

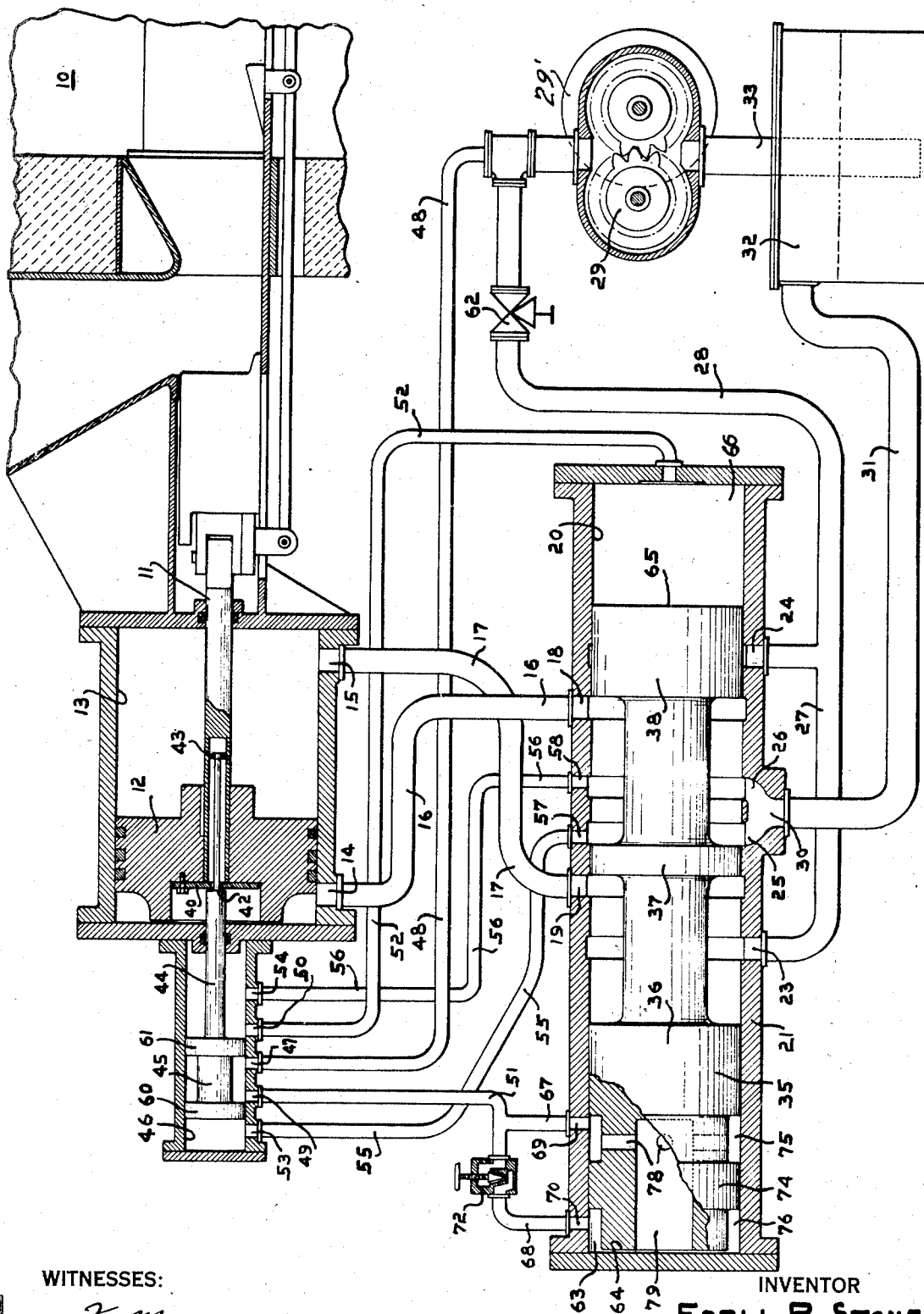
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STOKER DRIVE

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STOKER DRIVE

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The invention relates to a hydraulic transmission mechanism for transforming rotary motion of a constant speed motor into reciprocatory motion of a suitable element, for example, an underfeed stoker ram, and it has for an object to provide apparatus of this character with means securing pause or dwell intervals between strokes constructed and arranged to minimize consumption of power.

