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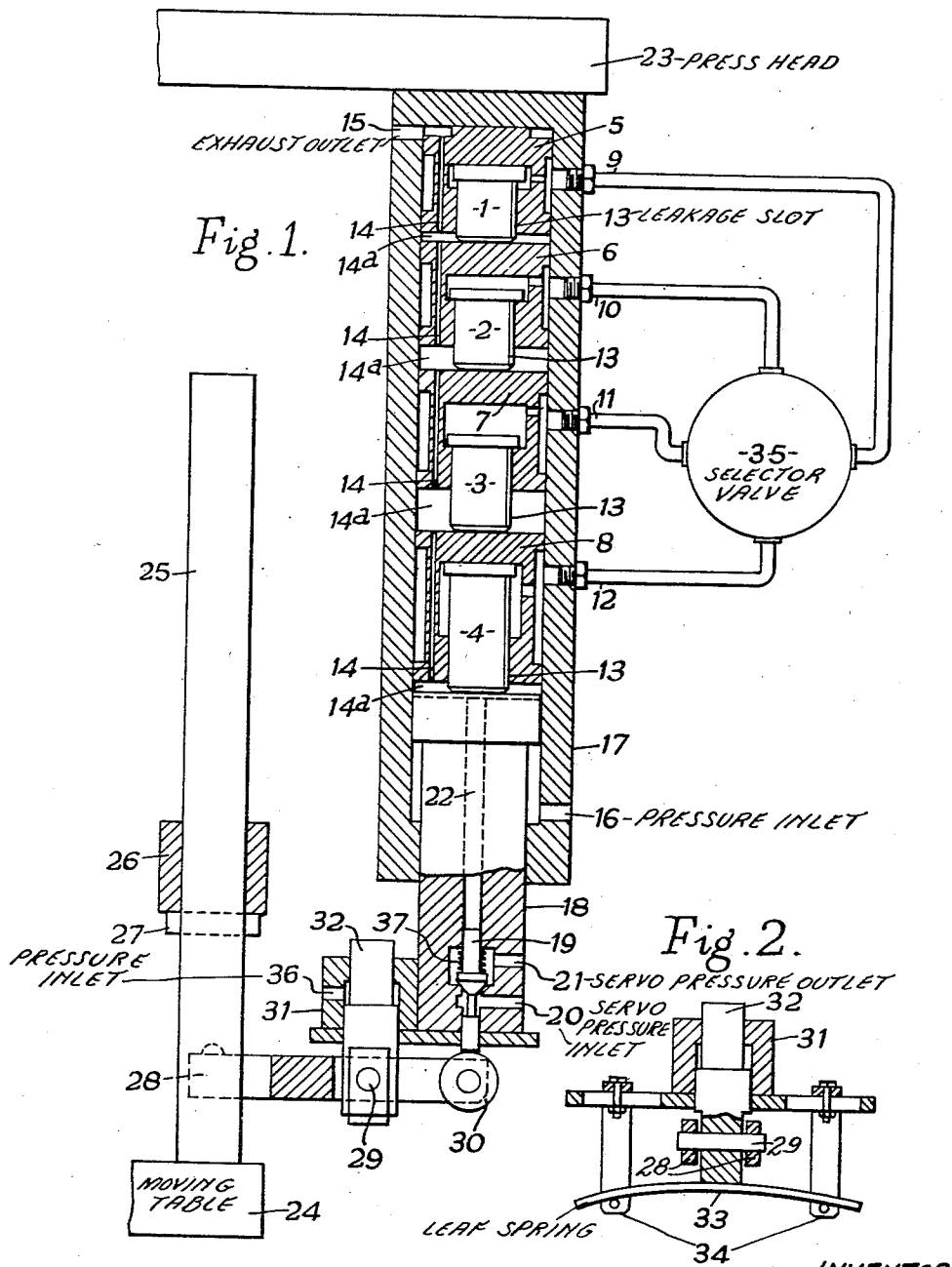
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CONTROL MECHANISM FOR HYDRAULIC PRESSES

