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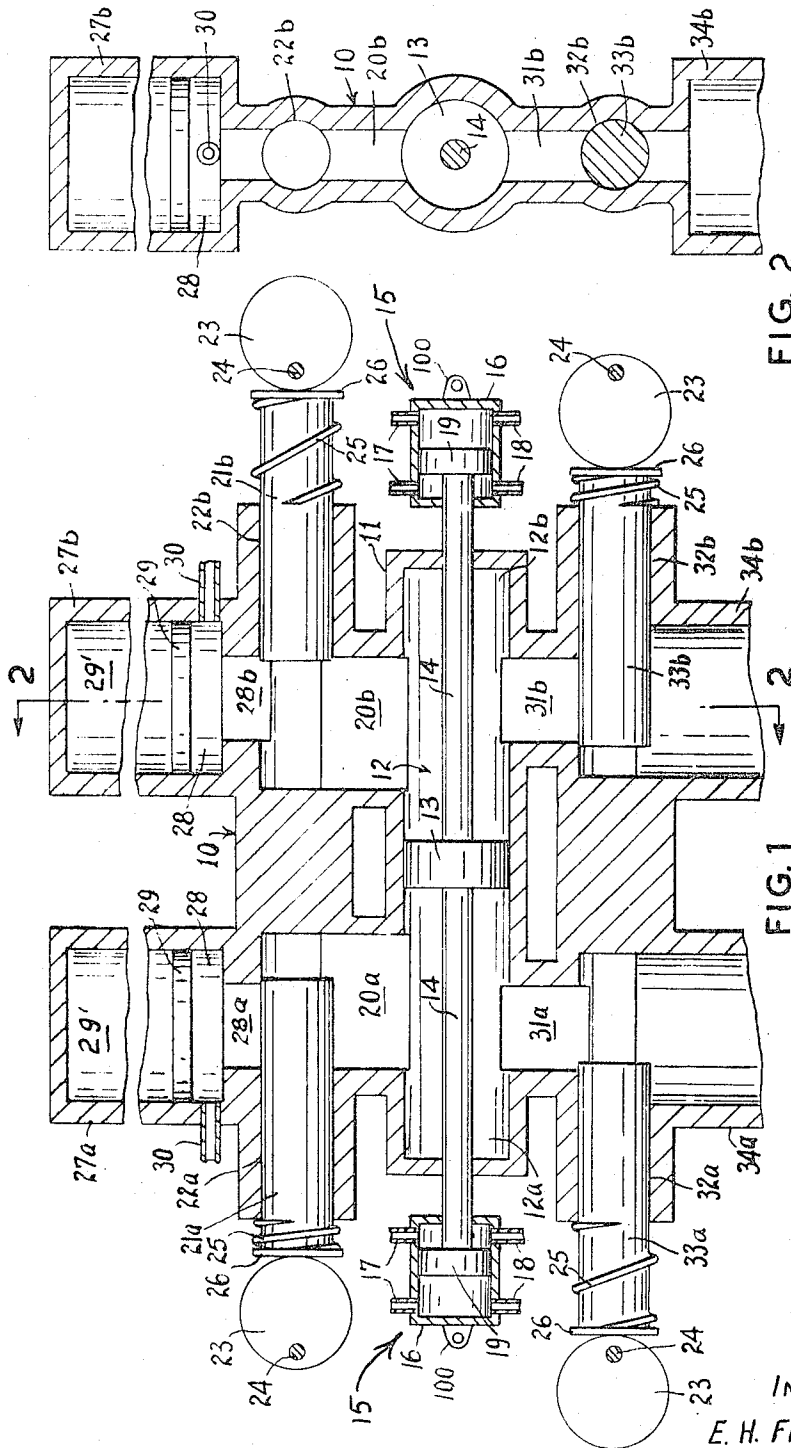
E. H. FISHER