Where an underfeed stoker ram is driven by an electric motor, it is desirable to provide some means to vary the number of ram strokes per unit of time. A variable speed electric motor involves undue complication and expense. Heretofore, attempts have been made to provide mechanical transmissions, but the necessity of a very wide range of speed variation has practically restricted the design to the intermittent type, wherein the drive is disconnected and reconnected at stroke end positions of the stoker crankshaft to provide dwell or pause intervals, which are varied to give the effect of speed variation; however, apparatus of this type, to give reasonably satisfactory operation, must have a clutch and means for connecting and disconnecting the latter, not only in proper phase relation with respect to the stoker crankshaft, but which shall be capable of adjustment to vary the dwell or pause interval, that is, the interval of clutch disconnection, and these requirements make the apparatus costly to manufacture and to maintain. Hydraulic drives have been proposed wherein a constant speed motor has been used to drive a gear pump whose suction and discharge spaces are connected to an operating cylinder to reciprocate an operating piston, means being provided to secure dwell or pause intervals between working strokes, but such devices have been unduly complicated and not as efficient as they might be because of excessive consumption of power to operate the valve mechanism for dwell and reversal. A further object of the present invention is to improve apparatus of the latter type in order to provide for reduced power consumption during dwell and reversal periods.

These and other objects are effected by my invention as will be apparent from the following description and claims taken in connection with the accompanying drawing, forming a part of this application, in which:

The single figure is a diagrammatic sectional view of the improved power-transmitting and driving arrangement.

In the drawing, there is shown an underfeed stoker generally, at 10, provided with a ram op-

erating rod or shaft 11 carrying an operating piston 12 arranged in the operating cylinder or chamber 13, the latter being provided with ports 14 and 15 adjacent to the ends thereof.

The ports 14 and 15 are connected, by passages 16 and 17, respectively, to the operating ports 18 and 19 of the main valve cylinder 21.

The main valve cylinder 21 has a pressure space defined, for example, by the pressure ports 23 and 24 spaced outwardly from the operating ports 18 and 19, respectively, a suitable distance and an exhaust space defined, for example, by the ports 25 and 26 arranged between the ports 18 and 19. The pairs of ports 23, 19 and 24, 18 constitute outer port arrangements which are alternately separated from the intermediate or exhaust port arrangement or space, including the ports 25 and 26, and both are placed in communication with the exhaust port arrangement or space alternately with events of separation by means of a main valve hereinafter described. Liquid under pressure is supplied to the pressure space by means of a bifurcated passage 27 communicating with the pressure conduit 28 connected to the outlet or discharge space of the displacement or gear pump 29 driven by the constant speed electric motor 29'.

Liquid is exhausted from the exhaust space by a passage 30 communicating with the exhaust ports 25 and 26 and with the exhaust or pump return line 31 discharging into the pump inlet space comprised by the reservoir 32 into which extends the pump suction inlet 33.

The main piston valve 35 has lands or piston portions 36, 37 and 38 suitably spaced in relation to the aforesaid port arrangements to secure operation of the ram or operating piston 12, movement of the main piston valve being effected by the means to be immediately described, and each stroke thereof involving movement in outer and intermediate zones. In the outer zones, the outer port arrangements, 18, 24 and 19, 23, are alternately separated from the intermediate port arrangement 25, 26 by means of the land 37 so that pressure developed by the pump may be applied to the operating piston; and, in the intermediate zone of movement, separation ceases and both outer port arrangements communicate with the intermediate or exhaust port arrangement to provide for direct communication of the pump discharge and inlet spaces.

The operating or ram piston 12 has a lost-motion connection provided by the abutment 40 carried by the piston and arranged between spaced abutments 42 and 43 associated with the

rod 44 of the pilot or reversing piston valve 45, the latter being arranged in the pilot or reversing piston cylinder 46. The spacing of the abutments 42 and 43 is such that, as the ram or operating piston 12 approaches the ends of its strokes in opposite directions, the pilot piston 45 is shifted to its extreme positions.

The pilot or reversing piston cylinder has a pressure port 47 preferably connected to a passage 48 leading to the pump 29 and operating ports 49 and 50 arranged at either side of the pressure port 47 and connected by passages 51 and 52, respectively, with the cylinder 21 in the manner and for the purposes hereinafter pointed out. Also, the pilot or reversing piston cylinder 46 has exhaust ports 53 and 54, arranged outwardly of the ports 49 and 50, respectively, connected to the exhaust or pump suction space. For example, the latter ports are shown as connected by passages 55 and 56, respectively, with ports 57 and 58 opening into the bore 20 of the main piston cylinder 21, the ports 57 and 58 being placed in communication with the exhaust ports 25 and 26 so that fluid may be exhausted from the pilot piston cylinder 46 through the exhaust ports 53 and 54 to the exhaust or return line 31 leading back to the reservoir 32.

