Dec. 19, 1967 J. H. BEARD 3,358,486

FORGING METHOD AND APPARATUS

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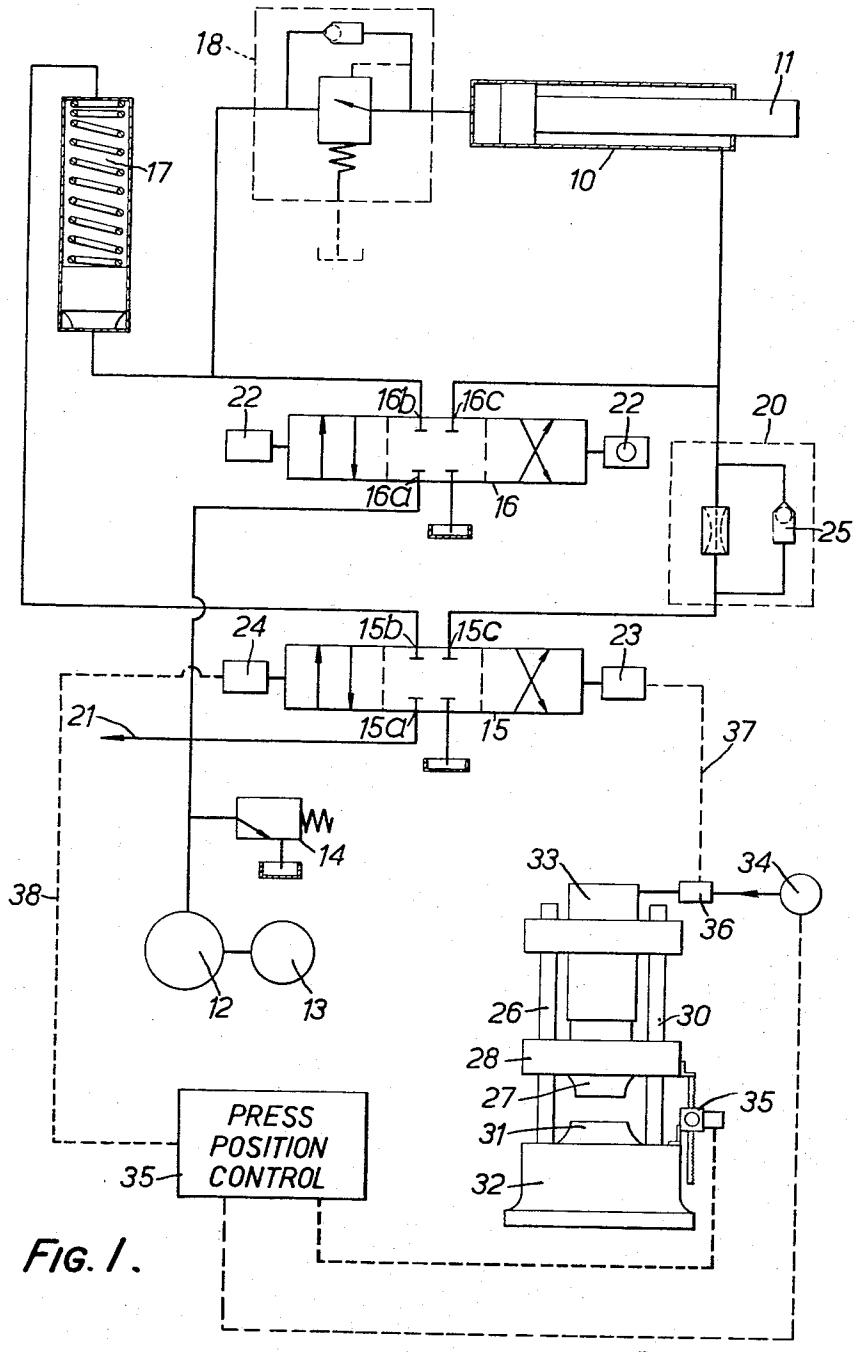

FIG. 1.

