United States Patent [19]

Paknke et al.

[11] **3,916,667**

[45] **Nov. 4, 1975**

[54] **FORGING MACHINES**

[76] Inventors: **Hans Joachim Paknke,** Lantzallee 27, 4 Duesseldorf; **Rudolf Guse,** Portweinmannweg 8, 403 Ratingen, both of Germany

[22] Filed: **Feb. 8, 1974**

[21] Appl. No.: **440,765**

[30] **Foreign Application Priority Data**

Feb. 10, 1973 Germany 2306566

[52] **U.S. Cl.** **72/402;** 72/403; 72/441; 72/453

[51] **Int. Cl.²** **B21J 9/12**

[58] **Field of Search** 72/453, 402, 403, 442, 72/441

[56] **References Cited**

UNITED STATES PATENTS

3,451,249	6/1969	Sharon	72/402
3,645,126	2/1972	Kralowetz	72/402
3,681,966	8/1972	Kralowetz	72/402

FOREIGN PATENTS OR APPLICATIONS

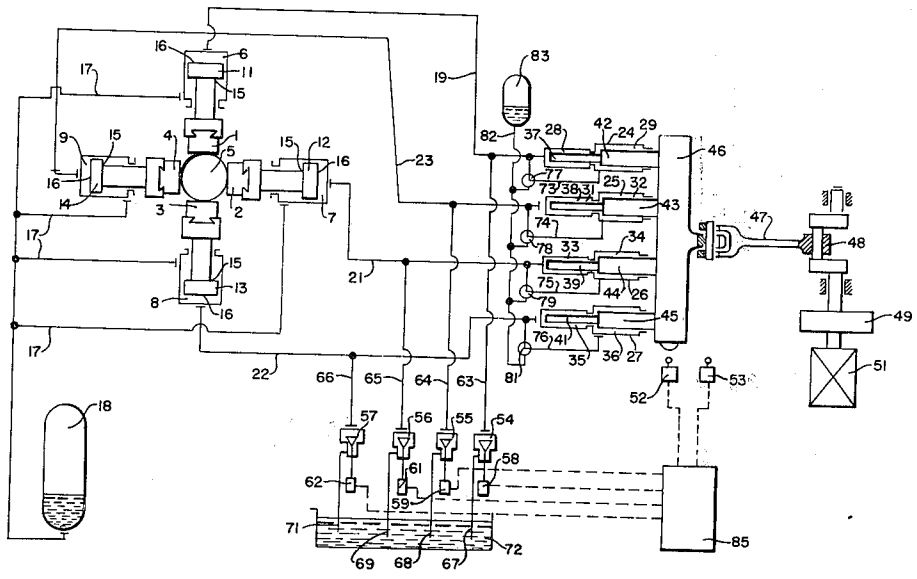
1,004,895	3/1957	Germany	72/402

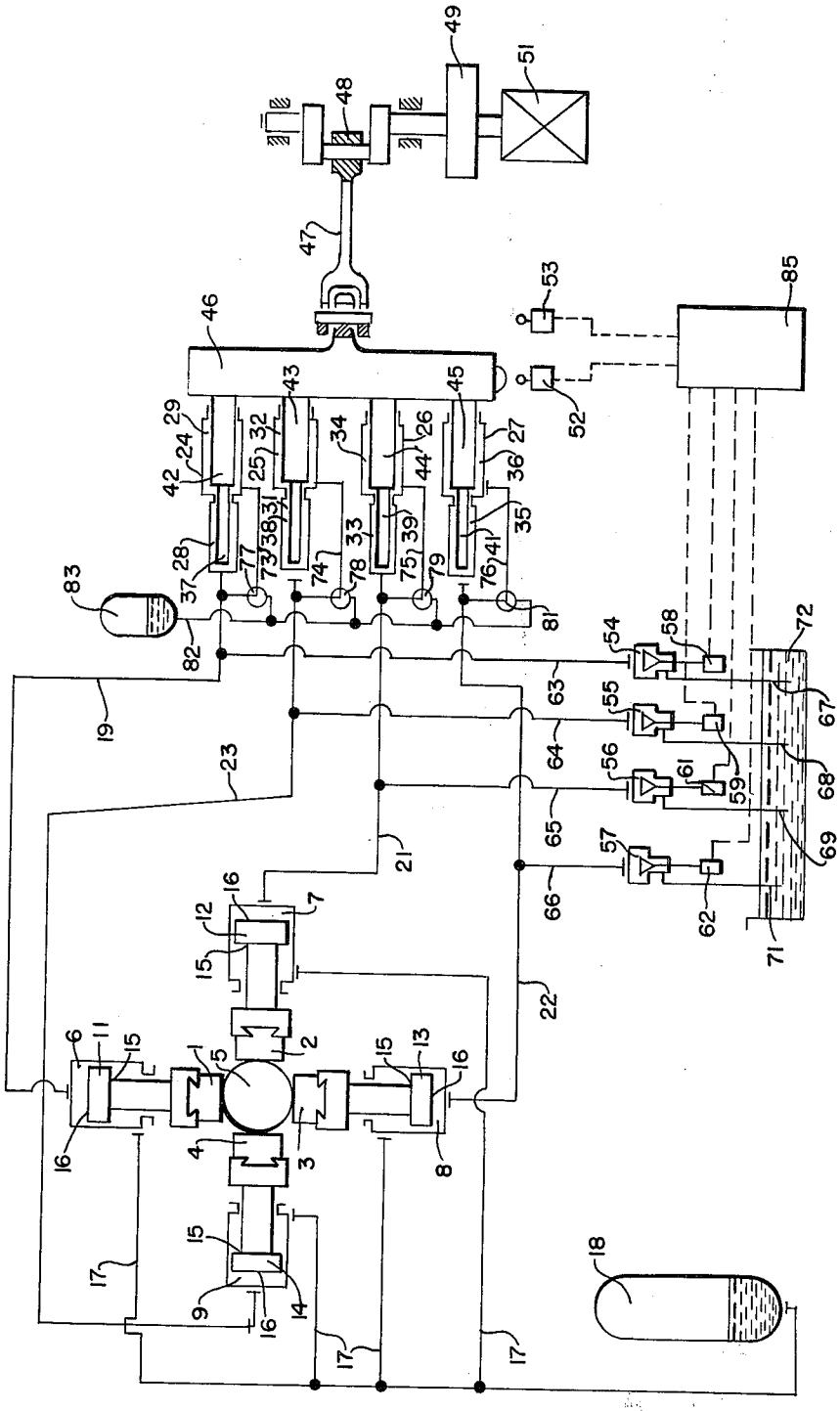
Primary Examiner—C. W. Lanham
Assistant Examiner—Gene P. Crosby
Attorney, Agent, or Firm—John J. Dennemeyer

[57] **ABSTRACT**

A forging machine having pairs of opposed hydraulically driven forging tools for forging rod-shaped workpieces. Valve control means is provided whereby predetermined valves are opened and closed in dependence upon the operating cycle of a pumping arrangement for producing the hydraulic working pressure to be supplied to each working cylinder. When the valves are opened the working pressure is dissipated to a fluid reservoir and the pair of opposed working cylinders associated with these valves is inactivated. The arrangement enables pairs of opposed forging tools to be brought into operation alternately.

1 Claim, 1 Drawing Figure




49
51
48
47
53
85
46
52
43
45
29
24
32
34
26
27
42
25
44
36
31
35
28
33
39
41
83
37
73
38
74
78
75
79
76
81
82
54
58
72
63
55
67
19
64
56
61
59
68
23
65
57
69
21
66
62
71
16
12
7
15
22
6
11
15
2
1
5
15
13
16
16
4
3
8
15
17
9
16
14
17
17
18

FORGING MACHINES