The pilot or reversing piston 45 is provided with lands or piston portions 60 and 61 spaced so that, with the pilot piston in its extreme position in one direction, the pressure port 47 is placed in communication with the operating port 49, the other operating port 50 then communicating with the exhaust port 54; and, in the other extreme position, the pressure port 47 is placed in communication with the operating port 50, the other operating port 49 then communicating with the exhaust port 53.

The passage 48 for supplying liquid from the pump 29 to the pressure port 47 communicates with the outlet of the pump 29 or with the main supply passage 28 at the pump side of a valve or orifice 62, the latter being set to maintain a pressure in the space between the pump and the restriction and including the passage 48 which is sufficiently larger than that in the passage 28 at the discharge side of the restriction 62 to assure of movement of the main piston valve 35 when the latter is in the position range connecting the supply and return passages 28 and 31.

Movement of the main piston valve 35 to control the ports 18, 19, 23, 24, 25, 26, 57 and 58 is effected by fluid motor means comprised by end piston areas or faces 64 and 65 on the piston valve and cylinder spaces 63 and 66 therefor, and provided by the outer end portions of the piston valve cylinder, the passages 51 and 52 communicating with the respective cylinder spaces.

The passage 51 is connected to the cylinder space 63 by branch passages 67 and 68, the latter being connected to ports 69 and 70 opening into the cylinder space 63 with the port 70 arranged adjacent to an outer end of the piston valve cylinder and the port 69 spaced axially inwardly of the port 70 a suitable distance. The branch passage 68 is provided with a suitable orifice or metering valve 72 to secure a desired fluid flow rate through the branch passage. The main piston valve 35 has a land or piston portion 74 arranged intermediately of the left-hand end and the land or piston portion 36, thereby providing the annular space 75 between the land or piston portions 74 and 36 and the annular space 76 disposed to the left of the land or piston portion 74. One or more ports 78 connect the

annular space 75 with the axial passage 79 opening through the left hand end of the piston valve.

The apparatus described operates as follows: The pump 29 is operated by the motor 29' to deliver fluid from the suction space, comprised by the lower portion of the pump casing, the conduit 33, the reservoir 32 and the return conduit 31, to the discharge space, comprised by the upper portion of the pump casing and the passages 28 and 48. Assuming that the operating piston 12 has just reached the end of its left-hand working stroke, as shown in the drawing, to make this stroke, the main piston valve 35 must be in the position such that the intermediate land 37 separates the left-hand port arrangement, comprising the communicating pressure port 23 and the operating port 19, from the exhaust port arrangement, including the ports 25 and 26, so that the pump discharge space is connected to the right-hand end of the operating cylinder, the left-hand end of the latter being in communication with the pump inlet or suction space by means of the return line 31 due to communication of the port 18 of the outer right-hand port arrangement with the intermediate or exhaust port arrangement, including the ports 25 and 26. As the operating piston completes its working stroke toward the left, the contacting abutments 40 and 42 shift the pilot or reversing valve 45 from its extreme right-hand position to its extreme left-hand position to place the pressure port 47 in communication with the operating port 49, the other operating port 50 then being placed in communication with the exhaust port 54, whereupon motive fluid will be admitted to the left cylinder space 63 of the piston valve cylinder to secure a stroke of the main piston valve 35 toward the right, the initial, or cut-off portion, of the stroke preferably proceeding relatively rapidly until the port 69 is lapped by the land 74, at which time the pump discharge or pressure port 23, as well as the operating port 19, will be placed in communication with the exhaust port arrangement connected to the pump return line 31, whereby the pump burden will be reduced to that due to the pressure differential provided by the valve or orifice 62 and frictional losses. The operating piston 12 dwells at its extreme left position during this brief cut-off interval and during the intermediate zone of travel of the piston valve, the duration of such intermediate zone being determined by the width of the land 74, and the throttling adjustment of the branch passage 68. As soon as the left-hand edge of the land 74 starts to uncover the port 69, the land 37 having already covered the exhaust port 26 and the land 38 having uncovered the pressure port 24 to place the latter in communication with the operating port 18, the final stage of rapid motion of the valve 35 begins, the land 36 immediately covering the pressure port 23 to interrupt communication of the latter with the exhaust port 25 and continues until its extreme right-hand position is reached, pressure being built up by the pump as soon as the pressure space is separated from the exhaust space by this action of the lands 36 and 37 and is supplied to the port 14 to move the piston 12 to the right; and, as the operating piston approaches its extreme right-hand position, due to engagement of the abutments 40 and 43, the pilot valve 45 is shifted from its extreme left-hand position to its extreme right-hand position in order to apply pres-

sure to the cylinder space 60 and to connect the cylinder space 63 to the pump return line, and the quick initial or cut-off portion of the stroke of the piston valve toward the left then begins followed by other phases of operation of the latter similar to those already indicated, the throttled branch passage 68 being effective during the intermediate zone of travel of the piston valve toward the left to throttle the exhaust from the cylinder space 63.

