponding hydraulic system;

FIG. 5 is a sectional view taken on line V—V of FIG. 1, also on a larger scale;

FIG. 6 is a radially sectional view of the block which encloses the rotary valve and the control valves;

FIG. 7 shows the block in fragmentary elevation and

FIG. 8 is a diagram of the hydraulic system for controlling the working piston.

Four hammers **1** constituting connecting rods are horizontally guided in the forging box not shown in detail. The shafts **2** driving said hammers are eccentrically mounted in rotatably adjustable housings. Each of these bearing housings, which are rotatable in the forging box, comprises a gear rim **3**, which is in mesh with a central gear **4**. By rotating this central gear, the distance of the driving shaft axes from the workpiece axis and thus the stroke position of the connecting rod-like hammers will vary owing to the eccentric mounting of the drive shafts **2** in the housings so that the depth of the penetration of the hammers into the workpiece and the corresponding radial dimension of hte workpiece can be adjusted by an appropriate rotation of the central gear. To effect this adjustment, a working piston **5** is provided, the piston rod **6** of which carries a rack **7**. By means of several pinions **8**, the movement of the piston or rack is transmitted to the central gear **4** and from the latter by the gear rims **3** to the bearing housings of the driving eccentric shafts **2**.

The workpiece is held by a gripping head **9**, which is vertically slidably guided in the machine frame and which may impart to the workpiece a rotary movement about its axis, if desired. The gripping head **9** is moved up and down with the aid of an additional working piston **10**. The cylinders of the two working pistons are designated **11** and **12**.

Each of the two pistons **5** and **10** is associated with a stepping roller **13**, **14**. The rollers **13**, **14** are parallel to the direction of movement of the respective piston and are coupled for rotation in unison by a pair of helical gears **15**. Limit stops **16**, **17** are longitudinally adjustably secured to the stepping rollers **13**, **14** on generatrices thereof which correspond to the steps of the movement of the rollers, The limit stops **16**, **17** have an inclined run-up surface **18** and the pistons **5**, **10**, the racks **7** and the gripping head **9** are provided with rollers **19** which act on the stops. The machine described thus far corresponds to the known forging machines of the present type.

When one of the rollers **19** impinges on the run-up face **18** of one of the limit stops **16** or **17**, the inclination of this face will result in a small angular movement of the stepping roller. This angular movement does not correspond to a complete step of the stepping roller but only initiates such step. The stepping roller **13** is connected for rotation in unison to a camwheel **20**, which operates a limit switch **21** as soon as the short angular movement of the stepping roller is effected by the run-up face of the stops. As seen in FIG. 5 a bell-crank lever **23** having a feeler roller **24** is provided, which is biased by a spring **22** and bears on the camwheel **20** and with its back acts on the operating lever **25** of the limit switch **21**. With the aid of an eccentric lever **26** the limit switch **21** can be pressed by hand, independently of the rotation of the stepping roller. The limit switch **21** controls a magnetic valve **27**, which controls the application of hydraulic pressure to a piston drive consisting of a cylinder **28** and a piston **29** formed with a rack.

The shaft of the stepping roller **13** carries a freely rotatable gear **30**, which is coupled to the stepping roller in one direction of rotation by a ratchet coupling **31**. When the limit switch **21** is operated during the short angular movement of the stepping roller by the impact of one of the rollers **19** on one of the stops **16** or **17**, the magnetic valve **27** will assume the position shown in FIG. 4, in which pressure oil from the pressure conduit **32** can flow through conduit **33** to the left-hand end of the cylinder **28** whereas the right-hand end of the cylinder is connected by the conduit **34** to the drain **35**. As a result, the piston **29** is moved to the right and the gear **30** is rotated in a counterclockwise direction and drives the stepping roller by means of the ratchet coupling **31**. At the end of this angular movement a stop member **36** engages a limit switch **37**, which returns the magnetic valve **27** to that position in which the conduit **33** is connected to the drain and the conduit **34** is connected to the pressure fluid supply conduit so that the piston **29** and the gear **30** perform the opposite movement. The ratchet coupling **31** does not transmit this movement to the stepping rollers.

The limit switch **21** energizes an additional magnetic valve **38** (FIG. 1), which controls the application of pressure to the pistonlike displaceable part of the ratchet coupling **31** so that pressure is applied to the pistonlike ratchet part during a rotation in the forward stepping sense whereas it is pressure-relieved during the resetting movement. The limit switch **37** also resets the magnetic valve **38**. Another limit switch **39**, which is also operable by the gear **30**, is a safety device. In the event of impulses succeeding each other at intervals shorter than those required for the stepping operation the switch **39** operates in such a manner that the piston **29** will return to its end position and the ratchet coupling **31** will be locked again before the next stepping movement.