The invention relates to forging machines with a plurality of working cylinders associated with forging tools or saddles for surrounding a rod-shaped workpiece and reducing the workpiece cross section by lateral pressure. The pistons of the working cylinders are subjected to the action of a substantially constant retraction force and are each connected to a pressure cylinder, the pistons of said pressure cylinders being mechanically connected to a drive mechanism for periodically advancing and retracting them. The valves connected to the connecting pipes extending between the working cylinders and the pressure cylinders are controllable by the drive mechanism.

In accordance with a previous proposal of the applicants as described in German published patent application (Auslegeschrift) no. **1.917.511** the valves are controlled in unison by the drive mechanism in such a way that the normally closed valves are simultaneously opened at a corresponding position of the drive mechanism so that communication is established between the working cylinders of the forging saddles and the fluid reservoir. In this way an unpressurized pressure medium circulation is obtained so that the operation of all the working pistons of the forging saddles can be simultaneously and intentionally interrupted at any time.

It has now been shown that such a forging machine does not completely satisfy all the requirements that occur in practice. Thus, a number of forging operations do not require all the forging saddles to be used simultaneously but rather successively in pairs. It is therefore desirable for a pressing operation to be carried out using successive pairs of opposed tools in order that the material can spread freely during the pressing operation. In such forging operations it is also often desirable to have a possibility for altering the stroke of the working cylinder as well as the number of strokes per unit time.