In brief, the operating piston is caused to move through working strokes due to appropriate admission and exhaust of motive fluid to the operating cylinder by means of the main piston valve 35, the final portion of movement of the piston valve in each direction assuring of proper port connections for the next working stroke. As the operating piston approaches the end of a working stroke, the pilot valve 45 is shifted from one extreme position to the other to reverse the connections to the fluid motor means including the cylinder spaces 63 and 66 and the piston areas or faces 64 and 65, to reverse the movement of the main piston valve, the initial portion of the movement or stroke of the latter resulting in rapid cut-off of the pump discharge to the operating cylinder and connection thereof to the pump return line, the operating piston remaining or dwelling at its end position and continuing to do so during the intermediate portion or zone of travel of the piston valve, and, at the end of such intermediate zone of travel, the ports are connected to effect the next working stroke of the operating piston. Thus, it will be seen that dwell periods of the operating piston occur between working strokes thereof, each dwell period including the brief time for the initial or cut-off portion of each stroke of the piston valve and the time for the intermediate portion or zone of travel thereof, the duration of dwell depending upon the throttling effect of the branch passage 68.

With the operating piston connected to apparatus such as a stoker ram, it will be apparent that the valve arrangement described assures that the pump has to carry the burden of the ram and operating piston load only when working strokes are effected, the pump being of the displacement type and subject only to a minimum load condition during dwell periods, with the result that the power demand of the transmission corresponds to the load requirements and a minimum of power consumption occurs during idle or dwell intervals of the operating piston and ram. The stoker speed may be varied by varying the duration of the dwell interval, this being effected by proper adjustment of the throttling valve 72 in the branch passage 68.

It is to be understood that the term "valve means," as used herein in reference to the main valve, comprised by the cylinder 21 and the piston member 35, is applicable to any suitable arrangement of valve housing and movable member structures so long as it is capable of admitting and exhausting motive fluid to the ends of the operating cylinder to effect strokes of the operating piston 12 and of connecting the supply and return passages 28 and 31 with the operating piston at stroke ends during pause intervals.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be

placed thereupon as are specifically set forth in the appended claims.

What I claim is:

1. In hydraulic mechanism for converting rotary motion of a substantially constant speed motor into intermittent reciprocatory motion of an operated element, a gear pump driven by the motor, means including the gear pump casing and a discharge conduit to provide pump suction and discharge spaces, an operating cylinder having ports at the ends thereof, an operating piston in the cylinder, and means for controlling communication of said ports with said spaces and of the discharge space with the suction space so as to secure strokes of the operating piston in opposite directions with controllable pauses thereof at stroke ends so as to vary the number of strokes per unit of time: said first-named means including a restriction in said discharge conduit to maintain a desired minimum pressure in the space between the restriction and the pump; a valve housing having a pair of operating ports in communication with said cylinder ports, a pair of pressure ports in communication with said discharge conduit at the side of the restriction remote from the gear pump, and an exhaust port space in communication with said suction space; movable valve means in the housing; pressure-responsive means for effecting successive cycles of movement of the valve means in opposite directions; said valve means having portions co-operating with the housing and with the ports and the exhaust port space thereof such that each movement cycle begins with a first pressure port communicating with a first operating port and the second operating port communicating with the exhaust port space, followed by an intermediate portion of movement thereof, wherein said pressure ports and the exhaust port space are placed in communication, and ending with the second pressure port in communication with the second operating port and the first operating port in communication with the exhaust port space; a pilot valve casing having a pair of operating ports connected by operating passages to the pressure-responsive means, a pressure port connected by a passage to said discharge space between said restriction and the gear pump, and an exhaust space connected by passageway means to said suction space; a pilot valve in the casing and having a first position in which the pressure port of the latter communicates with one operating port thereof and the other operating port communicates with the exhaust space and a second position in which the pressure port communicates with said other operating port and the first operating port communicates with the exhaust space; means for restricting flow of liquid to or from the pressure-responsive means through one of said operating passages during intermediate portions of movement cycles of said movable valve means; and means for transmitting the final portion of motion of each stroke of the operating piston, in one direction, to move the pilot valve from its first to its second position and, in the other direction, to move the pilot valve from its second to its first position.
2. In hydraulic mechanism for converting rotary motion of a substantially constant speed motor into intermittent reciprocatory motion of an operated element, a gear pump driven by the motor, means including the gear pump casing and a discharge conduit to provide pump suction and discharge spaces, an operating cylinder having ports at the ends thereof, an op-