3,369,459

HYDRAULIC INTAKE AND EXHAUST VALVING ARRANGEMENT

Filed Jan. 4, 1965

4 Sheets-Sheet 1



INVENTOR

E. H. FISHER

Fetherstonhaugh & Co.
ATTORNEYS

ATTORNEYS

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E. H. FISHER

3,369,459

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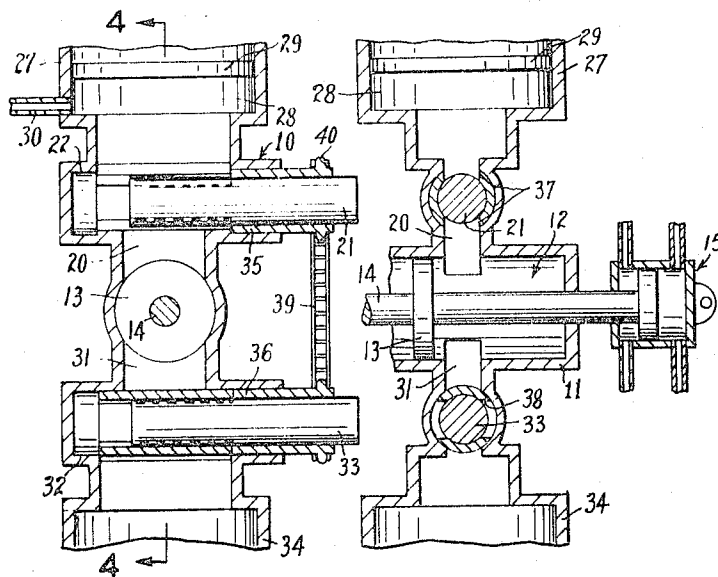


FIG. 3

FIG. 4

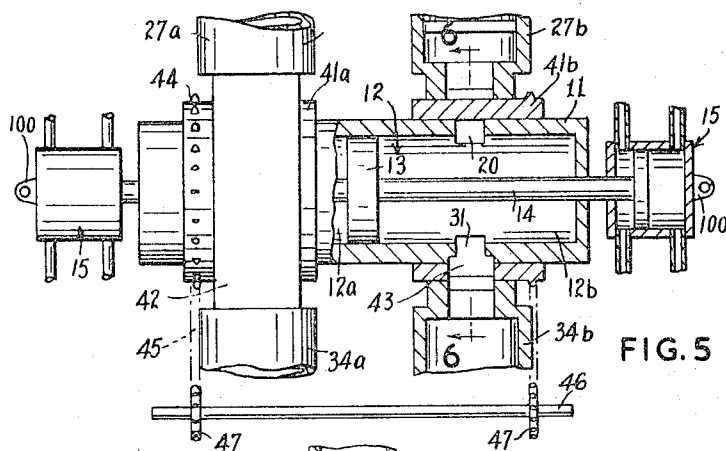


FIG. 5

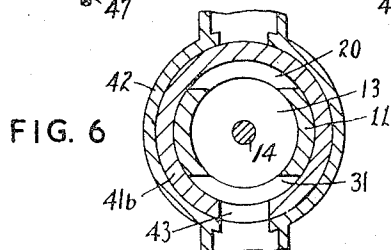


FIG. 6

INVENTOR
E. H. FISHER

Fetherstonhaugh & Co.
ATTORNEYS

Feb. 20, 1968

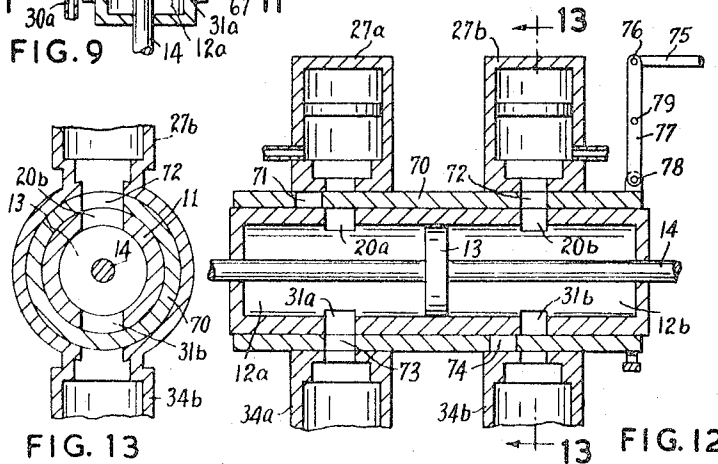
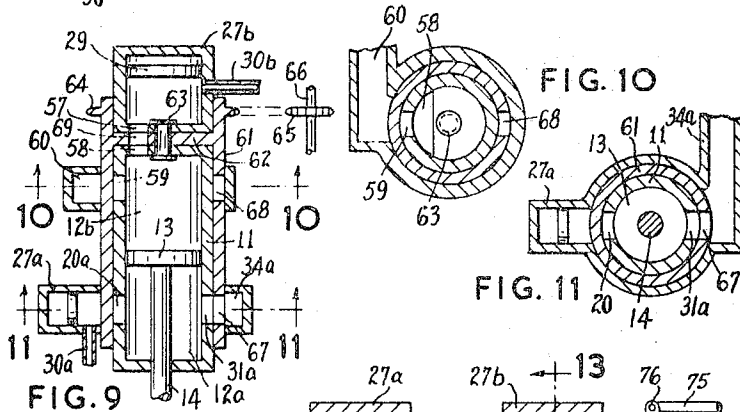
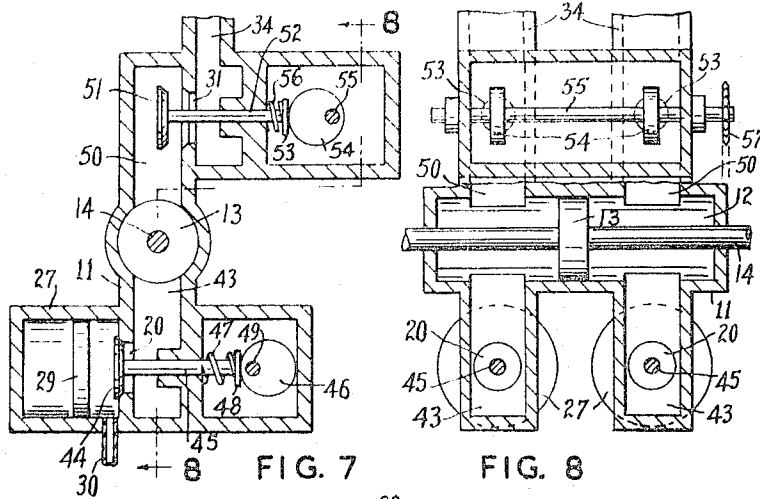
E. H. FISHER

