Feb. 13, 1934. A. L. ELLIS 1,947,253

RECIPROCATING DRIVE MECHANISM

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Fig. 1.

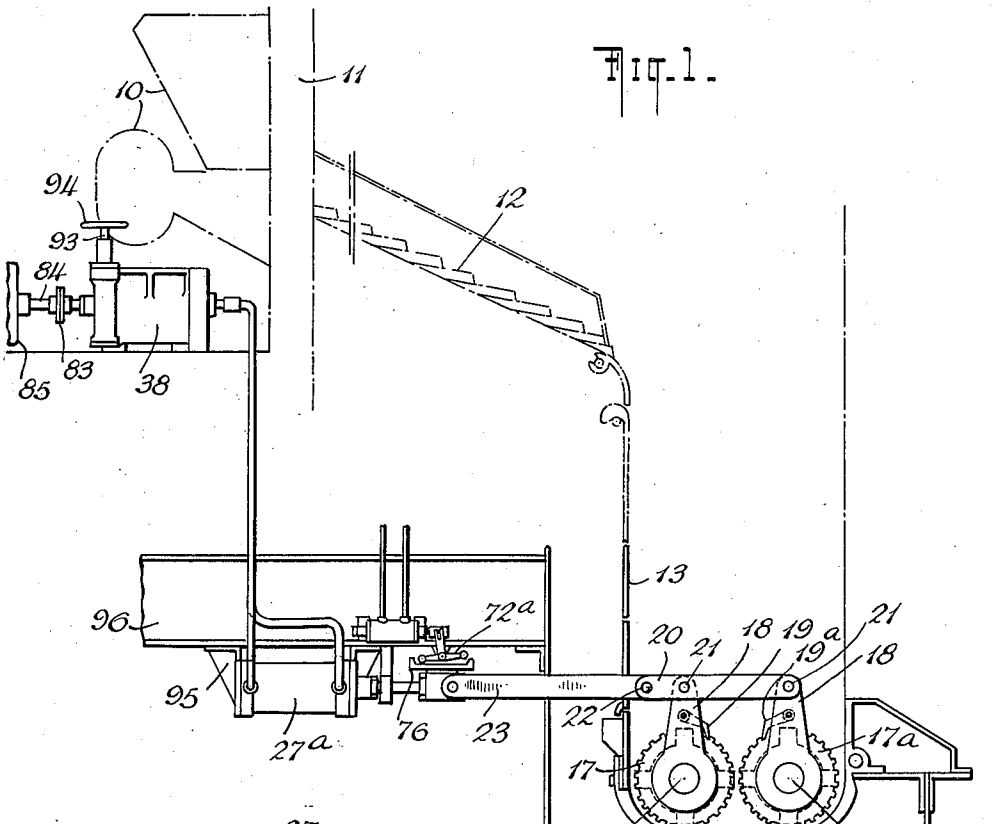
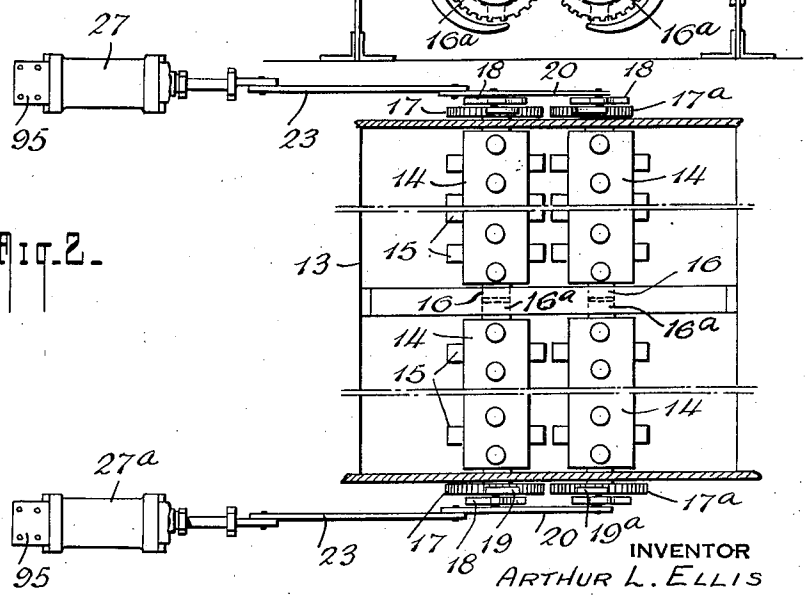


Fig. 2.