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3 Sheets-Sheet 1



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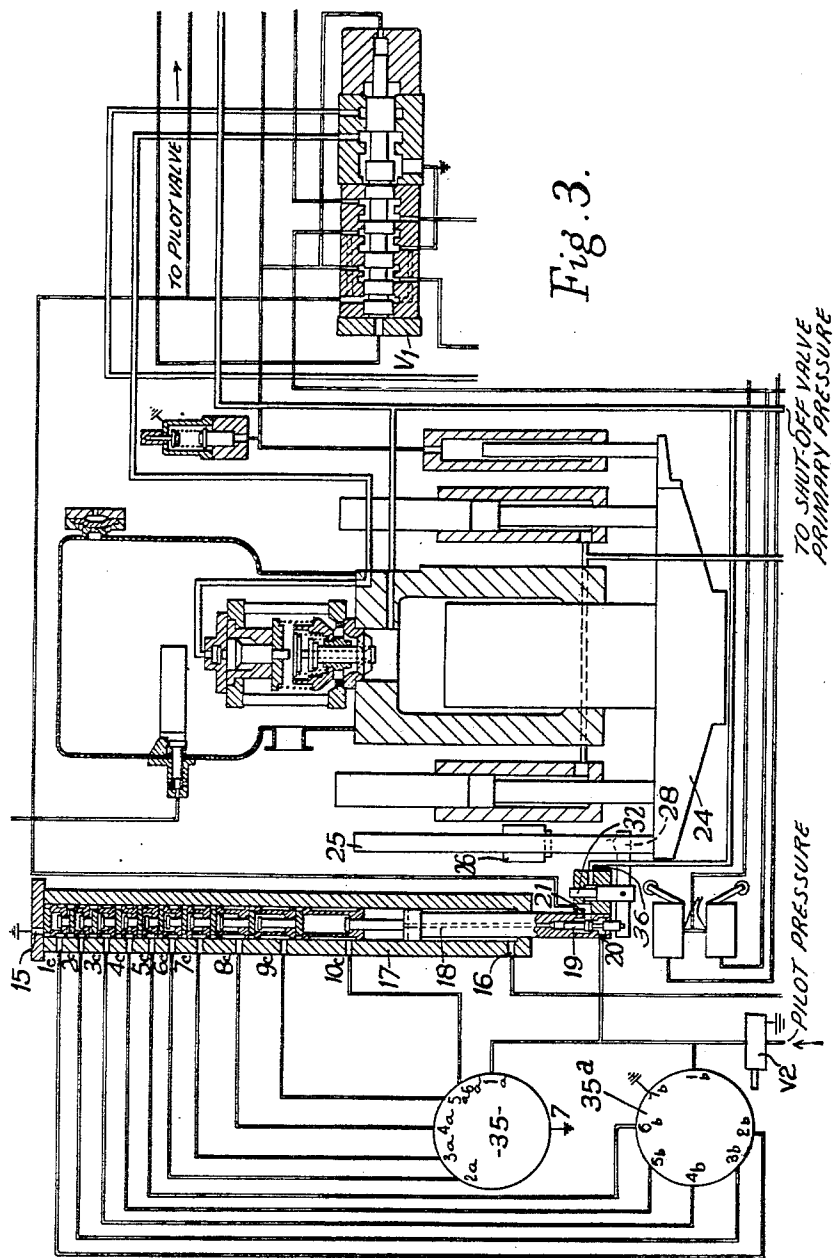
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CONTROL MECHANISM FOR HYDRAULIC PRESSES