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HYDRAULIC INTAKE AND EXHAUST VALVING ARRANGEMENT

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INVENTOR

E. H. FISHER

Fetherstonhaugh & Co.

ATTORNEYS

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E. H. FISHER

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HYDRAULIC INTAKE AND EXHAUST VALVING ARRANGEMENT

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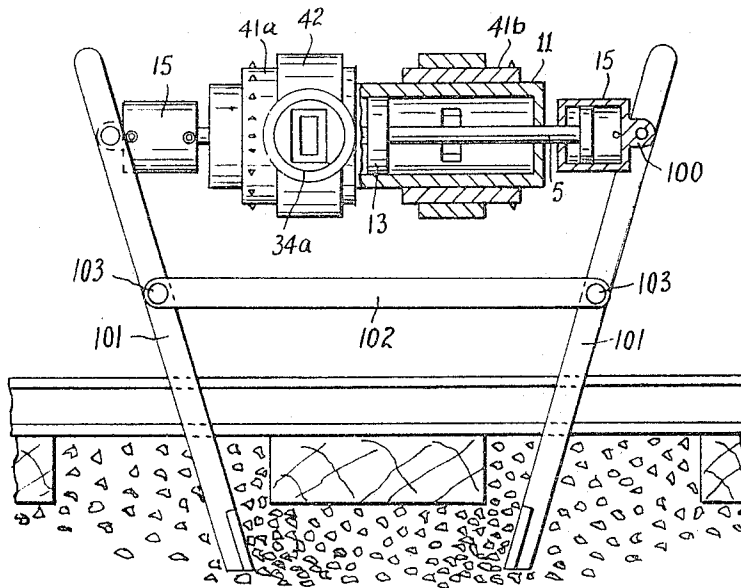


FIG. 15

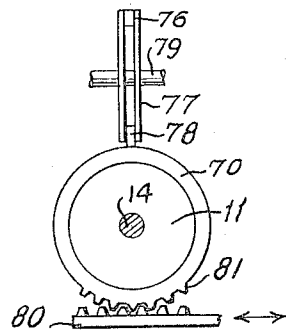


FIG. 14

INVENTOR

E. H. FISHER

Fetthurstons & Co.
ATTORNEYS

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3,369,459 HYDRAULIC INTAKE AND EXHAUST VALVING ARRANGEMENT

Earl H. Fisher, 630 Casgrain Ave.,

St. Lambert, Quebec, Canada

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11 Claims. (Cl. 91—39)

The present invention relates to a double-acting hydraulic cylinder, that is an hydraulic cylinder in which the piston is actuated alternately in each direction of movement to provide its reciprocating motion.

Such double-acting cylinders are usually conventionally constructed with a common line both for feeding and exhausting the hydraulic fluid in each portion of the chamber (i.e. on either side of the piston), the alternating direction of flow of the fluid being controlled by a valve arrangement in each line. This construction precludes use of the cylinder in situations where rapid reciprocation or oscillation is required, the reason being that the common line necessitates a reversal of flow through it. Moreover, sudden impact of fluid on the piston is unattainable because of the position of the valve remote from the cylinder and its double function in governing flow in two directions. Finally, this construction hinders adaptation of the cylinder to differing conditions of frequency and output. To sum up, the conventional double-acting hydraulic cylinder is a relatively slow acting, inflexible device not suitable for use in the operation of machinery such as a tamper, a vibratory screen, pile driving hammer, pavement breaker or forging hammer. In addition to the vibratory action described, this valving apparatus is also adaptable to slow reciprocating movement and, therefore the apparatus has a very wide range of applications.