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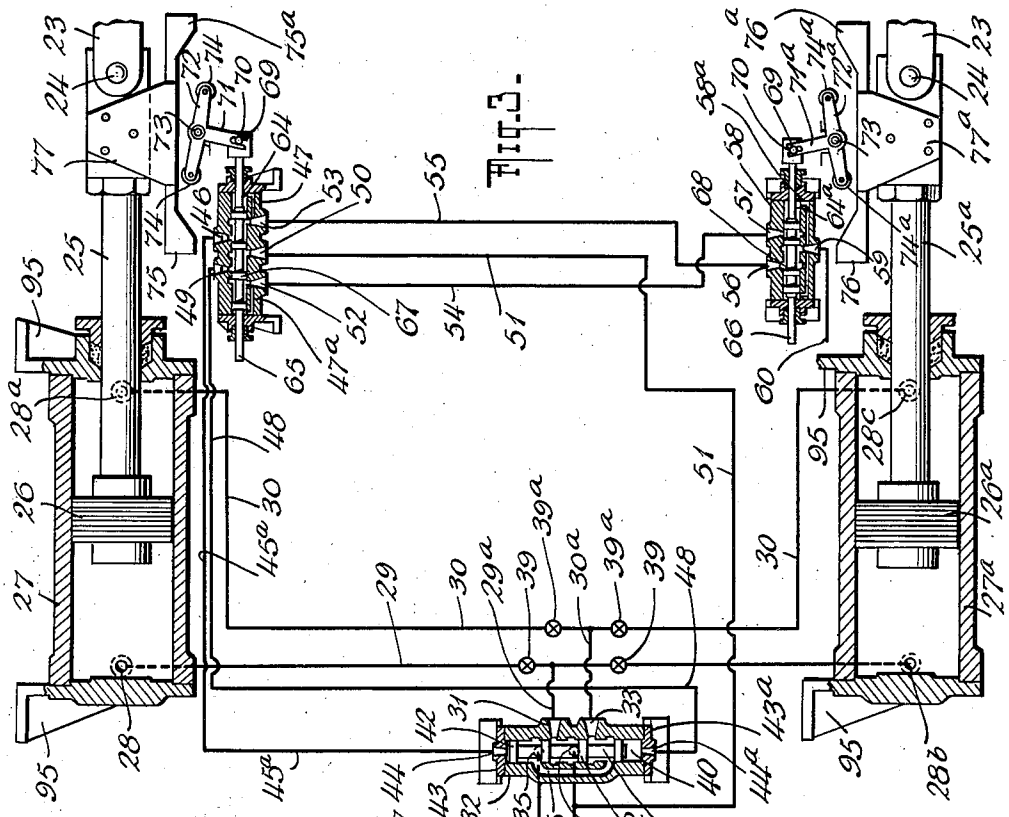


Fig. 3.

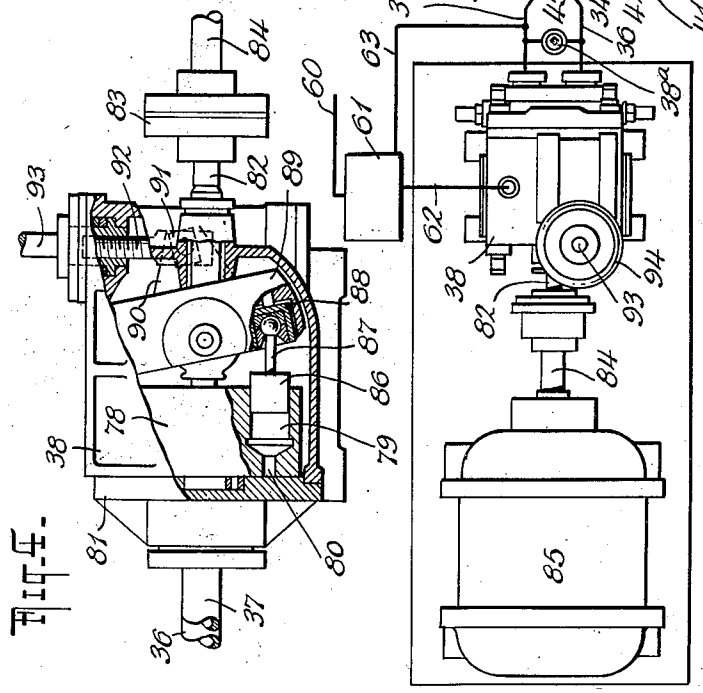


Fig. 4.

