Jan. 12, 1954 G. R. C. MARTINSSON 2,665,555

HYDRAULIC MECHANISM

Filed July 15, 1949

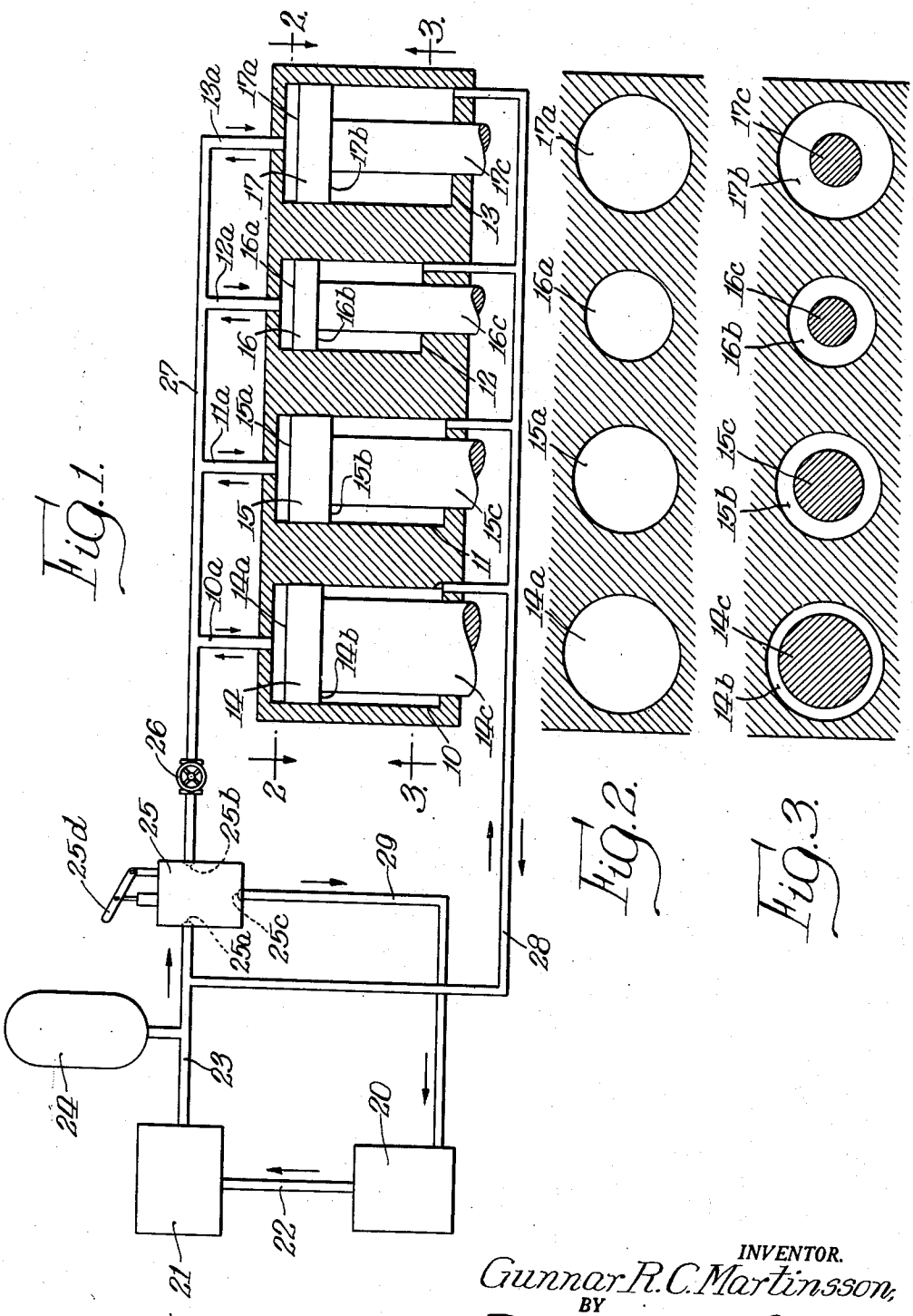

Fig. 1.

Fig. 2.

Fig. 3.

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Patented Jan. 12, 1954

2,665,555

UNITED STATES PATENT OFFICE

2,665,555

HYDRAULIC MECHANISM

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Application July 15, 1949, Serial No. 104,851

3 Claims. (Cl. 60—97)

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This invention relates to improvements in hydraulic mechanism and its purpose is to provide an improved system of the type comprising pistons operating in cylinders to which fluid under pressure is admitted in such a manner that the several pistons are caused to move sequentially in timed relation to each other for bringing about the successive operation of various devices to be controlled thereby.