A rotary valve **42** is coupled by a pair of gears **40**, **41** to the stepping roller **13** and is centrally disposed in a block **43**, in which control valves **44**, **45** are accommodated in two concentric circles. A pair of control valves is associated with each position of the stepping roller and rotary valve. The valves of each pair lie in one radial plane. The valves **44** disposed on the outer circle control the application of hydraulic pressure to the working piston **10** for the gripping head **9**. The values **45** of the inner circle are associated with the working piston **5** for setting the hammers. The valves **44**, **45** are plug valves. An

independently rotatable throttle member 47 is coaxially mounted in each valve plug 46. As is apparent from FIG. 8, pressure is permanently applied to the working pistons 5 and 10 on their rod side from the conduit 48 and the conduits 49 and 50. From the cover side of the cylinder 11 a conduit 51, 52 extends to the rotary valve 42 and from the same through bores 53, 54 to the operative control valve 45. In the position shown in FIG. 8 this control valve 45 establishes a connection through conduit 55 to the oil drain 56. Oil under pressure is supplied to conduit 48 by a pump 76 from a container 77, into which the oil from drain 56 is returned. Because the cover side of the cylinder 11 is connected to the drain whereas the rod side receives pressure oil, the piston 5 moves to the right, as viewed in FIG. 8, and the hammers open. This opening movement of the hammers is slow because the throttle member 47 obstructs a large part of the outlet opening of the plug 46. If the valve plug 46 of the illustrated control valve 45 is rotated by 180°, pressure oil flows from conduit 48 through conduit 57, the bores 53, 54, and the conduits 52 and 51 to the cover side of the cylinder 11. Since the effective piston area is much larger on the cover side than on the rod side, the piston 5 moves in the opposite direction and the oil on the rod side is discharged through the conduit system.

The conduit 58 from the cover side of the cylinder 12 is also connected to the drain through the conduit 59, the bores 60 and 61 and the control valve 44 and the conduit 62 so that the working piston 10 moves upwardly, as seen in FIG. 8, under fluid pressure applied to the rod side. Depending on the position of the throttle member 47 relative to the valve plug 46, the speed of this movement will be low or high. Upon rotation of the plug of the valve 44 through 180° a connection of the cover side of the cylinder 12 to the pressure conduit 48, 57 is established, so that the piston 10, the gripping head 9 and the workpiece descend. It is apparent that a rotation of the valve plugs of the valves 44 and 45 through only 90 degrees will shut off the conduits leading to the cover sides of the cylinders 11, 12 so that the working pistons 5 and 10 are at a standstill.

In each position of the stepping rollers, the rotary valve 42 connects the cover side conduits of the cylinders 10, 11 to a different pair of control valves 44, 45 and these can be preset, by a simple rotation of the valve plug, to cause any desired sequence of working piston movements. The speed of the working piston movement resulting from the respective control valve position can be predetermined by means of the throttle members, and any desired working program can therefore be preset at the block 43. A suitable inscription is provided for the position of the plug valve 46 and of the throttle member 47 so that the setting up does not involve any difficulty. The rotary valve has a radial pointer 63 (FIG. 7), which indicates the pair of control valves which are operative in each stepping roller and rotary valve position. FIG. 8 shows also manually adjustable valves 64, 65 with associated throttles 66, 67. These are emergency valves, which enable the establishment of a direct connection from the cover side of the cylinders 11, 12 to the drain so that a movement of the valves will immediately cause an opening of the hammers or an upward movement of the gripping head and workpiece.

The entire forging program is started by hand with the aid of a limit switch, not shown, which is connected in parallel to the limit switch 21 and actuates the magnetic valve 27, the piston drive 29, 30 and the ratchet 31 so as to initiate the first stepping movement of the stepping rollers. The shaft of the stepping roller 13 carries a second disc 68 provided with detachable cams. A camwheel rotating in unison with a stepping roller and carrying detachable cams is disclosed in the U.S. patent specification No. 2,793,548, particularly in FIGS. 2, 6 and 7 thereof. By this reference thereto, said patent specification is included in the present disclosure. A limit switch 69 is provided which is operated by the detachably mounted cams and controls the energization of the magnetic valve 27. When operated by the cams, the limit switch 69 causes the magnetic valve 27 to assume the position shown in FIG. 4, in which the valve 27 causes the stepping roller to be rotated by the rack piston 29, the gear 30 and the ratchet coupling 31, as has been described hereinbefore. This arrangement serves to ensure the return of the stepping rollers and of the rotary valve to the initial position when the working program has been completed before the stepping roller and rotary valve have reached their end position, i.e., when the angular positions and forging cycles available are not all utilized and the working pistons do no longer generate impulses for the continued rotation to the final or initial position. In this case the continued rotation through the remaining cycles is effected with the aid of the stop members on the disc 68 and of the limit switch 69.