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RECIPROCATING DRIVE MECHANISM

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Application June 29, 1932. Serial No. 619,884

9 Claims. (Cl. 60—52)

The invention relates to reciprocating drive mechanisms and more particularly to that type thereof which are primarily designed for operating clinker grinders constituting parts of the ash removal systems of mechanical stokers. Clinker grinders of the indicated class generally consist of series of two or more rollers provided with projections or teeth, and mounted in a grinder pit at the rear end of the boiler; in such arrangements the ashes and clinkers are discharged from the stoker to the grinder pit and from there pass to the ash disposal system. In order to efficiently break up the clinkers and ashes into relatively fine particles capable of being easily disposed of, the clinker rolls are rotated very slowly in periodic steps and generally in directions toward each other so that the teeth or projections thereof break up the clinkers and ashes as they feed through.

Various means have heretofore been used to drive the clinker rolls, one type of such means consisting of an electric motor or steam turbine connected up by means of a large gear reduction with a crank on the delivery shaft; the crank is operatively connected with a ratchet and pawl arrangement so that for each rotation of the crank shaft the grinder rolls will be given a partial rotation, the extent of which is determined by the number of teeth of the ratchet engaged by the pawl, the latter usually being capable of adjustment to vary its throw. This arrangement is objectionable because it requires a large and expensive gear reduction unit in order to obtain the slow rotary speeds desired in the clinker grinders.

Another arrangement consists of a hydraulic ram which replaces the aforesaid gear reduction drive and is connected to a pawl co-operating with a ratchet as in the first mentioned construction, various types of pumps and controls being used for operating the reciprocating piston of the ram. An existing form of this latter arrangement utilizes a variable stroke pump which delivers oil to two hydraulic rams connected with the clinker grinder drives, one at each side of the boiler. The control for the type last mentioned, which uses pressure to reverse the control means of the pump unit, has proven objectionable at different times, because it permits the two hydraulic rams to stall at both ends of their strokes; under such conditions when both rams are stalled at the ends of their forward strokes against the forward heads of the ram cylinders, the pressure of the system will build up to a predetermined setting. When this built up pressure reaches for instance 1000 pounds, a small amount of oil is delivered to a pressure control usually mounted on the pump whereby the latter is reversed and correspondingly reverses the flow of oil so that the pistons of the rams move in the opposite direction until they engage the heads at the opposite ends of said rams. This type of control has proved objectionable primarily because of the high pressures which are required at each end of the strokes to effect the reversal; this develops excessive load on all of the hydraulic mechanism and at the time of reversal produces considerable vibration in the pipe lines and excessive noise in the hydraulic unit due to the high pressure.

The object of the instant invention is to overcome these and other existing disadvantages and to provide a simple and novel reciprocating drive mechanism including an efficient control system which permits the continuous operation without the necessity for building up high pressures to effect the desired reversal of operation, and accordingly eliminates troubles due to such high pressures. Other more specific objects will appear from the description hereinafter and the features of novelty will be pointed out in the claims.

In the accompanying drawings which illustrate an example of the invention without defining its limits, Fig. 1 is an elevation of the novel arrangement in operative combination with the clinker grinders of a furnace; Fig. 2 is a diagrammatic plan view partly in section; Fig. 3 is a diagrammatic view on an enlarged scale with parts in section showing the novel mechanism, and Fig. 4 is an elevation partly in section of one form of hydraulic pump which may constitute part of the mechanism.

In Fig. 1, a portion of the stoker mechanism is indicated at 10 by broken lines, while 11 and 12 similarly designate a wall and a portion of the grate mechanism which inclines downwardly toward the grinding pit 13. Customary grinder rolls 14 provided with teeth or projections 15 are located in predetermined groups at the lower end of the grinder pit 13 and are fixed upon shafts 16 and 16a rotatably mounted in said pit in suitable bearings; the grinder rolls 14 in the illustrated example are arranged in co-operating pairs on the shafts 16 and 16a respectively and are rotatable in opposite directions toward each other in the customary manner, and the shafts 16 and 16a thereof extend exteriorly of the grinder pit 13 and carry ratchet wheels 17 and 17a respectively. Arms 18 are mounted on the shafts

16 and 16a so as to be capable of being rocked relatively thereto and are provided with oppositely acting pawls 19 and 19a adapted to co-operate respectively with the ratchet wheels 17 and 17a to rotatably actuate the grinder rolls 14 in periodic steps as will appear more fully hereinafter. The arms 18 are connected in pairs at opposite sides of the grinder pit 13 by means of members 20 pivotally secured at 21 to said arms 18 and pivotally connected at 22 with links 23. The one link 23 is pivotally connected at 24 with a piston rod 25 carrying a piston 26 adapted to be reciprocated in a cylinder 27, while the other link 23 is correspondingly connected at 24 with a piston rod 25a carrying a piston 26a adapted to be reciprocated in a cylinder 27a; the cylinders 27 and 27a and their associated elements comprise hydraulically operated rams forming part of the operating system. The cylinder 27 is provided with ports 28 and 28a located respectively at its opposite ends, while the cylinder 27a includes correspondingly located ports 28b and 28c. As shown diagrammatically in Fig. 3, a pipe 29 extends between and connects the ports 28 and 28b with each other, while a pipe 30 extends between and correspondingly connects the ports 28a and 28c, it being understood that this arrangement may be replaced by any other system of pipes producing the results, which will appear more fully from the description hereinafter. The pipe 29 is connected by means of a branch 29a with the port 31 of a four-way reversing valve 32, while the pipe 30 is connected by means of a branch 30a with a port 33 of said reversing valve 32. The latter is provided with additional ports 34 and 35 connected by pipes 36 and 37 respectively with the ports of a hydraulic pump 38 of any conventional and suitable type.