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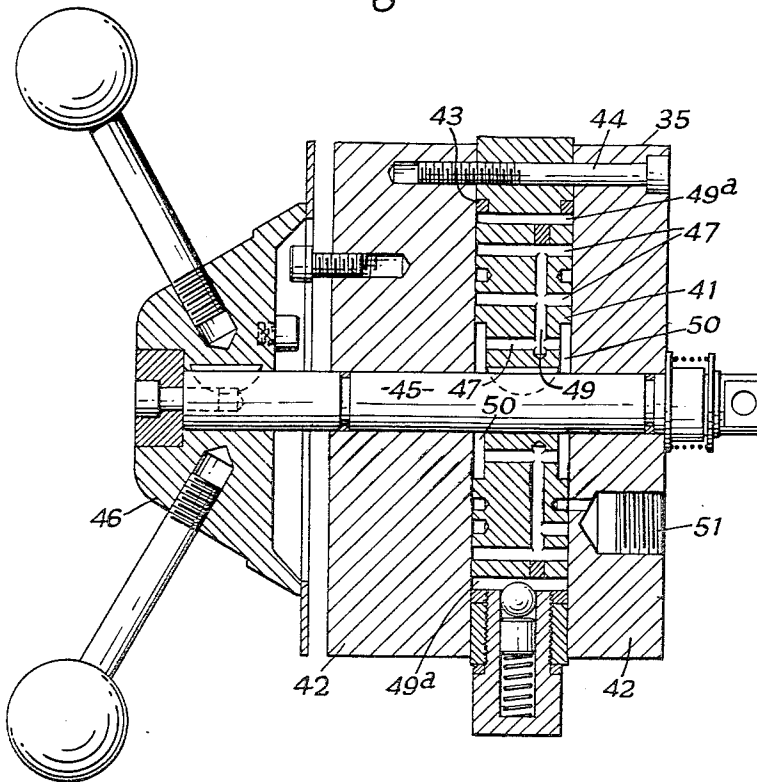
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Fig. 4.



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CONTROL MECHANISM FOR HYDRAULIC PRESSES

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7 Claims. (Cl. 121—38)

This invention relates to control mechanism for hydraulic presses such, for example, as hydraulic forging presses. One object of this invention is to provide improved automatic means for limiting the working or forging stroke of the press ram and reversing the press ram when the predetermined limit of stroke has been reached, of the kind whereby the said predetermined limit of stroke may be varied by the press operator. Another object of this invention is to provide means whereby the said predetermined limit of stroke may be varied by large or small amounts or by minute increments controlled by the operator. Yet a further object of this invention is to provide means whereby large or small variations of the said predetermined limit of stroke may be made quickly, for example, in about a second; or the stroke control mechanism may be made inoperative, without altering the setting, at the will of the operator.

A stroke control mechanism is known employing a number of tappet rods of different lengths mounted in a turret and the limit of stroke may be varied by rotating the turret to bring one of the said tappet rods into operation. Thus the limits of stroke correspond to the number of tappet rods. For example, if there are three tappet rods, there are three distinct limits of stroke. Consequently, a large number of tappets would be required if it were desired to make a large number of variations of stroke.

Broadly the present invention consists in stroke control means for limiting the working or forging stroke of the main ram of a hydraulic press which comprises a tappet rod assembly having a co-axial piston in a cylinder to which pressure fluid may be directed under control of an operator to effect displacement of the piston and a corresponding increase in predetermined increments or stops in the effective length of the tappet rod assembly.

In one embodiment of this invention the extensible tappet rod assembly comprises a number of hydraulic pistons and cylinders superimposed one upon the other or otherwise disposed in axial alignment. The said pistons and cylinders may be arranged to have different strokes. For example, there may be four pistons and cylinders having strokes of 1, 2, 4 and 8 millimetres respectively and so arranged that, if servo pressure is directed to all four pistons and cylinders, the length of the tappet rod assembly will be extended by 15 millimetres; on the other hand, if servo pressure is only directed to the pistons and cylinders having 2 and 4 millimetres stroke, the tappet rod will be extended by 6 millimetres. Thus, if a suitable control valve is provided, such for instance as that described in the copending application of Frank H. Towler et al., Serial No. 342,006, filed March 12, 1953, now Patent No. 2,827,924, issued March 25, 1958, to direct servo pressure to one or more of the above described pistons and cylinders in the appropriate sequence, then the length of the tappet rod assembly may be extended in 15 equal incre-

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ments of one millimetre by such a valve at the will of the press operator.

In order that the invention may be clearly understood and carried into effect the same will now be described by aid of the accompanying drawings in which:

Fig. 1 is a sectional elevation through the extensible tappet rod assembly according to the aforementioned embodiment showing the same as carried by the press head of a hydraulic press and in operative association with an adjustable tappet.

Fig. 2 is a view, taken at right angles, of the tappet lever and fulcrum shown in Fig. 1.

Fig. 3 is a view showing a stroke control means according to a further embodiment of the invention applied to a hydraulic down stroking forge press and including a valve for rendering the stroke control mechanism inoperative without altering the setting of the selector valve and the association of the tappet operated valve with a servo operated valve which on operation effects the reversal of the press ram.

Fig. 4 is a section through one suitable form of selector valve adapted for controlling the stroke control means shown in Fig. 3.