The present invention avoids the above-mentioned limitations associated with conventional double-acting cylinders by providing a double-acting hydraulic cylinder having separate intake and exhaust facilities, valving arrangements located adjacent the cylinder, and an accumulator or cushion associated with these elements. This enables the piston within the cylinder to reciprocate rapidly, and provides forceful impact and sustained pressure of the fluid on the piston. Moreover, the frequency of reciprocation of the piston, and its thrust, may be readily varied by manipulation of the above-mentioned elements along with variation of the volume and pressure of the supply fluid.

The invention in its broadest aspect resides in an apparatus consisting of a double-acting hydraulic cylinder comprising a casing having a chamber therein and a piston adapted to reciprocate in the chamber, the piston dividing the chamber into two portions. Separate intake ports open into each portion of the chamber divided by the piston, and outlet ports open from each portion of the chamber so one intake port and one exhaust port are associated in each chamber portion. Valve means are provided to open and close each of the four ports. An accumulator communicates with each intake port and has conduit means to supply it with hydraulic fluid under pressure. Conduit means are also provided to carry hydraulic fluid from each exhaust port. The valve means are adapted alternately to open one intake port and then the other intake port. On the opening of each intake port its associated exhaust port is closed with the result that the two portions of the chamber are alternately filled with pressurized fluid and the piston is reciprocated.

By way of illustration and not limitation, besides its use as in a temper for combination action of vibrating, impacting and squeezing the ballast under ties in railroad construction and maintenance, and for rapid vibratory action in this operation, the cylinder of the present invention can, for instance, be usefully employed in vibra-

tory screening apparatus. Another example use is in combination with a front-end loader bucket in which the apparatus provides vibratory action in conjunction with a "slicing" action by one side of the bucket with respect to the other, thus making it unnecessary to rely solely on the locomotive force of the bucket thrust into the material to be loaded followed by biting of the jaws and enabling faster and easier loading. In addition it can be used to activate a pile driving hammer, pavement breaker or a forging hammer etc.

It can readily be seen that where maximum sustained impact on the piston of the double acting hydraulic cylinder is not for any reason required, the nitrogen accumulators or other cushioning devices can be removed and the hydraulic pressure intake lines will lead direct to the intake ports of the double acting hydraulic cylinders valving arrangement. Furthermore, one end of the double acting cylinders piston rod can be removed if desired, as well as, one or both of the double acting hydraulic cylinders attached to the ends of the main double acting hydraulic cylinders piston rod.

Although the valving arrangements are shown being synchronously driven by mechanical means, nevertheless it can be readily see that they can be driven by other conventional well-known means such as electrical, air or hydraulic of gear, solenoid or other drive train mechanism.

Only single double acting hydraulic units are shown, however, it can be readily seen that more than one could be used for a common purpose and be synchronously or non-synchronously driven with respect to each other. Also the hydraulic double acting valving arrangement can be used in series on a common piston rod. In other words, the double acting hydraulic cylinders could be replaced by valving arrangements and double acting hydraulic cylinders could be inserted on the main piston rod as required. These valving arrangements and double acting hydraulic cylinders may be synchronously or nonsynchronously operated with respect to each other.

Example embodiments of the invention are illustrated in the accompanying drawings in which:

FIG. 1 is a side view of a double-acting hydraulic cylinder according to the invention, the casing being in cross-section;

FIG. 2 is a cross-sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is an end view, partly in cross-section, of a second embodiment of the invention;

FIG. 4 is a side view, partly in cross-section, taken along the line 4—4 of FIG. 3;

FIG. 5 is a side view, partly in cross-section, of a third embodiment of the invention;

FIG. 6 is a cross-sectional view taken along the line 6—6 of FIG. 5;

FIG. 7 is an end view of a fourth embodiment of the invention, the casing being in cross-section;

FIG. 8 is a view, partly in cross-section, taken along the line 8—8 of FIG. 7;

FIG. 9 is a side view of a fifth embodiment of the invention, the cylinder casing being in cross-section;

FIG. 10 is a cross-sectional view taken along the line 10—10 of FIG. 9;

FIG. 11 is a cross-sectional view taken along the line 11—11 of FIG. 9;

FIG. 12 is a side view of a sixth embodiment of the invention, the cylinder casting being in cross-section;

FIG. 13 is a cross-sectional view taken along the line 13—13 of FIG. 12;

FIG. 14 is an end view of the embodiment shown in FIG. 12; and

FIG. 15 is a diagrammatic showing of the application of the embodiment of the invention shown in FIG. 5 ap-

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plied to the tamping mechanism of a railroad tamping machine.