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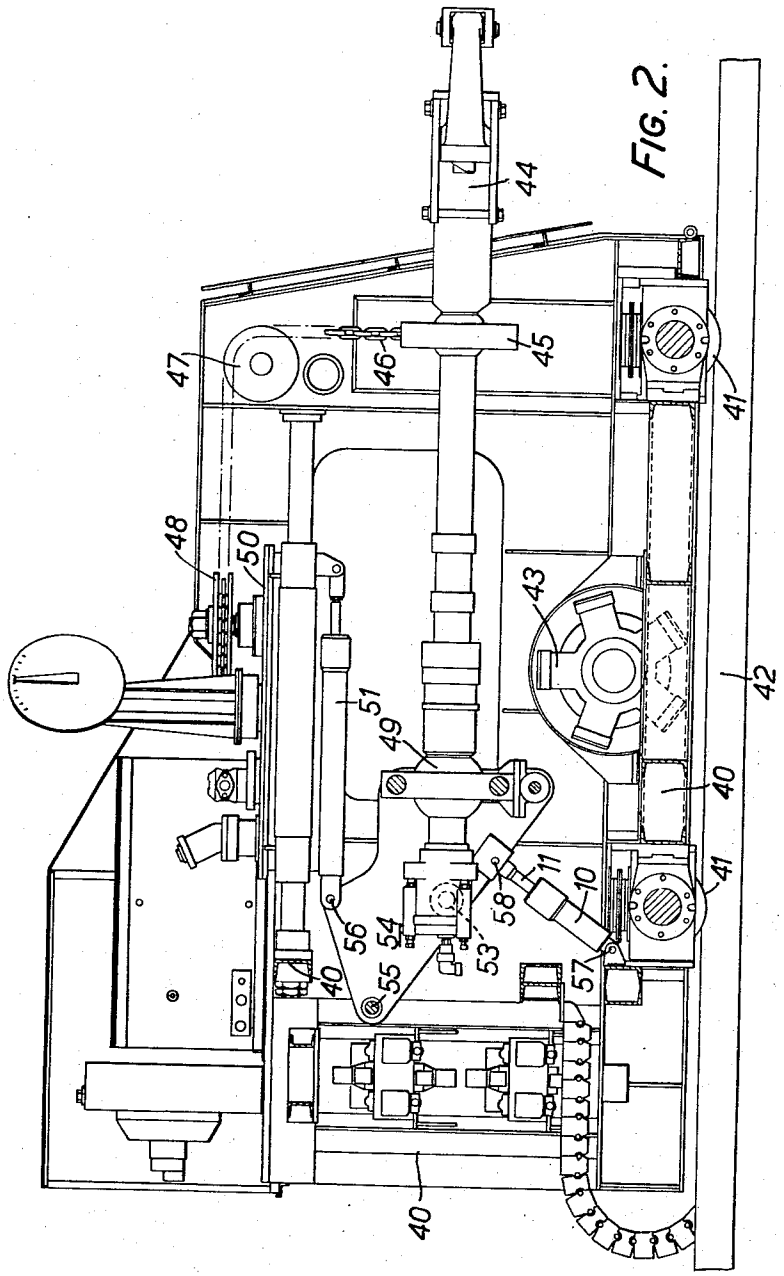
FIG. 2.



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FORGING METHOD AND APPARATUS

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ABSTRACT OF THE DISCLOSURE

The invention provides a method of and a control system for operating a forging press having a fixed and a movable press tool in which during the penetration stroke of the press the workpiece is moved parallel to the moving tool at substantially half the speed thereof.

This invention relates to a method of and apparatus for forging and more particularly to controlling the workpiece during the penetration stroke of a press having one fixed tool and one moving tool.

In one aspect the invention provides a method of forging a workpiece between a fixed and a movable press tool, in which during the penetration stroke of the press the workpiece is moved parallel to the moving tool at substantially half the speed thereof.

In another aspect the invention provides a control system for a press and manipulator, the press having one fixed and one movable tool and the manipulator having a piston and cylinder assembly connected with the peel for raising and lowering the peel, which system comprises means for deriving first and second signals at the start and end respectively of the penetration stroke, and hydraulic valve means responsive to the first and second signals to control the hydraulic flow to and from the piston cylinder assembly such that the peel and workpiece carride thereby are moved together in the direction of movement of the moving tool during the penetration stroke and after the penetration stroke are returned to their original position.

Preferably the control circuit is arranged to drive the peel towards the fixed tool at a speed equal to half the expected speed of penetration of the movable tool.

The control circuit may include a valve for connecting a pressurised hydraulic supply through an adjustable constant speed valve to one side of the piston of the peel hoist cylinder assembly so as to drive the workpiece towards the fixed tool, and means for returning the fluid driven from the other side of the piston during the penetration stroke, to that other side after the penetration stroke.

An embodiment of forging apparatus and control circuit therefor, in accordance with the invention, will now be described, by way of example only, with reference to the accompanying drawings of which:

FIGURE 1 is a control circuit for automatically controlling the lowering and raising of a manipulator peel during forging, and

FIGURE 2 is a side view of a manipulator.