Referring to Fig. 1, it will be seen that, in this example, there are four hydraulic pistons numbered 1, 2, 3 and 4 respectively with associated cylinders formed in elements numbered 5, 6, 7 and 8 respectively superimposed upon each other and mounted in end-to-end relation in a common main cylinder 17 having an associated tappet rod 18 with an integral piston enlargement slidable therein. The cylinder 17 also has a servo pressure inlet at 16 and an exhaust outlet at 15. The cylinders for the pistons 1, 2, 3 and 4 have inlet passages communicating with them numbered 9, 10, 11 and 12 respectively and servo pressure can be directed to any one or more of the said inlets by the servo selector control valve 35. The pistons are provided with leakage slots 13 and the pistons have an enlarged head to limit their stroke and this head partially closes the leakage slot when the piston has reached the end of its stroke. The associated cylinder elements 5, 6, 7 and 8 are slidably mounted within the cylinder 17 and each of the said cylinder elements has a longitudinal bore 14 permitting free communication between spaces 14a at the ends of the cylinders and the exhaust outlet at 15 so that any leakage past the pistons passes freely to exhaust. A tappet valve 19 is mounted in the end of the tappet rod and piston 18 and provided with a servo pressure inlet at 20 and an outlet at 21 for communication with the reversing valve V1 of the hydraulic press, see Fig. 3. The upper part of the spindle 19 slides in a bore 22 which is continuously in communication with the exhaust passages to the outlet 15, by way of the spaces 14a and the bores 14. The cylinder 17 is attached to the press head 23, and a tappet 26 consisting of a weight is slidably mounted on a rod 25 attached to the moving table of the hydraulic press on which is mounted the forging tool not shown. It will be understood that this embodiment is shown as applied to a downwardly acting forging press and, therefore, the moving table 24 moves downwards with the tool on the forging stroke. The tappet 26 is supported on a pin 27 and the said pin may be moved to other holes not shown in the rod 25 in order to change the position of the tappet 26.

On its downward movement the tappet 26 makes contact with a forked end of a tappet lever 28 causing it to turn about a fulcrum 29 thereby forcing the other end of the lever and its roller to lift the valve 19 off its seat in opposition to a light spring 37, the tappet or weight 26 being sufficient to overcome the said light spring 37. As soon as the valve 19 is lifted off its seat it directs

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servo pressure from the inlet 20 to the outlet 21 and thence to the reversing valve V1 of the hydraulic press to cause the press ram to be reversed. It will be noted that the fulcrum 29 is mounted on a piston 32 with associated cylinder 31 and the said cylinder is supplied with hydraulic pressure at its inlet 36 which is in continuous communication with the main cylinder of the hydraulic press, see Fig. 3, so that the piston 32 is always subject to the same pressure as that applied by the hydraulic press.

The lower end of the piston 32 is opposed by a leaf spring 33 see Fig. 2 mounted upon trunnions 34. Thus, as the pressure in the press cylinder increases the leaf spring 33 will be deflected and thereby move the fulcrum 29 further away from the press head 23 and, by suitably spacing the trunnions 34, the deflection of the leaf spring 33 may be made to compensate for the deflection of the press frame.

The reversing valve V1 of the hydraulic press which is connected to valve 19 by the outlet 21 may be of any suitable construction such for example as described in the co-pending application of John M. Towler, Serial No. 573,971, filed March 26, 1956, now Patent No. 2,839,897, issued June 24, 1958. The inlet 16 to the cylinder 17 is continuously subject to servo pressure operating on the annulus of the tappet rod piston 18 so as to move it upwards in opposition to the four superimposed pistons and cylinders. Consequently, if the supply of servo pressure is interrupted to any one or more of the pistons and cylinders, they will be forced upwards into their respective cylinders, the liquid in the cylinder passing down the leakage slot 13 and up the passage 14 to exhaust at 15. Thus, supposing that the pistons and cylinders have strokes of 1, 2, 4 and 8 millimetres respectively, then, if servo pressure is directed to all the cylinders, they will force the tappet rod piston 18 out of the cylinder 17 by 15 millimetres. On the other hand, if the supply of servo pressure is interrupted to the cylinder 8, the associated piston 4 will be forced into the cylinder thereby permitting the tappet piston 18 to return into the cylinder 17 by 8 millimetres. That is to say that the tappet rod can be extended by 15 equal increments of 1 millimetre by suitable movement of the control valve 35 to direct or interrupt servo pressure to the respective cylinders in the appropriate sequence. Fig. 1 shows the selector valve positioned to direct servo pressure to the cylinders for the pistons 2 and 3, thus advancing those pistons while pistons 1 and 4 remain in retracted position.