In the preferred arrangement, the pipe 29 is provided with control valves 39 located upon opposite sides of the point of connection with the branch 29a, and the pipe 30 is provided with corresponding valves 39a located upon opposite sides of the point of connection with the branch 30a for the purpose to be more fully set forth hereinafter. The reversing valve 32 includes an interior chamber 40 with which the ports 31, 33, 34 and 35 communicate and in which a plunger 41 is slidably mounted. The plunger 41 carries a plurality of heads 42 so located and arranged as to establish communication between the aforesaid ports of the valve 32 in accordance with a predetermined plan of action. The casing of the valve 32 is closed at its opposite ends by heads 43 and 43a respectively, said heads having ports 44 and 44a respectively, both communicating with the chamber 40 at opposite ends thereof, as shown in Fig. 3; the valve 32 is further provided with a passage 45 connecting opposite end portions of the chamber 40. The port 44 of the reversing valve 32 is connected by means of a pipe 45a with the port 46 of a pilot valve 47, and the port 44a is connected by means of a pipe 48 with a second port 49 of said pilot valve 47. The latter is provided with a third port 50 connected by means of a pipe 51 with the pipe 36 leading to one port of the pump 38, for instance, by way of the pipe 36. In addition, said pilot valve 47 includes ports 52 and 53 connected by pipes 54 and 55 respectively, with ports 57 and 56 of a second pilot valve 58, which furthermore includes an exhaust port 59 connected by a pipe 60, for instance, with the oil reservoir or expansion tank 61, mounted in the customary manner above the highest point of the system and connected by means of a pipe 62 with the pump 38 and by means of a pipe 63 with the previously mentioned pipe 37, as shown in Fig. 3. The pilot valves 47 and 58 are provided respectively with internal chambers 64 and 64a with which the various ports communicate as shown in Fig. 3; plungers 65 and 66 are slidably mounted in the pilot valves 47 and 58 respectively and are provided with a plurality of heads 67 and 68 adapted to be reciprocated respectively in the chamber 64 and 64a and located so as to bring the respective ports into communication with each other in accordance with the aforesaid predetermined plan of action. As shown in Fig. 3, the pilot valves 47 and 58 further include passages 47a and 58a leading from opposite ends of the respective chambers 64 and 64a to one or more of the ports with which said pilot valves are provided; these passages 47a and 58a serve to drain the opposite end portions of the chambers 64 and 64a and thereby prevent pressure from building up in said chambers to an extent sufficient to interfere with the balanced condition which otherwise exists. The plungers 65 and 66 project exteriorly of the valves 47 and 58 respectively, and at their free ends are provided with blocks 69 carrying pins or projections 70; the latter are straddled by the forked ends of arms 71 and 71a forming parts of rocking levers 72 and 72a respectively, said levers being pivoted at 73 to suitable stationary portions of the apparatus, and being preferably provided at their opposite ends with rollers 74 and 74a respectively. The rocking levers 72 and 72a are respectively located in the path of cams 75 and 75a, and 76 and 76a operating in opposed relation to each other in pairs; the cams 75 and 75a are carried by a bracket 77, which is secured to the piston rod 25 so as to be movable therewith, while the cams 76 and 76a are carried by a corresponding bracket 77a fixed upon the piston rod 25a to partake of the movements thereof.

As previously stated, the hydraulic pump 38 may be of any suitable type having an adjustable output and capable of being reversed, and in the illustrated example is of the well known Waterbury type of hydraulic variable stroke pump. This pump includes a rotatable cylinder barrel 78 provided with a plurality of cylinders 79 having openings 80 adapted to register successively in the well known way with suitable openings in the valve plate 81 to establish communication with the ports leading to the pipes 36 and 37 respectively. The cylinder barrel 78 is mounted upon the shaft 82, which is connected, for instance, by means of a flexible coupling 83 with the shaft 84 of the driving or operating medium; the latter may comprise a constant speed electric motor 85, a steam turbine or any other equivalent constant speed drive. The cylinders 79 of the barrel 78 slidably accommodate pistons 86 arranged to be reciprocated therein and connected by means of piston rods 87 with a swash plate 88 mounted for rotation in a tilting box 89. The latter is mounted on the shaft 82 so as to be capable of adjustment to different angles of inclination relatively to said shaft to thereby vary the output of the pump 38 and the speed of operation of the pistons 26 and 26a, as will appear more fully hereinafter; that is to say, the angular adjustment of the tilting box 89 governs the stroke of the pistons 86 and therefore the amount of fluid delivered by the pump 38 during each rotation of the barrel 78 through the pipes 36 and 37.