FIG. 1 of the drawings shows an embodiment of the invention in which a unitary casing 10 carries the various elements of the device. Located centrally within casing 10 is a main cylinder 11 having a chamber 12. Within chamber 12 is a reciprocable piston 13 mounted on a rod 14 which extends each way from piston 13 through the end walls of cylinder 11. Piston 13 divides chamber 12 into two portions 12a and 12b. Each free end of piston rod 14 terminates in a conventional double-acting hydraulic cylinder 15 having a casing 16, a pair of intake lines 17 and a pair of exhaust lines 18. Pistons 19 are mounted on the ends of rod 14 within each casing 16.

Opening into main cylinder 11 are a pair of intake ports 20a and 20b, one leading into each portion 12a and 12b of chamber 12. A pair of plungers 21a and 21b are axially slidable in a pair of bores 22a and 22b positioned normal to the axes of intake ports 20a and 20b respectively. Plungers 21a and 21b are actuated by cams 23 rotatable on shafts 24. Cams 23 act against compression springs 25 each bearing at one end on a cap 26 of plunger 21 and at the other end against casing 10.

Intake ports 20a and 20b respectively lead from a pair of reservoirs or accumulators 27a and 27b each having a chamber 28 and a free sliding piston 29 above which is a closed gas chamber 29'. Each chamber 28 is fed by a feed pipe 30.

In cylinder 11, diametrically opposed to intake ports 20a and 20b, are a pair of exhaust ports 31a and 31b, intersected normal to their axes by bores 32a and 32b respectively which carry plungers 33a and 33b actuated by cams 23 as before. Exhaust ports 31a and 31b lead from portions 12a and 12b of chamber 12 to return lines 34a and 34b.

In the operation of the embodiment shown in FIGS. 1 and 2 the movement of main piston 13 in chamber 12 is controlled by the movement of plungers 21 and 33 which are activated by cams 23 synchronously driven off shafts 24 which are in turn motivated by a common drive shaft (not shown). To activate piston 13, hydraulic fluid is fed under pressure through feed pipes 30 into chambers 28 of accumulators 27a and 27b. In the position shown in FIG. 1, intake port 20a is closed by plunger 21a and the pressure of the fluid in accumulator 27a forces piston 29 upwards to store energy. Meanwhile intake port 20b is open and the fluid entering accumulator 27b from feed pipe 30 under pressure passes into portion 12b of chamber 12. Exhaust port 31b opposite inlet port 20b is closed by plunger 33b at this time and the pressurized fluid acts against piston 13 to drive it leftward as seen in FIG. 1. As the plunger 21b moves further to the left, cutting off the intake port 20b, the plunger 21b displaces the fluid in the chamber 20b to provide additional pressure on the piston 13. The hydraulic fluid in portion 12a of chamber 12 is forced out of chamber 12 through exhaust port 31a which stands open and into return line 34a where it returns to the pressure source for recycling through the device.

In the second phase of the cycle synchronized cams 23 move plungers 21a, 21b, 33a and 33b to open intake port 20a and exhaust port 31b while at the same time closing intake port 20b and exhaust port 31a. The opening of intake port 20a releases the additional pressure in accumulator 27a which has been stored in chamber 28 and the hydraulic fluid from reservoir 28 is forced suddenly into portion 12a of chamber 12 where it acts with impact upon piston 13, forcing it to the right as seen in FIG. 1. No resistance is offered to the rightward movement of piston 13 since the hydraulic fluid in portion 12b of chamber 12 is free to flow through outlet port 31b into return line 34b where it moves back into the hydraulic pressure source for recycling.

The travel of piston 13 is controlled by the pair of double acting hydraulic cylinders 15 (if they are used

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in conjunction with the valving device), at each end of piston shaft 14 which are outside casing 10 depending upon how the pressure and exhaust is manipulated to intake and exhaust lines 17 and 18 respectively, as well as, the extent that piston assemblies 15 are restrained from movement because of the mechanism that is attached to eyes 160 of the double acting hydraulic cylinders 15.

As the four plungers 21 and 33 are reciprocated by the four cams 23, either piston 13 or casing 10 is oscillated depending on which is anchored and which is free to move. It will be appreciated that the frequency and length of movement of piston 13 in cylinder 11 will depend upon the size and proportion of the various ports and components of the device, the nature of the accumulator or cushion, and the pressure of hydraulic fluid received from the source.