The tappet mechanism or stroke control mechanism may be made inoperative by interrupting the supply of servo pressure to inlet 20 without altering the setting of control valve 35 and this may be done by providing an isolation valve V2 see Fig. 3 in the servo pressure line to inlet 20, the said isolation valve being hand actuated by the press operator.

In the further embodiment shown in Fig. 3 the extensible tappet rod of the present invention has ten pistons in cylinders with ports numbered 1 to 10, with five of said ports coupled to corresponding ports of one selector valve 35 and the remaining five ports coupled to the ports of a further selector valve 35a. In this embodiment, the longitudinal bores 14 shown in the embodiment of Fig. 1 are dispensed with.

The servo pressure liquid in this embodiment passes by way of the isolation valve V2 to inlets 1a-1b of the two selector valves and also to the inlet 20 of the tappet valve 19. In Fig. 3 the spindle of the isolation valve is shown in the position where the inlet for servo pressure is connected to exhaust. The stroke control mechanism is thus rendered inoperative. In the second position of the spindle of the isolation valve V2 its inlet is isolated from the exhaust outlet and connected to the inlet 20.

The selector valve 35 shown by way of example in Fig. 4 is a control valve of the rotary type consisting of a valve member, hereafter referred to as a rotor 41 enclosed in a valve body built up of three parts comprising a cylin-

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dricl portion sandwiched between two circular flanges 42 and provided with suitable sealing rings 43 and held together by screws 44. The rotor is keyed to a spindle 45 which in turn is keyed to a knob and rotary dial 46, and the rotor is provided with a number of axial bores passing right through from face to face; there are three rows of axial bores 47 arranged in circles concentrically around the spindle, and they are all interconnected by radial bores 49 a few only of which are shown. Pressure liquid for distribution to the cylinders in the stroke control means is admitted to an annular clearance 49a around the rotor. The said clearance 49a is connected by radial and axial passages (not shown), similar to the axial bores 47 and the radial bores 49. These bores in the drawing are for exhausting the cylinders in the stroke control means and replace the bores 14 shown in Fig. 1. For this reason the outer of the three axial bores is isolated from the annular recess 49a by the plugs shown in Fig. 4.

So that the rotor shall be in axial balance it is formed on opposite sides with circular recesses 50 of equal diameter. These recesses are in open connection with the bores 47 and 49 so as to be maintained at exhaust pressure.

To adapt the distributing valve of Fig. 4 for controlling the operation of the stroke control means according to Fig. 1 the recesses 50 and the bores 47 and 49 will all be open to the annular clearance 49a as the exhausting of the cylinders is effected through the longitudinal bores 14.

Résumé

In operation, the improved tappet assembly may be preset to any effective length within its range for stopping the press ram at a precise selected position by appropriate manipulation of the selector valve 35. Before such setting, the assembly is collapsed to its minimum length by the action of pilot pressure fluid introduced through the inlet port 16, the valve 35 being set, of course, in position to cut off pressure fluid from all of the cylinder elements 5-8. Depending on the number of units by which the length of the assembly is to be increased, the valve 35 is turned to a position to direct pressure fluid to a selected one or to a combination of the cylinder elements. Thus, in the form of the assembly shown in Fig. 1 in which the piston strokes vary in algebraic progression, the extension of the assembly may be effected in increments of from one to fifteen units, as, for example, millimeters. The operation of the assembly shown in Fig. 3 is the same except that adjustments may be effected in a greater number of increments by manipulation of the selector valves 35 and 35a.

Assume by way of illustration that the tappet assembly is to be extended six units. Valve 35 is accordingly set to direct pilot pressure fluid to the cylinder elements 6 and 7, thus causing their respective pistons 2 and 3 to advance. Piston 2 pushes the cylinder elements 7 and 8 toward the tappet rod 18 advancing the rod two units. Piston 3 in its advance pushes the cylinder element 8 toward the tappet rod and advances the rod an additional four units. Thus, the tappet rod 18 is projected from the cylinder 17 a total of six units to increase the effective length of the assembly by that amount.