The pump 38 further includes means whereby the tilting box 89 may be adjusted from the zero position in which it extends at right angles to

the shaft 82, to any degree of inclination relatively to said shaft within the range of adjustment. In the illustrated example, the tilting box 89 is accordingly provided with a bifurcated lug 90 projecting therefrom and accommodating a vertically slidable bearing block 91, which is pivotally connected with the lower end of an externally screw-threaded rod or spindle 92; the latter is in threaded engagement with the internally screwthreaded lower end of a control shaft 93 mounted for rotation but held against longitudinal movement in any suitable manner upon the casing of the pump 38 and projecting upwardly beyond said casing as shown in Figs. 1 and 4. The upper end of the control shaft 93 may be provided with a hand wheel or equivalent device 94 for facilitating the operation of the shaft 93 and the adjustment of the control means.

In addition to the parts so far described, a relief valve 38*a* of any standard type and conventional construction is connected with the pipes 36 and 37 so as to connect the two sides of the pump 38 with each other; this relief valve is capable of operating at a predetermined pressure and provides a means for taking care of all of the oil delivered by the pump 38 in case the pressure developed in the system becomes excessive for any reason.

In practice, the cylinders 27 and 27*a* may be supported by means of brackets 95 or equivalent means, which preferably are secured to girders 96 or the like at suitable points below the floor line of the boiler room, while the pump 38 and motor 85 or its equivalent generally are located on the boiler room floor at some convenient location easily accessible to the attendant, for instance, in the manner indicated in Fig. 1.

In the practical operation of the apparatus, one or the other of the pistons 26 or 26*a* reaches the ends of its strokes slightly in advance of the other piston, this being due primarily to variable resistances encountered by the different sets of grinder rolls 14; that is to say, if one set of rolls 14 meets with greater resistance than another set, that set which encounters the lesser resistance will rotate easier and slightly faster and the co-operating piston 26 or 26*a* will reach the end of its stroke first. In addition, the aforesaid differences in the relative travel of the pistons is attained by adjusting the valves 39 and 39*a*, which may be set to choke the flow of oil to either one cylinder or the other, as may be necessary or desirable, said valves being also capable of being closed to completely shut off the supply of oil to either or both cylinders. In the following description of the operation, it has been assumed that the piston 26 arrives at the end of its strokes in advance of the piston 26*a*, it being understood that this is done simply for purposes of description. With the parts occupying the positions illustrated in Fig. 3, oil in predetermined volume determined by the setting of the tilting box 89 and swash plate 88, will be delivered by the pump 38 through the pipe 36 and port 34 into the chamber 40 of the reversing valve 32. The oil thus delivered will pass through the port 31 of the reversing valve 32 and the branch 29*a* into the pipe 29 in which it will flow in opposite directions to the ports 28 and 28*b* respectively, and accordingly will pass into the rear or left-hand ends of the cylinders 27 and 27*a* and accordingly cause the pistons 26 and 26*a* and their associated elements to move toward the right in Fig. 3. At the same time, oil passes from the pressure side of the pump 38 through the pipe 51 and the port 50 into the chamber 64 of the pilot valve 47; from the chamber 64 of said pilot valve 47 the oil passes through the port 49 and pipe 48 and from thence through the port 44*a* into the chamber 40 of the reversing valve 32 at the one end thereof. Pressure is thus exerted against the one end of the plunger 41 and forces it against the head 43 and maintains it in this position, while the pistons 26 and 26*a* are moving forward in the cylinders 27 and 27*a*; at the same time the oil located in the front or right hand ends of the cylinders 27 and 27*a* will pass therefrom through the ports 28*a* and 28*c* into the pipe 30, and then through the branch 30*a*, port 33, passage 45 and port 35 into the pipe 37 and back to the pump 38. The aforesaid forward movements of the pistons 26 and 26*a* will be transmitted to the piston rods 25 and 25*a* and to the links 23 and members 20, and accordingly will swing the arms 18 relatively to the shafts 16 and 16*a* toward the right in Fig. 1; during these operations, the pawls 19 will act on the cooperating ratchet wheels 17, while at the same time the pawls 19*a* will ride over the teeth of the ratchet wheels 17*a*. As a result, the one grinder roll 14 of each pair will be rotated to a predetermined extent, while the other grinder roll of each pair at this stage will remain stationary. As it has been assumed that the apparatus operates so that the piston 26 travels slightly in advance of the piston 26*a*, the described forward movements will cause the cam 75 to engage the left-hand roller 74 in Fig. 3, and as the movement to the right continues, will shift said roller 74 downwardly to thereby pivotally actuate the lever 72 in a manner to swing the arm 71 to the right in Fig. 3. The plunger 65 will accordingly be correspondingly shifted to the right to a position in which the pressure oil passes through the port 46 of the pilot valve 47 and pipe 45*a* through the port 44 to the opposite end of the reversing valve 32; pressure will thereby be exerted upon the plunger 41 tending to force it lengthwise of the chamber 40 in a direction toward the head 43*a*. At this stage, however, the oil in the chamber 40, in engagement with the opposite end of the plunger 41 cannot escape, although it tends to pass in a reverse direction through the pipe 48, ports 49 and 52 of the pilot valve 47 and through the pipe 54 and port 57 into the pilot valve 58; with the plunger 66 of the pilot valve 58 still in the position shown in Fig. 3, the port 57 is blocked and flow of the oil is prevented so that the valve plunger 41 of the reversing valve 32 accordingly remains in the position indicated in Fig. 3. The piston 26*a* in the meantime has continued its forward movement so that the co-operating cam 76 will finally strike the left-hand roller 74*a* whereby the lever 72*a* is rocked on its pivot 73 in a manner to swing the arm 71*a* and with it the plunger 66 toward the right in Fig. 3. This operation of the plunger 66 blocks the port 56 of the pilot valve 58 and brings the port 57 thereof into communication with the port 59 of said pilot valve 58, so that the oil is now free to pass out through the pipe 60 and back to the expansion tank 61 or its equivalent. The restraining pressure on the plunger 41 of the reversing valve 32 is thereby relieved, so that the pressure effective through the port 44 of said valve 32 moves said plunger 41 lengthwise of the chamber 40 into engagement with the head 43*a* thereof. The port 34 of the reversing valve 32 is thereby brought into communication with the port 33, so that the oil now flows through the branch 30*a* to the pipe 30 in which it is divided into two streams flowing in opposite directions to the ports 28*a* and 28*c* respectively; oil is thereby