An object of the invention is the provision of a drive with hydraulic synchronizing control for a forging machine of the kind mentioned above which permits the individual working pistons of the forging saddles to be driven in accordance with the predetermined requirements.

This object is achieved according to the invention in that the valves are controllable independently of each other for movement into an open position connecting the working cylinder with a fluid reservoir via the connecting pipes. It is of importance for the invention that the valves can be brought individually, i.e., independently of each other, into their open positions in which there is uninterrupted communication between the respective working cylinder and the fluid reservoir so that no pressure can build up in the connecting pipe and the working cylinder or working piston in question is not pressurized. A forging machine with such features can therefore best be adapted to particular conditions occuring during forging, in particular successive forging of opposed pairs of sides of the workpiece.

German Auslegesschrift No. **1,004,895** discloses a machine in which individually controllable valves are provided in the connecting lines between the pressure cylinders and the working cylinders of the forging saddles. However, this machine is not a forging machine in the sense of the present application but a machine for free forging of vessels, thick-walled pipes or similar

heavy hollow bodies. In addition to a drive mechanism consisting of two multi-stage cylinder and piston units for the actual drive of the working pistons of the forging saddles, this machine requires a second drive mechanism for mechanical synchronization serving for accurately adjusting the postion of the forging saddles at start-up and compensating for possible leakage losses. Connected to this second drive is a compensating apparatus having a plurality of plungers displaceable in cylinders and connected by connecting lines to the first drive mechanism and to the working cylinders. In these connecting lines are disposed non-return valves and, in a pipe leading to the fluid reservoir, a corresponding number of inlet valves. By virtue of the presence of the non-return valves and the arrangement of the inlet valves in the discharge line to the fluid reservoir the known valves, even when under individual control, are not suited to establishment of a direct connection between the individual working cylinders and the fluid reservoir. Thus, it is impossible with the known apparatus to bring individual forging saddles into operation selectively and successively.

According to a preferred embodiment of the invention, predetermined valves are opened in dependence upon the position of the drive mechanism. Such a drive construction makes it an easy matter to readjust the valves according to the operational requirements of the moment so that these are opened in the predetermined selective manner when the drive mechanism reaches the predetermined position and establish a direct connection with the fluid reservoir in these connecting pipes whereby the working cylinder connected to the respective fluid reservoir remains unpressurized in spite of the fact that the drive mechanism continues to rotate and thus the pistons displaceable in the pressure cylinder continue to carry out a pumping action.

Preferably, the selected valves reach their open position when the drive mechanism is in a dead center position, preferably in the rearward dead center position. In this position of the drive mechanism, the working pistons and the pistons of the pressure cylinders are also in their rearward positions. In this way it is avoided that the working pistons become unsynchronized and are accelerated too forcibly on to the working cylinder by virtue of the retracting force acting on their retracting surfaces. A suitable position dependent opening signal for the rotary apparatus may be furnished by limit switches arranged in the dead center positions of the drive mechanism and connected, e.g., electrically, with the valves.

Apart from the selection of certain forging saddles to operate at particular moments in time, it is also desirable in certain forging operations to alter the length of stroke of the working pistons. This can be easily accomplished by switching valves separating each pressure cylinder from its associated working cylinder and connecting it with a pressure reservoir. If each pressure cylinder consists of stepped cylinder portions and has a correspondingly stepped piston and a by-pass pipe having the switching valve leads into the cylinder section, a simple switching of the switching valve will result in delivery of the volume of fluid throttled by the cylinder section receiving the by-pass pipe to the pressure reservoir so that this amount of pressure medium cannot become effective in the working cylinders. In this way the reduced amount of fluid exhausted only from the other section of the pressure cylinder will ef-

fect a correspondingly smaller stroke of the working cylinder. If, finally, a corresponding increase in the number of revolutions of the drive mechanism or a change in the transmission ratio of the associated gearing is effected, a forging machine according to the invention can be brought into operation with predetermined forging saddles, an easily variable stroke of the working pistons and a rapidly adjustable number of strokes per unit time, so that for all the requirements occuring in forging of longitudinally extended workpieces in each case the best possible adaptation of the forging machine to the working conditions can be effected.

A preferred embodiment of the invention is illustrated in the drawing and has four forging saddles **1, 2,** 3 and 4 of which adjacent saddles are disposed at **90°** to each other and which are arranged about a workpiece **5** to be formed.