FIGS. 3 and 4 illustrate a second embodiment of the invention in which the valving arrangement (embodied in the plungers and ports in FIGS. 1 and 2) is varied. In this embodiment the opening and closing of intake ports 20 and exhaust ports 31 from accumulator 27 to chamber 12 of cylinder 11 are controlled by synchronized rotatable cylindrical sleeves 35 and 36 respectively while plungers 21 and 33 control the amount of flow of the hydraulic fluid through the ports. Cylindrical sleeve 35 circumscribes plunger 21 and is axially rotatable within bore 22 while cylindrical sleeve 36 circumscribes plunger 33 and is axially rotatable in bore 32. Sleeves 35 each carry a pair of diametrically opposed slots 37 of a size and position which will fully register with its associated intake port 20 as shown in FIG. 4. Sleeves 36 each carry a similar pair of diametrically opposed slots 38 adapted to register fully with its associated exhaust port 31. The axial rotation of sleeves 35 and 36 are effected synchronously by an endless chain drive 39 engaging sprocket teeth 40 adjacent the end of the sleeves which protrude from casing 10.

The operation of the embodiment shown in FIGS. 3 and 4 is essentially the same as that of the embodiment shown in FIGS. 1 and 2 except that the opening and closing of the intake and exhaust ports are effected by synchronous rotation of apertured sleeves 35 and 36 rather than by synchronous rotation of cams acting on plungers. An additional feature of this embodiment is the supplementary control of the flow of hydraulic fluid to and from chamber 12 of cylinder 11 by means of the longitudinal movement of plungers 21 and 33. It will be appreciated, of course, that FIGS. 3 and 4 illustrate only one half of the complete system and that the rotation of sleeves 35 and 36 are synchronized through chain drive with the movement of the pair of sleeves at the left hand side of the casing but opposite in phase.

FIGS. 5 and 6 of the drawings illustrate a third embodiment of the invention which is similar to the previous embodiment shown in FIGS. 3 and 5 except that each pair of apertured sleeves 35 and 36 is replaced by a single cylindrical sleeve 41 which circumscribes main cylinder 11. Each accumulator 27 and return line 34 is coupled with cylinder 11, registering with the appropriate intake port 20 and exhaust port 31, strap 42 circumscribing sleeve 41. As seen in FIG. 6, each sleeve 41 carries a single aperture 43 adapted to register alternately with intake port 20 and exhaust port 31 of chamber 12. Each sleeve 41 carries sprocket teeth 44 which are engaged by an endless sprocket chain 45 driven from a common drive shaft 46 through a pair of sprockets 47.

In the operation of this embodiment the two sleeves 41 are synchronized to rotate 180 degrees out of phase, that is when aperture 43 of the left hand sleeve (as seen in FIG. 5) registers with its associated intake port 20, aperture 43 in the righthand sleeve registers with its associated exhaust port 31 as seen in FIG. 5 with intake port 20 being closed. Piston 13 consequently reciprocates in the usual manner.

FIGS. 7 and 8 of the drawings show an embodiment

wherein the opening and closing of the intake and exhaust ports of the main cylinder of the device are controlled by a set of combustion cylinder type of cam-driven seating valves. Each intake port 20 is spaced from chamber 12 and connected with it by a passage 43. Seated on port 20 is a valve head 44 having a valve stem 45 which extends through port 20 and passage 43 and is slidable longitudinally in the sidewall of passage 43 diametrically opposite intake port 20. Stem 45 is slidably actuated by a cam 46 against the action of a compression spring 47 bearing at one end against a cap 48 on stem 45 and at the other end against the sidewall of passage 43. Cam 46 is driven off a drive shaft 49. Each exhaust port 31 is spaced from chamber 12 and connected with it by a passage 50. A valve head 51 is seated on port 31 within passage 50. A stem 52 extends from head 51 through port 31 and return line 34 and terminates in a cap 53. A cam 54 driven off drive shaft 55 bears on cap 53 against the action of a compression spring 56 on stem 52. Cams 46 and cams 54 are synchronized in their operation by a chain and sprocket arrangement 57 linking driveshafts 49 and 55. Each of the pair of valves 44 is adapted to move out of phase with one another, as are each of the pair of valves 51. The device then operates in the manner of the first embodiment described with reference to FIGS. 1 and 2.

A fifth embodiment of the invention is shown in FIGS. 9, 10 and 11. In this embodiment, piston 13 is mounted at one end of rod 14 through portion 12a of chamber 12. Accumulator 27a and return line 34a are positioned in the usual manner in line with intake port 20a and exhaust port 31a respectively. However, the other accumulator 27b is positioned axially at the end of cylinder 11 remote from accumulator 27a and rod 13. An outlet port 57 in accumulator 27b is aligned with an intake port 58 in the end of cylinder 11 leading into chamber 12. An exhaust port 59 is located in the sidewall of cylinder 11 adjacent intake port 58 and a return line 60 is positioned in line with exhaust port 59. A cylindrical valve sleeve 61 is positioned concentrically about cylinder 11 and accumulator 27b, and carries a disc 62 in its diametrical plane which is interposed between the end of cylinder 11 and accumulator 27b, the cylinder and accumulator being spaced apart but rigidly joined through a pin 63 on which disc 62 is rotatable. Sleeve 61 carries a ring of teeth 64 on its periphery which cooperate with a sprocket and chain assembly 65 driven by a shaft 66. Sleeve 61 carries an aperture 67 adapted to register with inlet port 20a and outlet port 31a respectively as the sleeve rotates on cylinder 11. Sleeve 61 also carries an aperture 68 adapted to register with exhaust port 59 at a point in the rotation of the sleeve 180 degrees out of phase with the registration of aperture 67. Finally, disc 62 carries an aperture 69 adapted to register simultaneously with ports 57 and 58 at a point in the rotation of sleeve 61 when aperture 68 is in registration with port 59, as seen in FIG. 9.