introduced into the right hand ends of the cylinders 27 and 27*a* and causes the pistons 26 and 26*a* to be moved rearwardly in return movements. At the same time the oil in the left hand ends of the cylinders 27 and 27*a* passes out through the ports 28 and 28*b* into the pipe 29, and then through the branch 29*a*, ports 31 and 35 of the reversing valve 32 into the pipe 37 and back to the pump 38. As the pistons 26 and 26*a* thus move in the return direction, the piston rods 25 and 25*a* will exert a pulling force upon the links 23 and members 20 and accordingly will rock the arms 18 relatively to the shafts 16 and 16*a* toward the left in Fig. 1. As this operation of said arms takes place, the pawls 19*a* will act on the teeth of the ratchet wheel 17*a* to rotatively advance the second grinder roll 14 of each pair; at the same time, the pawls 19 will move over the teeth of the ratchet wheels 17 in movements of recovery. It will be noted that the rotative movements of the grinder rolls 14 comprising each pair are in opposite directions or toward each other, so that the teeth or projections 15 develop a most effective breaking up action on the clinkers and ashes, which results in a uniform disposal of refuse throughout the entire width of the grinder pit. The aforesaid operative movements continue until the cam 75*a* strikes the right hand roller 74 and the cam 76*a* correspondingly engages the right-hand roller 74*a* to thereby restore the plungers 65 and 66 to the positions illustrated in Fig. 3, whereupon the parts are again operated to introduce oil through the ports 28 and 28*b* of the cylinders 27 and 27*a* to thereby again start the pistons 26 and 26*a* in forward directions. These operations continue in repeated sequence during any given active period of the apparatus, the reciprocation of the pistons 26 and 26*a* being continuous as long as the pump 38 is operating to deliver oil to the system.

If in the operation of the apparatus the piston 26*a* reaches the ends of its strokes before those of the piston 26, the plunger 66 of the pilot valve 58 will be operated by the cam 76 in the manner previously described to bring the port 57 into communication with the exhaust port 59, but the plunger 41 of the reversing valve 32 will not be shifted in the manner above set forth until the cam 75 has operated the lever 72 and arm 71 and shifted the plunger 65 of the pilot valve 47 to bring the port 49 into communication with the port 52 and the pipe 54, and to thereby connect said pipe 54 through the ports 57 and 59 with the return pipe 60. The pressure effective against the end of the plunger 41 through the port 44*a* of the reversing valve 32 will thereby be relieved and permit said plunger 41 to be shifted into engagement with the head 43*a* in the manner previously set forth.