It will be apparent from the foregoing that the tappet rod may be extended up to fifteen units in increments of a single unit by appropriately setting the valve 35 to direct pressure fluid to the proper cylinder unit or to combinations of the cylinder units. As stated in the specification, piston 1 advances the tappet rod one unit; piston 2, two units; piston 3, four units and piston 4, eight units. Intermediate advances are effected by the combined action of two or more of the pistons. Thus, pistons 1 and 2 advance the tappet rod three units; pistons 1 and 3, five units; and pistons 1 and 4, nine units. Pistons 2 and 3 advance the tappet rod six units; pistons 2 and 4, ten units; and pistons 3 and 4, twelve units. Oper-

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ating in combinations of three, pistons 1, 2 and 3 advance the tappet rod seven units; pistons 1, 2 and 4, eleven units; pistons 1, 3 and 4, thirteen units; and pistons 2, 3 and 4, fourteen units. All four pistons acting at the same time effect the maximum advance of fifteen units. This range is merely exemplary and can be increased or decreased as required for a particular installation by increasing or decreasing the number of cylinder and piston elements employed in the tappet rod assembly. It will be evident that with the arrangement shown, the number of incremental units obtainable is on the order of $2^n - 1$ in which n represents the number of cylinder and piston elements provided in the assembly.

It will be understood that this invention may be applied with equal facility to a horizontal or to an upwardly acting hydraulic press.

I claim:

1. A tappet rod assembly for controlling the stroke of a hydraulic press ram comprising, in combination, a tappet rod, a plurality of cylinder and piston units, means supporting said units and said rod for relative endwise movement and in coaxial relation, with the cylinder and piston units adjacent each other and with an end one of said units adjacent said tappet rod, and with the pistons of all of said units, except that of said end one of said units, engaging the cylinder of the next adjacent unit, the piston of said end one of said units engaging said tappet rod, each of the cylinders of said units having a drain connection permitting the piston thereof to retract into its cylinder in the absence of a supply of pressure fluid to said cylinder, and means for directing pressure fluid to the cylinder and piston units individually and in selected combinations and in greater volume than is exhausted through their respective drain connections, to project the pistons from said cylinders to thus vary the overall length of the tappet rod assembly.

2. A tappet rod assembly as defined in claim 1 including means acting on the piston of said end one of said units to return the pistons and associated cylinders of all of the units to retracted positions upon interruption of the pressure fluid supply to the units.

3. A tappet rod assembly as defined in claim 1 in which the pistons of the respective units have strokes of different length.

4. A tappet rod assembly as defined in claim 1 in which the cylinders of the units and the tappet rod are slidably

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mounted in a common cylinder with one end of the tappet rod projecting outwardly therefrom.

5. A tappet rod assembly comprising, in combination, an elongated main cylinder closed at one end and open at the other end, a tappet rod projecting at the open end of said main cylinder and having a piston enlargement slidable in the cylinder, a plurality of cylinder elements slidably mounted in end-to-end relation in said main cylinder, each of said elements defining a cylinder opening toward the open end of said main cylinder, a piston slidable in the cylinder of each element with one end projecting therefrom to engage and shift the next adjacent element except the piston in the cylinder element adjacent the tappet which engages the piston enlargement of said tappet rod, said main cylinder having a fluid inlet passage individual to each cylinder element, and each cylinder element having an inlet in communication with the associated inlet passage in the main cylinder in all positions of the element and valve means operable to direct pressure fluid to the main cylinder inlet passages individually or in any combination to effect the selective actuation of the cylinder and piston elements for advancing the tappet rod in incremental steps.

6. A tappet rod assembly as defined in claim 5 in which the main cylinder has an exhaust outlet adjacent its closed end and each of the cylinder elements is formed with a vent passage opening at opposite ends of the element to permit passage of fluid from the spaces between the elements to the exhaust outlet.

7. A tappet rod assembly as defined in claim 6 in which each of the pistons in the cylinder elements is formed with a longitudinal passage through which fluid is exhausted from the cylinders of the elements into the spaces between the elements.

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