This application is a continuation-in-part of application Serial Number 165,516, filed January 11, 1962, now abandoned.

This invention relates to hydraulically operated jaw crushers and more particularly to the valve mechanism of such crushers.

The present invention is concerned with hydraulically operated jaw crushers of the kind comprising a power-driven plunger, a jaw-propelling ram and a commutating valve which, during alternate oscillations of the plunger breaks hydraulic connection between it and the ram cylinder and opens communication between it and elsewhere, thereby immobilising the ram during every alternate oscillation of the plunger and so permitting outfall of crushed material from between the jaws to occur during three quarters of operating time.

In crushers of this kind the commutating valve may be of any suitable kind, and the present invention relates to such crushers in which that valve is of hollow, cylindrical, rotary type moving in a cylindrical bore of substantially like diameter, and in particular it relates to means for maintaining the valve in hydraulic balance radially so that, irrespective of operating pressure, no considerable bearing pressure can be developed between the cylindrical surface of the valve and the bore in which it moves.

A problem incidental to the use of a valve member in a jaw crusber which is subject to substantially continuous rotation in one or two directions resides in the fact that the pressure intensities developed by the plunger are quite high and these pressure intensities interfere to a substantial extent with the desired smooth and effective operation of the valve member.

An object of the present invention is to provide a jaw crusber wherein the continuously rotatable valve member of the valve mechanism thereof is in substantially complete balance transversely thereof during operation thereof and as a result there is no appreciable bearing pressure between it and the valve cylinder in which it is mounted.

With that end in view, a longitudinal duct or chamber in constant communication with the plunger cylinder is provided in the valve which also comprises two pairs of ports, one of which pairs connects intermittently between the said duct and the ram cylinder while the other pair connects intermittently between said duct and another vessel, or space. The arrangement of the ports is such that while one pair is open the other pair is closed, and vice versa; and the movement of the valve is such that during alternate oscillations of the plunger the ports leading to the ram cylinder are closed and the ram and jaw are at rest.

Both ports of a pair are of equal area and are diametrically opposed; and the corresponding ports in the bore in which the valve moves are of like description.

That being the case, the force exerted by the fluid pressure between the valve and its cylinder over any area of the valve surface is balanced by an equal force in the opposite direction. The resultant radial force on the valve is, therefore, zero in all directions; no force is transmitted by contact between the valve and its bore and no metal-to-metal friction occurs between them.

The invention will be described with reference to the accompanying drawing, in which

FIGURE 1 is a sectional elevation of a valve mechanism in accordance with the invention.

FIGURE 2 is a section on line 2-2 of FIGURE 1.

FIGURES 3, 4, 5 and 7 are cross-sectional views showing sequential operating positions of the valve.

FIGURE 6 is a section on line 6-6 of FIGURE 1.

FIGURE 8 is a partial sectional elevation of an alternative form of valve actuating means, and

FIGURE 9 is a partial end elevation, showing driving means for the valve structure of FIGURE 8.

Referring to FIGURES 1, 2 and 6, 1 is a valve housing in accordance with the invention. A plunger cylinder 3 is fixed to tubularly transversely extending trunnion members 4 and 4a which are rotatably mounted in housing 1.

A plunger 5 is reciprocally mounted in cylinder 3 and is carried by a cranck 6 fixed to a crankshaft 7 of which will cause reciprocating movement of the plunger and oscillating movement of the plunger and plunger cylinder. The crankshaft 7 is driven by any suitable means, not shown. Rotatably mounted in the trunnion members, the bore of which constitutes a valve cylinder 8c, is a tubular valve 8 having a chamber 9 therein and ports 10 placing the plunger cylinder 3 in constant communication with the chamber 9. Valve 8 also has a pair of ports 11 of like size and in diametrically opposed relation to each other. Trunnion member 4a has a pair of ports 12 of like size with respect to ports 11 and diametrically opposed relation to each other. The diametrical axes of ports 11 and 12 are in the same plane extending transversely of the tubular valve 8. It will be apparent that relative movement of valve 8 and trunnion member 4a will act to place ports 11 and 12 into and out of registry with each other.

Housing 1 has a passage 13 therein leading to a ram cylinder 14 constituting part of another conventional jaw crusber such as shown in United States Patent 2,609,994. An annular duct 15 in cylinder 2 places both ports 12 in communication with passage 13.