Several forms of hydraulic mechanism for effecting the sequential operation of a plurality of pistons have heretofore been devised but none of them has been entirely satisfactory. In some of these prior devices, the successful operation of the pistons by hydraulic pressure requires the use of sequencing valves which are controlled by a trip mechanism or cams and, in some of the systems, check valves have also been required to effect the proper draining of the cylinders. All of the systems of this form have been objectionable because the use of numerous valves has required a substantial expenditure for piping and connectors, thus increasing the cost of the construction while at the same time requiring an excessive amount of space, frequent replacement and repair, and regular maintenance. An effort has been made to overcome these disadvantages by providing a sequencing hydraulic system in which the admission of fluid to each cylinder is controlled by the opening of a port in response to the movement of the piston in a preceding cylinder of the series. While this form of construction has eliminated the use of sequence valves, check valves are still required and the system has the disadvantage that it is sluggish in operation so that there is a delay between the successive operation of the pistons, besides requiring fluid lines for connecting the cylinders with each other.

The principal object of the present invention is to overcome the above mentioned difficulties by providing a hydraulic system in which the successive operation of a number of pistons in their cylinders is brought about automatically without the use of sequence valves or check valves. Another object of the invention is to provide a hydraulic system comprising a plurality of pistons and cylinders constructed and arranged to bring about a fast sequential operation of the pistons while at the same time eliminating the use of control valves for the several cylinders. Still another object of the invention is to provide a fixed sequencing hydraulic system which does not require adjustment for maintaining the proper timed relation of the operations of the

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several pistons. A further object of the invention is to provide a sequencing hydraulic system having a minimum number of fluid lines and a minimum of valves so that it may be constructed in compact form and employed in places where space is limited. Another object is to provide a sequencing hydraulic system which, because of its fixed timing and use of a minimum of valves, requires very little maintenance as compared with other systems heretofore known. Other objects relate to various features of construction and arrangement which will appear more fully hereinafter.

The nature of the invention will be understood from the following specification taken with the accompanying drawing in which one embodiment is illustrated. In the drawing,

Figure 1 shows a somewhat diagrammatic side elevation of a hydraulic system embodying the features of the present invention with the cylinders of the system shown in vertical section;

Fig. 2 shows a horizontal section taken on the line 2—2 of Fig. 1; and

Fig. 3 shows a horizontal section taken on the line 3—3 of Fig. 1.

As illustrated in the drawing, the improved hydraulic system comprises four cylinders 10, 11, 12 and 13 which have different internal diameters and which have mounted therein the respective pistons 14, 15, 16 and 17 which are arranged to reciprocate in response to the fluid pressures set up in the cylinders. The pistons are of varying diameters in relation to their piston rods 14a, 15a, 16a and 17a so that the ratio of the area of the upper or forward face of each piston to the area of its lower or reverse face is different from that of each of the other pistons. This difference in the ratio of the surface areas of the opposite faces of the pistons is made use of to bring about their sequential operation in fixed timed relation to each other.

As shown in the drawing, fluid such as oil is drawn from a fluid reservoir 20 by a pump 21 through a pipe 22. The pump discharges oil under pressure through discharge line 23 to which there is connected a pressure relief drum or accumulator 24. This discharge line is connected through an operating valve 25 and a flow control valve 26 with the inlet line 27 which is connected through the branch inlet pipes 10a, 11a, 12a and 13a to the cylinders 10, 11, 12 and 13, respectively. The other ends of the cylinders 10, 11, 12 and 13 are connected to a common return line 28 which communicates with the discharge line 23 in advance of the operating valve 25. The operating

valve is a three-way valve, having ports 25*a*, 25*b* and 25*c* which may be selectively interconnected through a valve member (not shown) which may be actuated by a handle 25*d* to cause the hydraulic fluid to be discharged from the discharge line 23 into the inlet line 27 or returned through the return line 29 to the tank 20.

With the foregoing arrangement of apparatus, a constant fluid pressure is applied through the inlet line 23 to the upper faces of the pistons 14, 15, 16 and 17 when the valve 26 is open and the valve 25 has been adjusted to connect the ports 25*a* and 25*b* and thereby permit the flow of oil through the line 27 to the various branch pipes 10*a*, 11*a*, 12*a* and 13*a*. The pressure of this oil is thereby applied to the upper or forward faces of the several pistons. At the same time that this constant pressure is applied to the upper faces of the several pistons, a constant uniform pressure is continuously applied to the lower or reverse faces of the same pistons through the line 28 leading from the discharge line 23 but, after the pressure has been built up and applied, the total effective pressure acting upon the lower or reverse face of each piston is less than that acting upon the upper or forward face thereof because the effective area of the lower face of each piston is reduced to the extent of the cross-sectional area of its piston rod.