Referring first to FIGURE 1, a cylinder **10** and ram **11** form the peel hoist assembly of a manipulator, one example of which is shown in FIGURE 2. Movement of the ram **11** to the right, in the drawing, serves to hoist the peel, while movement of the ram to the left, in the drawing, serves to lower the peel.

A pump **12** driven by motor **13** and having a safety valve **14** provides a pressurised hydraulic supply. The output of the pump is connected to the inlets **15***a*, **16***a* of control valves **15**, **16** respectively. Connection **15***b* of valve **15** is connected to one side of a piston type accumulator **17**, the other side of which connection **16***b* of valve **16** are connected through a counterbalance valve **18** to the head side of the hoist cylinder **10**. The annular side of the hoist cylinder is connected to connection **16***c* of valve **16**, through an adjustable pressure compensated speed control valve **20** to the connection **15***c* of valve **15**. The valve **15**, accumulator **17** and valve **20** are effectively in parallel with the valve **16**, and the inlets **15***a*, **16***a* are connected on line **20** to further control valves. The solenoids **22** of the valve **16** are intended to be operated manually, so that the operator may raise or lower the peel at any desired time independently of the movement of the press. When neither of solenoids **22** is energised, valve **16** will automatically be maintained in its neutral position permitting no flow through itself. Valve **15** is provided automatically to supply pressurised fluid to the appropriate side of the hoist cylinder during the penetration and return strokes of the press. Energisation of solenoid **23** acts on valve **15** to connect connections **15***a* and **15***c*, and to connect connection **15***b* to an unpressurised tank. Energisation of solenoid **24** is adapted to act on valve **15** to connect connection **15***a* with connection **15***b* and to connect connection **15***c* to the unpressurised tank. The forging press is shown diagrammatically at **26** and has a moving tool **27** secured to cross head **28** slidable vertically on columns **30**, and a fixed tool **31** secured to the press base **32**. The crosshead is reciprocated by means of an acting piston and cylinder assembly **33** and lifting piston and cylinder assemblies (not shown) supplied from a pressurised source **34** controlled by the press position control **35** which may be of any known form such for example as that described in British Patent No. 874,908. The position of the moving tool may be measured by measuring means **35** connected between the moving crosshead **28** and the press base or other known means. In operation, the moving tool is moved downwards until it contacts the workpiece at which point the pressure in the cylinder **33** rises; this pressure rise is measured by a pressure switch, of any known form e.g. a J. Langham Thompson type B.P.I. pressure transducer, which switch gives a signal passed on line **37** to energise solenoid **23**. At the end of the penetration stroke, which may be determined either by the press positional control **35**, in known manner, or by the pressure in cylinder **33** reaching predetermined maximum again indicated by pressure switch **36**, the upper tool **27** is raised and the press positional control gives a control signal on line **38** which energises solenoid **24**. Before a press stroke, while the moving tool is in its upper position, the workpiece will be held in the manipulator peel on or just above the fixed tool **31** and valve **15** is in its neutral position. The upper tool is moved downwards until it contacts the workpiece and the pressure rises at the beginning of the penetration stroke, at which point the pressure switch **36** emits a signal which operates the solenoid **23** to direct pump pressure to the annular side of the hoist cylinder **10** through the pressure compensated speed control valve **20**, which has been previously adjusted to cause the peel to be lowered at half the penetration velocity of the moving tool. Oil from the head side of the hoist cylinder passes through the counterbalance valve **18**, to the piston accumulator **17**. The piston of the accumulator rises against the load of its light spring, oil from the spring loaded side of the piston being permitted to escape to an atmospheric tank via valve **15**.

When the pressure is reversed, either by the press positional control gear or on attainment of maximum pressure, the control signal causing the press reversal also operates the solenoid **24** to direct oil from the pump to the spring loaded side of the piston accumulator **17**. The oil which was expelled from the head side of the hoist piston during the automatic lowering of the peel is now

forced back to raise the peel to its original height before the penetration stroke. Oil from the annular side of the hoist piston flows via the non-return valve **25** incorporated in valve **20** and via valve **15** to atmospheric tank.

The solenoids **23** and **24** are de-energised when the press positional control gear signals the end of the press return stroke.

It will be appreciated that there will be some lowering of the peel while the press load is being built up, that is, when the oil is being compressed and there is little penetration of the workpiece. This early lowering of the peel will serve to remove the strain in the peel shaft and its support induced by the weight to the workpiece and the taking up of the initial clearance between the workpiece and the bottom tool.