Valve 8 also has a pair of ports 16 of like size and in diametrically opposed relation to each other. Trunnion member 4a has a pair of ports 17 of like size with respect to ports 16 and in diametrically opposed relation to each other. The diametrical axes of ports 16 and 17 are in the same plane and the diametrical axis of ports 16 is normal to the diametrical axis of ports 17. It will be apparent that relative movement of valve 8 and trunnion member 4a will act to place ports 16 and 17 into and out of registry with each other.

Housing 1 has a passage 18 leading to a vessel 19. An annular duct 20 in cylinder 2 places both ports 17 in communication with passage 18 and vessel 19.

As shown more particularly in FIGURES 2 and 6, the arrangement of ports 11 and 12 and ports 16 and 17 is such that when ports 11 and 12 are in communication ports 16 and 17 are out of communication with each other and vice versa.

Means are provided for imparting continuous rotation to valve 8 and, as shown, comprises a sprocket 21 on an end portion 22 of the valve projecting from the housing, a sprocket 23 on the crankshaft 6, and a connecting chain 24. It is proposed that valve 8 will be rotated at one-quarter the angular speed of the crankshaft 6 whereby the plunger cylinder 3 will be placed in communication with the ram cylinder 14 through ports 10, 11 and 12 during alternate strokes of the plunger and the cylinder 3 will be placed in communication with the vessel 19 through ports 10, 16 and 17 during the intervening strokes of the plunger (communication between plunger cylinder 3 and ram cylinder 14 being interrupted during such intervening strokes). It will be apparent that, in this instance, sprocket 21 will have a diameter four
times that of sprocket 23. Vessel 19 is simply a receiver for hydraulic fluid delivered by the "idle" strokes of the plunger. It will be apparent that the receiver vessel 19 could constitute a second ram cylinder of a second jaw crusher.

An oil-receiving sump 24 may be provided in the housing 14 for drainage of leakage through running clearances, a conduit 25 being provided to effect communication between the sump and a space 26 in the cylinder 2 at the end of the valve. Because of the arrangement of ports 11, 12, 16 and 17 and the ducts 15 and 20, pressure conditions about any diametral plane of the valve are symmetrical, and there is no resultant transverse force on the valve in any position. Running of the valve at quarter the speed of the crankshaft permits duplication of the valve ports thereby to achieve the conditions necessary for transverse balance.

The operation of the valve over two revolutions of the crankshaft and half of a revolution of the connecting valve is illustrated in FIGURES 3 to 7, inclusive.

In the position of FIGURE 3 the plunger is at the beginning of an active stroke and the valve is just beginning to open communication through chamber 9 between the plunger cylinder and the ram cylinder.

In the position of FIGURE 4 the plunger is at the end of its forward active stroke, and the valve is wide open.

In the position of FIGURE 5 the plunger has returned to its original position, the active oscillation of the plunger has been completed, the valve has just interrupted communication between plunger cylinder and ram cylinder, and an "idle" stroke of the plunger is about to commence, during which it will be in communication through ports 16, 17 and passage 18 with the vessel 19.

In the position of FIGURE 7 the idle stroke of the plunger, while it has been discharging into the air vessel 19, has completed, the valve is about to re-open communication between plunger cylinder and ram cylinder and another active stroke of the plunger is about to commence.

In the drawing, as thus far described, the valve is illustrated as being driven in continuous rotation from the crankshaft and, because of its simplicity, this arrangement would normally be preferred. The valve may, however, be moved in a to and fro rotary motion, as illustrated in FIGURES 8 and 9 by means of a crank 27 fixed to the valve, crankpin 28, connecting rod 29, crankpin 30 on gear 31 carried by shaft 32, and gear 33 on crankshaft 34. In this instance, the valve is arranged to be oscillated to and fro through 90° or other appropriate angle at half the frequency of the crankshaft.

As shown in the drawing, when the valve is oscillated through 90° both its ports 11 would be closed at the end of its movement, where it would be momentarily at rest in the position of FIGURE 6; and the plunger cylinder would then be connected to the vessel 19 through the other pair of ports 16.

When in the position of FIGURE 3, the valve would be moving at its greatest speed, its ports 11 would be beginning to open, and the plunger would be at the beginning of a forward stroke.