The areas of the upper faces 14*a*, 15*a*, 16*a* and 17*a* of the pistons are shown in Fig. 2, which illustrate p an views of the upper or forward faces of several pistons, while the effective areas of the lower faces 14*b*, 15*b*, 16*b* and 17*b* of these pistons are shown in Fig. 3 which show bottom plan views of the lower or reverse faces of the pistons with their respective piston rods 14*c*, 15*c*, 16*c* and 17*c* illustrated in cross section. Due to the difference in the diameters of the piston rods in relation to the diameters of the pistons to which they are connected, the ratio of the areas of the forward and reverse faces of each piston differs from the ratio of the areas of these faces for each of the other pistons and this differential of the surface areas is utilized in bringing about a sequential operation of the pistons in response to the pressures which are applied to the upper and lower faces thereof.

The speed with which the pressure builds up on the faces of the pistons is controlled by adjusting the flow control valve 26 and each piston operates through a forward stroke when the total pressure on the forward side thereof exceeds the total pressure acting constantly on the reverse face thereof. The piston 14, which has the largest area, moves first through a forward stroke because the total pressure on its forward side 14*a* exceeds the total pressure on its reverse side 14*b* before a corresponding condition is reached with respect to the pressures acting upon the other pistons. The unbalanced pressure acting on piston 14, therefore, causes this piston to move first and its movement is followed by the successive movements of the other pistons 15, 16 and 17, in that order. The time interval between the operation of two successive pistons will be determined by the period required for building up the pressure on the forward face of the second piston until it becomes sufficiently unbalanced to cause its movement. In this way, the four pistons may be caused to operate successively in a definite timed relation to each other in response to the admission of hydraulic pressure to their opposite faces and without the use of sequence valves or check valves in connection with any of the cylinders. Of course, the same principle may be applied to any number of pistons and cylinders depending upon the number of successive operations which are to be performed by the mechanism.

After all of the pistons have been operated, the operating valve 25 is actuated to break the connection between the ports 25*a* and 25*b* and to connect the ports 25*b* and 25*c*, thereby causing the fluid pressure acting upon the forward sides of the pistons to be diverted to the return line 29 by which the fluid is returned to the fluid reservoir 20. This causes the pressure on the upper or forward side of each piston to diminish until it is exceeded by the total constantly applied pressure acting upon the opposite faces of these pistons which are continuously connected to a constant pressure acting through the pipe 28. This change in the relative pressures acting upon the opposite faces of the pistons will continue until a pressure unbalance again exists with respect to each piston, with the higher pressures then acting upon the reverse faces of the pistons, so that the pistons return to their initial positions in the inverse order of their leaving those positions. Thus, the piston 17 will return first followed by the successive return movements of the pistons 16, 15 and 14.

It will be apparent that in the system which has been described above, the pressure builds up or falls off simultaneously on the forward sides of all of the pistons so that the pressure per unit of area on the forward sides of the piston is the same for all of the pistons at any instant. This is an important advantage over other systems where the pressure builds up in each cylinder individually from a low pressure to a high pressure every time that a piston is caused to operate.

The several piston rods 14*c*, 15*c*, 16*c* and 17*c* may, of course, be connected to various forms of mechanism to bring about desired mechanical operations in timed relation to each other. For example, a sequencing hydraulic mechanism of the type herein described may be employed for bringing about successive operations of different parts of a stapling machine as set forth in the copending application of Chester M. MacChesney, Gunnar R. C. Martinsson, and Godfrey Stanius, Serial No. 108,674, filed August 5, 1949.

Although one form of the invention has been shown and described by way of illustration, it will be understood that it may be constructed in various other embodiments which come within the scope of the appended claims.

I claim:

1. In hydraulic mechanism, a plurality of pistons and cylinders, each piston having forward and reverse faces of different areas, the ratio of said areas for each piston being different from said ratio for each of the other pistons, means for constantly supplying liquid under a uniform pressure to the reverse faces of said pistons, and means for intermittently supplying liquid to the forward faces of said pistons and building up the pressure thereof to equal said uniform pressure.

2. In hydraulic mechanism, a plurality of pistons and cylinders, each piston having forward and reverse faces of different areas, the ratio of said areas for each piston being different from said ratio for each of the other pistons, means for constantly supplying liquid under a uniform pressure to the reverse faces of said pistons, means for intermittently supplying liquid to the forward faces of said pistons and building

up the pressure thereof to equal said uniform pressure, and means operated in alternation with said last named means for intermittently relieving the pressure in said cylinders adjacent said forward faces.

3. In hydraulic mechanism, a plurality of pistons and cylinders, each piston having forward and reverse faces of different areas, the ratio of said areas for each piston being different from said ratio for each of the other pistons, means for constantly supplying liquid under a uniform pressure to the reverse faces of said pistons, and means for intermittently supplying liquid to the forward faces of said pistons and building up the pressure thereof to equal said uniform pressure, said last named means operating to supply liquid to all of said forward faces simultaneously.

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