The forging saddles **1, 2, 3** and **4** are directly connected to working pistons **11, 12, 13** and **14** displaceably accommodated in hydraulic working cylinders **6,** 7, 8 and **9.** The working cylinders **6, 7, 8** and **9** are double-acting so that they each have a retraction side **15** and a pressure side **16.** When the retraction sides **15** of the working cylinders **6, 7, 8** and **9** are pressurized the working pistons **11, 12, 13** and **14** can be returned into their respective starting positions after each forging stroke. For pressurization, the retraction sides **15** of the working cylinders **6, 7, 8** and **9** are connected by supply lines **17** to a pressure reservoir **18** by which a constant pressure is maintained on the retraction sides in the hydraulic circuit.

In order to pressurize the pressure sides **16** of the working pistons **11, 12, 13** and **14** these are connected by connecting lines **19, 21, 22** and **23** with respective pressure cylinders **24, 25, 26** and **27.** In the illustrated embodiment the cylinders **24, 25, 26** and **27** have cylinder sections of different diameters **28, 29, 31, 32, 33,** 34, 35, 36, in which corresponding stepped pistons are guided with a front piston portion **37, 38, 39** or **41** adapted to the smaller diameter cylinder portion **28,** 31, 33 or **35** and also a rear wider diameter piston portion **42, 43, 44** or **45.** Engaging the piston rods of the displaceably mounted pistons **37 – 45** is a yoke **46** which is connected via a connecting rod **47** to a drive mechanism. In the illustrated forging machine this comprises a single throw crank drive **48** which is driven via a gear **49** by a motor **51.**

In place of the four stepped pistons with the different diameter cylinder portions **28, 31, 33, 35, 42, 43, 44** or **45** there could equally well be provided eight cylinders with simple plunger pistons (this possibility not being illustrated).

At the level of the front and rear dead center positions of the crank drive **48** and at the side of the yoke **46** are limit switches **52, 53.** Since the valves may only be closed or opened at the rear reversal point the limit switch **53** should be sufficient. Since, however, it is a requirement that the valve must open from the rear reversal point and must be closed at the rear reversal point, two opposed signals are required shortly before the rear reversal point. This function is assumed by the limit switch **52.** Because of the high switching frequency and the accurate determination of the reversal point, the limit switchs **52, 53** are preferably contactless limit switches each of which transmits a signal when the drive mechanism is positioned at the front and at the rear reversal point. In order to control the opening and closing of the valves **54, 55, 56** and **57** these signals (shown in dotted line) are amplified and arrive directly at the solenoids **58, 59, 61** and **62** of the valves **54, 55, 56** and **57** which lie in the control pipes **63, 64, 65** or **66** branching in the form of discharge pipes from the connecting pipes **19, 21, 22** and **23** in the vicinity of the pressure cylinders **24, 25, 26** and **27** and connected via the valves **54, 55, 56** and **57** and a respective discharge line **67, 68, 69** or **71** with a fluid reservoir **72.**

A by-pass line **73, 74, 75** or **76** is connected to the rearward, larger diameter cylinder portions **29, 32, 34** and **36** and accommodates a reversing or switching valve **77, 78, 79** or **81.** As illustrated in the drawing, these switching valves can be so adjusted that a connection is established between each by-pass line and the connecting lines **19, 21, 22** and **23;** however, they can also be so adjusted that the by-pass lines **73, 74, 75** and **76** are connected with a common supply line **82** of a pressure reservoir **83.**

In use of the forging machine the yoke **46** and thereby the pistons in the pressure cylinders **24, 25, 26** and **27** are moved uniformly towards the left by the crank drive **48** and the connecting rod **47.** Since the valves **54, 55, 56** and **57** are normally closed, the fluid exhausted from the pressure cylinders **24, 25, 26** and **27** is passed via connecting lines **19, 21, 22** and **23** into the associated working cylinders **6, 7, 8** and **9.** By this means the pressurized working pistons **11, 12, 13** and **14** move the forging saddles **1, 2, 3** and **4** inwards so that the workpiece **5** which is pushed through the machine by manipulators (not shown) in stepwise fashion perpendicular to the plane of the drawing is reduced in cross section on all sides.