Between the positions of FIGURES 3 and 4 of the valve, the ports 11 would be open and the plunger would be delivering through them and through passage 13 into the ram cylinder. When in position of FIGURE 4 the plunger would be at the end of its forward stroke, and the valve would be momentarily at rest with its ports 11 full open.

During the succeeding return stroke of the plunger, the valve would return to position of FIGURE 3 after which the ports 11 would be closed as in FIGURE 6 during the next oscillation of the plunger when it would be connected to vessel 19 through the other pair of ports 16.

As previously indicated, because of the diaphragm symmetry of the valve the liquid pressure at any point of its outer surface is equal to that at a point directly opposite.

The valve is, therefore, in complete balance transversely and there is no appreciable bearing pressure between it and the cylinder in which it rotates. The chain or other gearing whereby the valve is driven may, therefore, be of light construction.

I claim:

1. In combination with a hydraulically-operated jaw crusher, a plunger cylinder, a plunger mounted for reciprocating movement in said cylinder, a crankshaft carrying said plunger and being continuously rotatable to impart reciprocating movement to said plunger, a ram cylinder, and a hydraulic fluid receiving vessel, valve mechanism for placing said plunger cylinder out of communication with said ram cylinder and into communication with said vessel during alternate strokes of said plunger and into communication with said ram cylinder and out of communication with said vessel during intervening strokes of said plunger which comprises a housing, a cylindrical valve member rotatably mounted in said housing and having an elongated valve chamber therein, said housing having a first passage in constant communication with said plunger cylinder, said valve member having an opening in constant communication with said first passage and said chamber and first and second pairs of ports opposite ports communicating with said chamber, said housing having a second passage in constant communication with said ram cylinder, a third passage in constant communication with said vessel, a first annular passage in constant communication with said second passage, and a second annular passage in constant communication with said third passage, said valve member being rotatable sequentially to open said first pair of ports while closing said second pair of ports and to close said first pair of ports while opening said second pair of ports, and means drivably connecting said valve member and said crankshaft.

2. In combination with a hydraulically-operated jaw crusher having a plunger cylinder, a plunger mounted for reciprocating movement in said cylinder, a crankshaft carrying said plunger and being continuously rotatable to impart reciprocating movement to said plunger, a ram cylinder, and a hydraulic fluid receiving vessel, valve mechanism for placing said plunger cylinder out of communication with said ram cylinder and into communication with said vessel during alternate strokes of said plunger and into communication with said vessel during intervening strokes of said plunger which comprises a housing, a cylindrical valve member, said housing having an elongated bore therein, trunnion means carrying said plunger cylinder snugly and rotatably disposed in said housing means having an elongated bore in coaxial relation to said first bore, a cylindrical valve member snugly and rotatably disposed in said second bore and having a valve chamber therein, said housing having a first passage in constant communication with said plunger cylinder, said valve member having an opening in constant communication with said first passage and said chamber, said valve member also having first and second pairs of diametrically opposite ports communicating with said chamber, the axes of said pairs of ports being substantially normal to each other, said trunnion means having third and fourth pairs of diametrically opposite ports registerable with said first and second pairs of ports, said housing having a second passage in constant communication with said ram cylinder, a third passage in constant communication with said vessel, an annular passage in constant communication with said second passage and said third pair of ports, and an annular passage in constant communication with said third passage and said fourth pair of ports, and means drivably connecting said valve member and said crankshaft for constant rotation of said valve member in response to rotation of said crankshaft.

3. A jaw crusher valve mechanism as defined in claim 2, said valve member opening comprising a plurality of
ports, said first passage comprising an annular portion in constant communication with said last-mentioned ports.

4. A jaw crusher valve mechanism as defined in claim 2, said driving connection comprising a sprocket on each of said crankshaft and valve member and a chain connecting said sprockets for unidirectional rotation of said valve member, said sprockets having diameters providing rotation of said valve member at one-quarter the speed of said crankshaft.

5. A jaw crusher valve mechanism as defined in claim 2, said driving connection driving said valve member alternatingly in two directions and constantly in response to rotation of said crankshaft and comprising a crank on said valve member, a gear on said crankshaft, a second gear meshing with said first gear, a shaft carrying said second gear, and a connecting rod connected to said crank and having an eccentric mounting on said second gear, said valve member being thereby oscillated to and fro at one-half the frequency of revolution of said crankshaft.

No references cited.

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