erating piston in the cylinder, and means for controlling communication of said ports with said spaces and of said discharge space with the suction space so as to secure strokes of said operating piston in opposite directions with controllable pauses thereof at stroke ends so as to vary the number of strokes per unit of time: said first-named means including a restriction in said discharge conduit to maintain a desired minimum pressure in the discharge space between the restriction and the pump; a valve housing having a pair of operating ports in communication with said cylinder ports, a pair of pressure ports in communication with said discharge conduit at the side of the restriction remote from the gear pump, and an exhaust port space in communication with said suction space; movable valve means in the housing, pressure-responsive means for effecting successive cycles of movement of the valve means in opposite directions, said valve means having portions cooperating with the housing and with the ports and the exhaust port space thereof such that each movement cycle begins with a first pressure port communicating with a first operating port and the second operating port communicating with the exhaust port space, followed by an intermediate portion of movement thereof wherein said pressure ports and the exhaust port space are placed in communication, and ending with the second pressure port in communication with the second operating port and the first operating port in communication with the exhaust port space; a pilot valve casing having a pair of operating ports connected by operating passages to the pressure-responsive means, a pressure port connected by a passage to said discharge space between said restriction and the gear pump, and an exhaust space connected by passageway means to said suction space; a pilot valve in the casing and having a first position in which the pressure port of the latter communicates with one operating port thereof and the other operating port communicates with the exhaust space and a second position in which the pressure port communicates with said other operating port and the first operating port communicates with the exhaust space; one of said operating passages having a pair of branches providing for parallel flow to or from the pressure-responsive means; means for adjustably restricting flow in one of the branches; means operated by said movable valve means to close the other branch during intermediate portions of movement cycles of said movable valve means; and means for transmitting the final portion of motion of each stroke of the operating piston, in one direction, to move the pilot valve from its first to its second position and, in the other direction, to move the pilot valve from its second to its first position.

3. In hydraulic mechanism for converting rotary motion of a substantially constant speed motor into intermittent reciprocatory motion of an operated element, a gear pump driven by the motor, means including the gear pump casing and a discharge conduit to provide pump suction and discharge spaces, an operating cylinder having ports at the ends thereof, an op-

erating piston in the cylinder and connected to the operated element, and means for controlling communication of said ports with said spaces and of said discharge space with said suction space so as to secure strokes of said operating piston in opposite directions with controllable pauses thereof at stroke ends so as to vary the number of strokes per unit of time: said first-named means including a restriction in said discharge conduit to maintain a desired minimum pressure in the space between the restriction and the pump; a valve housing having a pair of operating ports in communication with said cylinder ports, a pair of pressure ports in communication with said discharge conduit at the side of the restriction remote from the gear pump, and an exhaust port space in communication with said suction space; movable valve means in the housing; pressure-responsive means for effecting successive cycles of movement of the valve means in opposite directions; said valve means having portions cooperating with the housing and with the ports and the exhaust port space thereof such that each movement cycle begins with a first pressure port communicating with a first operating port and the second operating port communicating with the exhaust port space, followed by an intermediate portion of movement thereof wherein said pressure ports and exhaust port space are placed in communication, and ending with the second pressure port in communication with the second operating port and the first operating port in communication with the exhaust port space; a pilot valve casing having a pair of ports connected by operating passages to the pressure-responsive means, a pressure port connected by a passage to said discharge space between said conduit restriction and the gear pump, an exhaust space connected by passageway means to said suction space; a pilot valve in the casing and having a first position in which the pressure port of the latter communicates with one operating port thereof and the other operating port communicates with the exhaust space and a second position in which the pressure port communicates with said other operating port and the first operating port communicates with the exhaust space; said pressure-responsive means comprising oppositely directed piston faces formed on said movable valve means and means providing pressure chambers for the piston faces; said operating passages communicating with the pressure chambers and one thereof having first and second branches terminating in axially-spaced first and second ports communicating with its pressure chamber; an adjustable valve in the first branch; a valve portion carried by the movable valve means for closing the second branch port during intermediate portions of cycles of movement of the movable valve means; and means for transmitting the final portion of motion of each stroke of the operating piston, in one direction, to move the pilot valve from its first to its second position and, in the other direction, to move the pilot valve from its second to its first position.

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