In the operation of this embodiment it will be seen that, in the position of sleeve 61 shown in FIG. 9, cylinder 12 will receive hydraulic fluid under pressure from accumulator 27b through ports 57 and 58 and drive piston 13 downwardly. The hydraulic fluid below piston 13 will be able to escape through exhaust port 31a (see FIG. 11) and return line 34a. When sleeve 61 rotates through 180 degrees aperture 67 will register with intake ports 20a and hydraulic fluid will enter chamber 12 below piston 13 to drive it upwardly, exhaust port 34a being closed by the sleeve. At the same time aperture 68 will register with exhaust port 59 and allow the hydraulic fluid to escape through return line 60, inlet port 58 being closed by disc 62. Hence, by feeding pressurized hydraulic fluid through intake lines 30a and 30b and rotating sleeve 61, piston 13 will reciprocate within chamber 12.

In the sixth embodiment of the invention illustrated in FIGS. 12 and 13 of the drawings a valve sleeve 70 circumscribes main cylinder 11 and is adapted to be reciprocated longitudinally of the cylinder. Sleeve 70 carries apertures

71, 72, 73 and 74 adapted to register, depending on the axial position of the sleeve with respect to cylinder 11, with intake ports 20a and 20b, and exhaust ports 31a and 31b respectively in the cylinder. The apertures are positioned in sleeve 70 such that when apertures 72 and 73 register with intake ports 20b and exhaust port 31a respectively, then apertures 71 and 74 are out of register and sleeve 70 closes intake port 20a and exhaust port 31b as seen in FIG. 12. When intake port 20a and exhaust port 31b are opened by apertures 71 and 74, then intake port 20b and exhaust port 31a are closed by sleeve 70. Axial reciprocation of sleeve 70 is effected by a rod 75 pivotally attached by a pin 76 to one end of a link 77. The other end of link 77 is pivotally attached by a pin 78 to sleeve 70 while link 77 itself pivots on a fulcrum pin 79. When sleeve 70 is positioned as shown in FIG. 12, then piston 13 will be driven to the left. When sleeve 70 is moved to the right then piston 13 will be driven to the right. Rod 75 may be actuated by any suitable cam or eccentric driving means.

In the above embodiment the quantity of hydraulic fluid actually entering chamber 12 through the open intake ports, as well as that escaping from the exhaust ports, may be covered by the auxiliary arrangement shown in FIG. 14 in which sleeve 70 is circumferentially rotated by a rack 80 acting on teeth 81 located peripherally on sleeve 70. This governing effect is similar to the action of the plungers in the embodiment shown in FIGS. 3 and 4 of the drawings, enabling a variable power and frequency of movement of piston 13 to be obtained.

On practicable application of the invention is shown in FIG. 15 applied to a railroad tamping machine, making use of the embodiment of the invention shown in FIG. 5 of the drawings. In this application, the cylinder 11 is not attached to the tamping machine but is free to oscillate on the shaft 5. The eyes 109 on the ends of the cylinders 15 are secured to the tamping tools 101 and the tamping tools are connected together by a rod 102 by means of the pin connections 103. Oil pressure applied to the cylinders 15 with the greater pressure being applied on the piston side closest to the connection of the cylinders with the tamping tools 101, results in movement of the top portions of the tamping tools in an outwardly direction and the lower portions moving inwardly, thereby squeezing the ballast under the railroad tie. At the same time the valve mechanisms 41a and 41b are set in motion and cylinder 11 will oscillate as piston 13 is restrained from movement. The resulting combination impact-vibration brought about by oscillation of cylinder 11 combined with the squeezing action of cylinders 15 consolidates the ballast under the tie.

It will be appreciated that the action described above, using one embodiment of the invention applied to one form of operating machine, can be applied with any other of the embodiments of the invention and with any other type of operating machine where a wide range between slow and rapid impact or vibratory action is required.