To delay the stepping from one stepping roller and rotary valve position to the next, in order to enable a prolonged forging at the same point of the workpiece, e.g., for an exact forging of collars, a time limit relay 70 can be connected to the limit switch 21 and with the normally open contact of this relay interposed between the limit switch and the magnetic valve. Thus the response of the valve 27 to the operation of switch 21 is delayed for a predetermined period of time so that the hammers can work during this time delay without a change of the axial position of the workpiece and without a change of the depth setting of the hammers. A radial feeler pin 71 is displaceably mounted in the rotary valve 42 and by a bell-crank lever 72 and a rod 73 engages a switch combined with the relay 70 and operable to connect it to the limit switch 21. Its normally open contact is interposed between the switch 21 and valve 27. A spring 74 urges the feeler pin 71 radially outwardly. Angularly adjustable stops 75 are carried by the block 43 with a spacing which corresponds to the stepping angles. Depending on the position of these stops 75, the feeler pin 71 is displaced radially inwardly so that the switch of relay 70 is actuated by the linkage 72, 73, or the feeler pin remains in its position to which it is urged outwardly by the spring 74 and does not act on the switch of relay 70. The angular adjustment of the stops 75 enables different faces of the stops to be presented to the feeler pin 71 so as to engage or clear the same (FIG. 7). Thus, the entire operation, i.e., the direction and speed of the movements of the working pistons in each control position and the so-called collar delay can be preset at the block 43 by a simple rotation of the valve plugs 46 and of the throttle members 47 and stops 75 and it is sufficient to determine the workpiece diameters and the desired forging lengths with the aid of the stops 16 and 17 on the stepping rollers 13, 14.

What I claim is:

1. A forging machine which comprises hammers formed as connecting rods, eccentric shafts operable to drive said hammers, angularly adjustable housings eccentrically mounting said shafts, workpiece feed means, a first hydraulic setting piston operable to axially move said workpiece feed means, a second hydraulic setting piston operable to effect an angular movement of said housings, first and second control conduits adapted to apply hydraulic pressure to said first and second pistons, respectively, two stepping rollers which are coupled for joint rotation to a plurality of predetermined positions and associated each with one of said pistons and arranged to perform an angular movement to the next of said predetermined positions in response to the completion of a movement of one of said pistons, and a valve system arranged to control said setting pistons in dependence on the position of said stepping rollers, said valve system comprising a common rotary valve arranged to be moved by said stepping rollers to a plurality of positions corre-

sponding to said positions of said stepping rollers, a plurality of pairs of control valves, each of said pairs of valves being associated with one of said predetermined positions, said rotary valve being arranged to connect in each of said predetermined positions said first control conduit to one and said second control conduit to the other of said control valves of the pair associated with said position, said machine comprising further a pressure fluid supply conduit and a drain conduit, each of said control valves being arbitrarily pre-adjustable to three positions, in one of which it is connected to said supply conduit, in the second of which it is connected to said drain conduit and in the third of which it is closed.

2. A forging machine as set forth in claim 1, which comprises a throttle associated with each of said control valves and means selectively operable to connect said throttle in series with said control valve.

3. A forging machine as set forth in claim 2, in which said throttle and control valve are combined in a unit.

4. A forging machine as set forth in claim 2, in which each of said control valves consists of a plug valve having a valve plug and an independently rotatable throttle member is coaxially mounted in said valve plug.

5. A forging machine as set forth in claim 1, which comprises a valve block accommodating said rotary valve and said control valves, said control valves being arranged in two concentric circles and said rotary valve being disposed at the center of said circles.

6. A forging machine as set forth in claim 5, in which the centers of the control valves of each of said pairs lie in a common radial plane.

7. A forging machine as set forth in claim 1, in which each of said pistons has a piston rod connected to one end of the piston and is slidably movable in a cylinder, to which said control conduit is connected on the side opposite to said piston rod, said machine further comprising means for permanently applying hydraulic pressure to said pistons at said one end thereof.

8. A forging machine as set forth in claim 1, in which said setting pistons are adapted to impart at the end of each of their movements to said stepping rollers an angular movement which is only a fraction of the movement required to reach the next of said predetermined positions, and which comprises a hydraulic piston drive operable to continue the angular movement of said stepping rollers until said next predetermined position has been reached, a magnetic valve arranged to control said hydraulic piston drive, a limit switch arranged to control said magnetic valve, and a camwheel arranged to rotate in unison with said stepping rollers and to operate said limit switch.

9. A forging machine as set forth in claim 8, in which said piston drive comprises a displaceable part formed as a rack, and which comprises a pinion in mesh with said rack, a ratchet coupling for coupling said pinion to one of said stepping rollers, and an additional limit switch operable to reset said magnetic valve, said pinion being arranged to operate said additional limit switch when said stepping rollers have reached said next predetermined position.

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