If during any given period of operation the oil pressure in the system should for any reason become excessive or rise beyond the point at which the relief valve 38*a* is set, the oil will be by-passed either wholly or in part through said relief valve 38*a* in the conventional manner.

The improved arrangement provides a continuously operating apparatus in which the excessive pressures developed in existing mechanisms at the instance of reversal are avoided and excessive loads on the hydraulic mechanism, and other objectionable features resulting from such excessive pressures, are entirely overcome. In other words, in the novel construction, provision has been made for continuous operation without the necessity for building up high pressures at the points of reversal; the apparatus is simple in construction and requires no particular skill in its operation.

While the apparatus illustrated and described is particularly adapted for operating clinker grinders, it may be used with equal efficiency in any mechanism where two or more cylinders are operated in parallel in successive steps; in addition, practically the same equipment could be used for operating the rams of stokers in place of the mechanical drives now utilized, or other pushers operating to feed various types of heating furnaces. The apparatus furthermore may be efficiently used in mechanisms where a plurality of operations are to be performed by different moving slides and where reversal of any one unit cannot take place until all of the pistons have reached the ends of their strokes.

Various changes in the specific forms shown and described may be made within the scope of the claims without departing from the spirit of the invention.

I claim:—

1. A reciprocating drive mechanism comprising reciprocable pistons, cylinders in which said pistons are adapted to reciprocate coincidentally in the same direction, a variable stroke hydraulic pump, a four-way reversing valve having ports connected with said pump and additional ports, a slidable plunger movable lengthwise of said reversing valve for controlling the communication between said ports, said reversing valve further being provided with opposed ports at opposite ends thereof, connections from the additional ports of said reversing valve to opposite ends of each of said cylinders, control valves in said connections whereby the travel relation of said pistons is controlled, a first pilot valve, a pressure connection from the pressure side of said pump to said first pilot valve, connections from said opposed end ports of said reversing valve to said first pilot valve, a second pilot valve having an exhaust port, connections from said first pilot valve to said second pilot valve, a valve plunger slidable in said first pilot valve for directing the flow of pressure medium through the opposed end ports of said reversing valve for reciprocating the plunger therein, a second valve plunger in said second pilot valve adapted to establish communication between its exhaust port and the connections to the first pilot valve whereby restraining pressure on the plunger of the reversing valve is relieved and reversal in the direction of movement of the pistons is effected, rocking devices for operating said pilot valve plungers, and opposed cams movable with said pistons for operating said rocking devices at predetermined points in the travel of said pistons.

2. A reciprocating drive mechanism comprising reciprocable pistons, cylinders in which said pistons are adapted to reciprocate coincidentally in the same direction, a variable stroke hydraulic pump, a four-way reversing valve having ports connected with said pump and additional ports, a slidable plunger movable lengthwise of said reversing valve for controlling the communication between said ports, said reversing valve further being provided with opposed ports at opposite ends thereof, connections from the additional ports of said reversing valve to opposite ends of each of said cylinders, control valves in said connections whereby the travel relation of said pistons is controlled, a first pilot valve, a pressure connection from the pressure side of said pump to said first pilot valve, connections from said

opposed end ports of said reversing valve to said first pilot valve, a second pilot valve having an exhaust port, connections from said first pilot valve to said second pilot valve, a valve plunger slidable in said first pilot valve for directing the flow of pressure medium through the opposed end ports of said reversing valve for reciprocating the plunger therein, a second valve plunger in said second pilot valve adapted to establish communication between its exhaust port and the connections to the first pilot valve whereby restraining pressure on the plunger of the reversing valve is relieved and reversal in the direction of movement of the pistons is effected, and means controlled by said pistons for operating said pilot valve plungers at predetermined points in the travel of said pistons.

3. A reciprocating drive mechanism comprising two reciprocable pistons, two cylinders in which said pistons are adapted to reciprocate coincidentally in the same direction, a variable stroke hydraulic pump, a four-way reversing valve connected with said pump, connections from said reversing valve to opposite ends of each of said cylinders, a first pilot valve, a connection from the pressure side of said pump to said first pilot valve, opposed connections from said reversing valve to said first pilot valve, a second pilot valve having an exhaust port, connections from said first pilot valve to said second pilot valve, rocking devices for adjusting each of said pilot valves throughout their operative range, opposed cams movable with said pistons for operating said rocking devices to control and effect actuation of said reversing valve whereby the direction of travel of said pistons in said cylinders is reversed, and means whereby one of said pistons may be caused to travel in predetermined advance of the other piston.