After the forging stroke, the crank drive **48** starts its retracting stroke so that the pistons in the pressure cylinders **24, 25, 26** and **27** are also retracted towards the right. In this way the fluid pressure in the pressure cylinders **24, 25, 26** and **27** and in the connecting lines **19,** 21, 22 and **23** is reduced so that the working pistons **11,** 12, 13 and **14** are returned by the pressure of the pressure reservoir **18.** The uniform loading of all working cylinders **6, 7, 8** and **9** only takes place if the valves **54,** 55, 56, 57 in the control lines **63, 64, 65** and **66** are closed. If the valves **54, 55, 56** and **57** are open then in spite of continued operation of the crank drive and consequential pumping action in the pressure cylinders **24, 25, 26** and **27** no pressure can build up in the connecting lines **19, 21, 22** and **23** and thus no drive of the working pistons **11, 12, 13** and **14** of the working cylinders **6, 7, 8** and **9** can be achieved since the pressure sides **16** of the working cylinders are in direct communication with the liquid reservoir **72** via the connecting lines **19, 21, 22** and **23** and the open valves **54, 55, 56** and **57.** In this case the pressure medium being transported oscillates between the pressure cylinders **24, 25,** 26 and **27** and the liquid reservoir **72.**

If particular forging purposes require the simultaneous operation of only two opposed forging saddles while the other two opposed forging saddles are stationary, it is possible by means of a suitable known construction of the valve control with the assistance of the limit switches **52, 53** to periodically open and close the valves **54** and **57** or **56** in such a way that the forging saddles **1,3** and **2,4** are alternately subject to pressure. One way in which this may be accomplished is that the

valves 54 and 57 are closed on the first travel of the yoke 46 through the dead centre point so that only the working pistons 11 and 13 of the working cylinders 6 and 8 execute a working stroke and the two other opposed working pistons remain stationary. On the next revolution of the crank drive 48 the valves 54 and 57 are then opened again and the valves 55 and 56 are therefore closed so that the pistons 12 and 14 of the other working cylinders 7 and 9 now execute a working stroke. This mode of operation according to the invention can be repeated if desired and in certain circumstances it can be varied to such an extent that only one working cylinder is brought into operation.

If, apart from a predetermined operational succession of the forging saddles, the stroke of the working pistons 11, 12, 13 and 14 is also to be varied, this can occur with the aid of the switching valves 77, 78, 79 and 81. Whereas normally, i.e., when the by-pass pipes 73, 74, 75 and 76 are connected to the connecting lines 19, 21, 22 and 23, the fluid quantity exhausted from the rear as well as the front cylinder sections of the pressure cylinders 24, 25, 26 and 27 flows to the pressure side 16 of the individual working cylinders 6, 7, 8 and 9, when the reversing valves 77, 78, 79 and 81 are appropriately reversed, i.e., on connection of the by-pass lines 73, 74, 75 and 76 with the supply line 82 of the pressure reservoir 83, the quantity of fluid leaving the rearward cylinder portions 29, 32, 34 and 36 is led via the by-pass lines 73, 74, 75 and 76 and the supply line 82 into the pressure reservoir 83 so that only the volume of pressure medium from the front cylinder portions 28, 31, 33 and 35 is effective in the working cylinders 6, 7, 8 and 9 via the connecting lines 19, 21, 22 and 23, thereby producing a reduced length of stroke of the working cylinders 11, 12, 13 and 14. Finally, in addition to such a control of the length of stroke, the number of revolutions of the crank drive 48 can be varied by an increase in the number of revolutions of the motor or switching of the gear 49 so that the forging machine can be operated with a high number of strokes with a reduced working stroke as is necessary, for example, for finishing operations.

The selection of the valves or pairs of valves which are to be open for inactivating working cylinders 6 – 9 in dependence upon the working cycle of the drive mechanism 48 can be pre-programmed in a control device 85 into which pass the signals of the limit switches 53, 52 and the output of which is the control signals to the solenoids 58, 59, 61, 62 of the valves.

We claim:

1. A forging machine comprising a plurality of double-acting piston and cylinder ram units arranged for multidirectional lateral forging of an elongate workpiece disposed therebetween, a plurality of fluid pressure transmitting piston and cylinder unit being connected by a connection line to a corresponding double acting piston and cylinder ram unit, a drive mechanism mechanically connected to the pistons of said fluid pressure transmitting piston and cylinder units for reciprocation of said pistons in unison, the improvement consisting in that

a. each piston of the fluid pressure transmitting piston and cylinder units is a two-stage piston cooperating with two pressure chambers,

b. each connection line is directly connected to one of the two pressure chambers and by a branch line to the other pressure chamber of the associated two-stage piston whereby a pressure chamber pair is arranged in parallel to the associated ram unit, and

c. a switching valve is disposed in each branch line to inactivate said other pressure chamber of each pair of pressure chambers by connecting said branch line to a pressure reservoir.

* * * * *