It should also be appreciated that in any of the embodiments described in the present disclosure, piston 13 may either reciprocate or it may remain stationary and the whole casing oscillate with respect to the piston. Also, certain of the components of the device may be integral with the double-acting main cylinder, for instance accumulators 27 included in main casting 10 in the embodiment shown in FIG. 1, or such components may be separate from the main cylinder and connected with it for example by flexible lines for transmitting the hydraulic fluid.

What I claim is:

1. In a double-acting hydraulic cylinder assembly, the combination of a casing having a chamber therein, a piston positioned in said chamber and having a piston rod projecting at least at one end thereof to the outside of said casing, said casing and said piston being reciprocable relative to each other, said piston dividing said chamber into a pair of chamber portions, said casing being pro-

vided with a pair of hydraulic fluid inlet ports and with a pair of exhaust ports communicating with the respective chamber portions, a pair of oppositely acting inlet valves and a pair of oppositely acting exhaust valves provided in the respective inlet and exhaust ports, valve actuating means coordinating opening and closing of said inlet and exhaust valves to produce relative reciprocation of said casing and piston, an external piston provided on the projecting end of said piston rod exteriorly of said casing, an external cylinder containing said external piston, said external cylinder being separate and detached from said casing, said external piston and said external cylinder being reciprocable relative to each other independently of movement of said piston rod, and means for admitting fluid under pressure into said external cylinder selectively to either side of said external piston and discharging fluid from the relatively opposite side.

2. The combination as defined in claim 1 wherein said casing is also provided with a pair of pressure accumulators each having a free sliding piston therein dividing the same into a closed gas chamber and an open fluid chamber, the fluid chambers of said pair of accumulators communicating with the respective inlet ports and also with a source of hydraulic fluid under pressure.

3. A cylinder assembly as defined in claim 1 wherein said inlet and exhaust valves comprise a plurality of plungers one associated with each of said ports, a bore intersecting the axis of each of said ports, said plungers being reciprocable in said bores to open and close said ports, and spring means biasing each of said plungers to open said ports, said valve actuating means including cam means operable against said spring means to close said ports.

4. A cylinder assembly as defined in claim 1 wherein said inlet and exhaust valves comprise a plurality of apertured sleeves each rotatable axially in a bore intersecting the axis of each of said ports, the apertures in each of said sleeves being adapted to register with its associated port whereby the port may be opened and closed.

5. A cylinder assembly as defined in claim 4 including a plurality of plungers one longitudinally slidable in each of said sleeves whereby the size of said apertures may be varied to govern the amount of hydraulic fluid passing through said ports.

6. A cylinder assembly as defined in claim 4 wherein said sleeves each carry a circumscribing ring of sprocket teeth, said valve actuating means including a pair of sprocket chains one chain engaging the sprocket teeth of the pair of sleeves associated with the ports of one portion of the chamber, and the other chain engaging the sprocket teeth of the pair of sleeves associated with the ports of the other portion of the chamber, each sprocket chain being driven from a common drive shaft whereby the axial rotation of the sleeves is synchronized.

7. A cylinder assembly as defined in claim 1 wherein said inlet and exhaust valves comprise a pair of sleeves circumscribing said casing and concentric therewith, one sleeve having a single aperture adapted to register alternately with the inlet port and exhaust port of one portion

of the chamber, the other sleeve having a single aperture adapted to register alternately with the inlet port and exhaust port of the other portion of the chamber, whereby said ports may be opened and closed.

8. A cylinder assembly as defined in claim 7 wherein said sleeves each carry a circumscribing ring of sprocket teeth, said valve actuating means including a pair of sprocket chains one engaging each ring of teeth and also engaging a sprocket mounted on a common drive shaft, whereby said sleeves may be synchronously rotated.

9. A cylinder assembly as defined in claim 1 wherein said inlet and exhaust valves comprise a valve head adapted to seat in each of said ports, each valve head carrying a stem spring biased to seat said head, said valve actuating means including cam means adapted to act on each valve stem to unseat each of said heads synchronously with respect to said other heads.

10. A cylinder assembly as defined in claim 1 wherein said inlet and exhaust valves are constituted by a sleeve outside said casing and concentric therewith, apertures in said sleeve one adapted to register with and open each of said ports, said apertures being positioned in said sleeve in a manner such that on longitudinal axial reciprocation of said sleeve with respect to said casing the inlet parts will alternately be opened and their associated exhaust ports closed, said valve actuating means including means for reciprocating said sleeve relative to said casing.

11. A cylinder assembly defined in claim 10 wherein the sleeve is rotatable on said casing to vary the degree of registration of said apertures with said ports whereby the amount of hydraulic fluid under pressure entering said chamber may be varied.

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MARTIN P. SCHWADRON, *Primary Examiner.*

G. N. BAUM, *Assistant Examiner.*