4. A reciprocating drive mechanism comprising pressure operated means, a variable stroke hydraulic pump, a reversing valve connected with said pump and with said pressure operated means, a plunger in said reversing valve for controlling the communication between said pump connections and the connections to the pressure operated means, a first pilot valve connected with the pressure side of said pump, connections leading from said pilot valve to opposite ends of said reversing valve, a second pilot valve connected with the first pilot valve and provided with an exhaust port, means controlled by said pressure operated means whereby said first pilot valve is operated to direct the flow of pressure medium to said reversing valve for operating its plunger in one direction or the other, and additional means controlled by said pressure operated means whereby said second pilot valve is operated to establish communication, through the pilot valve connections, between the first pilot valve and the exhaust port of said second pilot valve to thereby release pressure medium from said reversing valve to permit said plunger to effect reversal of said pressure operated means.

5. A reciprocating drive mechanism comprising pressure operated means, a variable stroke hydraulic pump, a reversing valve connected with said pump and with said pressure operated means, a plunger in said reversing valve for controlling the communication between said pump connections and the connections to the pressure operated means, a pair of pilot valves connected with each other, one of said pilot valves being directly connected with the pressure side of said pump independently of said reversing valve and with opposite ends of said reversing valve, and the other of said pilot valves having an exhaust port, and means controlled by said pressure operated means whereby said pilot valves are relatively operated to direct the pressure medium to said reversing valve for operating its plunger in one direction or the other to control the connections between said pump and said pressure actuated means, and for establishing communication, through the pilot valve connections, between the first pilot valve and the exhaust port of the second pilot valve to thereby release pressure medium from said reversing valve to permit said plunger to effect reversal of said pressure operated means.

6. A reciprocating drive mechanism comprising reciprocable pistons coincidentally movable in the same direction, cylinders in which said pistons are adapted to reciprocate, a variable stroke hydraulic pump, connections from said pump to opposite ends of each of said cylinders, a reversing valve in said connections, pilot devices connected with each other and with the pressure side of said pump, connections from one of said devices to said reversing valve, and independent means controlled individually by each of said pistons for independently adjusting said pilot devices whereby opposing pressures are developed on said reversing valve tending to restrain it in an adjusted position and to move it from said position and whereby said restraining pressure is relieved to permit operation of said reversing valve for reversing the direction of movement of said pistons.

7. A reciprocating drive mechanism comprising reciprocable pistons coincidentally movable in the same direction, cylinders in which said pistons are adapted to reciprocate, a variable stroke hydraulic pump, connections from said pump to opposite ends of each of said cylinders, a reversing valve in said connections, pilot devices connected with each other and with the pressure side of said pump, connections from one of said devices to said reversing valve, independent means controlled individually by each of said pistons for independently adjusting said pilot devices whereby opposing pressures are developed on said reversing valve tending to restrain it in an adjusted position and to move it from said position and whereby said restraining pressure is relieved to permit operation of said reversing valve for reversing the direction of movement of said pistons, and means in the connections between said pump and cylinders whereby the travel relation of the respective pistons may be varied.

8. A reciprocating drive mechanism comprising a hydraulic pump, cylinders having their opposite ends connected with said pump, reciprocating pistons in said cylinders coincidentally movable in the same direction, means in the connections between said pump and cylinders whereby the travel relation of the respective pistons may be adjusted, a single reversing valve in said last named connections for controlling the same to effect the reversals of all of said pistons, pilot valves connected with each other and with said reversing valve, one of said pilot valves being connected with the pressure side of said pump, and means controlled by said pistons and operating said pilot valves to initially develop restraining and operating pressures on said reversing valve and to subsequently relieve said restraining pressure whereby said reversing valve operates to effect reversal in the directions of movement of said pistons.

9. A reciprocating drive mechanism comprising a pair of cylinders, a piston in each of said cylinders, said pistons being coincidentally movable in the same direction by an applied pressure medium, a hydraulic pump connected with the opposite ends of said cylinders for developing a flow of said pressure medium, means for regulating the flow of said pressure medium to said cylinders whereby the sequence of operation of said pistons is predetermined, a single pressure actuatable reversing valve in said connections, interconnected devices connected with said pump and with said single reversing valve, and means controlled by said pistons for operating said interconnected devices in predetermined sequence corresponding to the operative sequence of said pistons to direct pressure medium to and from said single reversing valve whereby the latter is pressure actuated to direct the flow of pressure medium to opposite ends of both of said cylinders for reversing the direction of movements of the pistons therein.

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