FIGURE 2 shows one example of manipulator which may be controlled in accordance with the invention. The manipulator comprises a carriage structure **40** supported on wheels **41** for movement towards or away from the press along a fixed track **42**, and a drive motor **43**. The forward end **44** of the peel projects from the carriage to carry a workpiece in conventional manner the peel being supported at its forward end in a block **45** surrounding the peel and housing a sprocket mounted in and keyed to the peel in the manner described in U.S. Patent No. 2,864,-271. A depending loop of an endless chain **46** engages the sprocket within the block **45** while the upwardly extending reaches of the chain pass over a pair of pulleys **47** and the horizontal reaches of the chain pass round a sprocket wheel **48** mounted on a slidable platform **50**. The platform **50** is slidable horizontally on the carriage support **40** by operation of a double-acting piston and cylinder assembly **51**, forward movement of the carriage **50** and thus sprocket wheel **48** serving to lower the forward end of the peel and rearward movement of carriage **50** serving to raise the forward end of the peel. The rear end **52** of the peel is rotatably carried by a ball end **49** mounted between a pair of crank plates **54**, only one of which is seen in the drawing, the crank plates being rotatably mounted on trunnions **53** on the support carriage. The rear end of the piston cylinder assembly **51** is also connected at **56** with the crank plates **54**. The peel hoist piston cylinder assembly **10**, **11** is pivotally mounted at **57** on the manipulator carriage **40** is such that extension of the cylinder assembly **10**, **11** pivots the crank plates **54** anticlockwise about the trunnions **53** serving to raise the rear end of the peel and at the same time to withdraw the piston cylinder assembly **51** and thereby the platform **50** rearwardly so that the forward end of the peel is raised by the same amount; similarly when the ram **11** is withdrawn the crank plates are pivoted clockwise about trunnions **53** which lowers the forward end of the peel and pushes piston cylinder assembly **51** forward, pushing platform **51** and sprocket wheel **48** forward and lowering the forward end of the peel by the same amount as the rearward end of the peel; by this arrangement operation of the hoist piston cylinder assembly always moves the peel in a parallel manner.

What is claimed is:

1. A method of forging a workpiece comprising the steps of placing a workpiece between a fixed and a movable press tool, and during the penetration stroke of the press moving the workpiece parallel to the moving tool at substantially half the speed thereof.

2. A method according to claim **1** in which the workpiece is carried by a manipulator peel and in which the workpiece is moved during the penetration stroke by hydraulically driving the peel in the direction of the moving tool.

3. A method according to claim **2** including the step of restoring the peel to its position before the penetration stroke after that stroke is completed.

4. A control system for a press and manipulator, the press having one fixed and one movable tool and the manipulator having a piston and cylinder assembly connected with the peel for raising and lowering the peel, which system comprises means for deriving first and second signals at the start and end respectively of the penetration stroke and hydraulic valve means responsive to the first and second signals to control the hydraulic flow to and from the piston and cylinder assembly such that the peel and workpiece carried thereby are moved together in the direction of movement of the moving tool during the penetration stroke and after the penetration stroke are returned to their original position.

5. A control system according to claim **4** arranged to move the workpiece and peel at substantially half the speed of the moving tool during the penetration stroke.

6. A control system for a press and manipulator, the press having one fixed and one movable tool, and the manipulator having a peel carrying a workpiece, the system comprising means for deriving a first signal at the commencement of the pentration stroke, means for deriving a second signal at the end of the penetration stroke, and a hydraulic control circuit responsive to the first and second signals to drive the peel in the direction of movement of the movable tool towards the fixed tool at a predetermined constant speed during the penetration stroke and to return the peel to its original position after the penetration stroke.

7. A control system according to claim **7** in which the predetermined constant speed is substantially half the speed of movement of the movable tool during a penetration stroke.

8. A control system according to claim **6** including an adjustable constant speed valve for determining the predetermined constant speed.

9. A control system according to claim **8** including a peel hoist cylinder assembly having a piston and including a control valve operative by the first signal to connect a pressurised supply through the adjustable constant speed valve to one side of the piston of the peel hoist cylinder assembly so as to drive the peel parallel to the movable tool.

10. A control system according to claim **9** including means responsive to the second signal for returning the fluid driven from the other side of the piston of the peel hoist cylinder assembly during the penetration stroke to that other side after the penetration stroke.

11. A control system according to claim **10** including a spring loaded piston type accumulator connected to the other side of the piston of the peel hoist cylinder assembly.

12. A control system according to claim **6** in which the means for deriving the first signal includes a pressure switch responsive to the rise in hydraulic pressure in the movable tool drive when that tool contacts a workpiece.

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