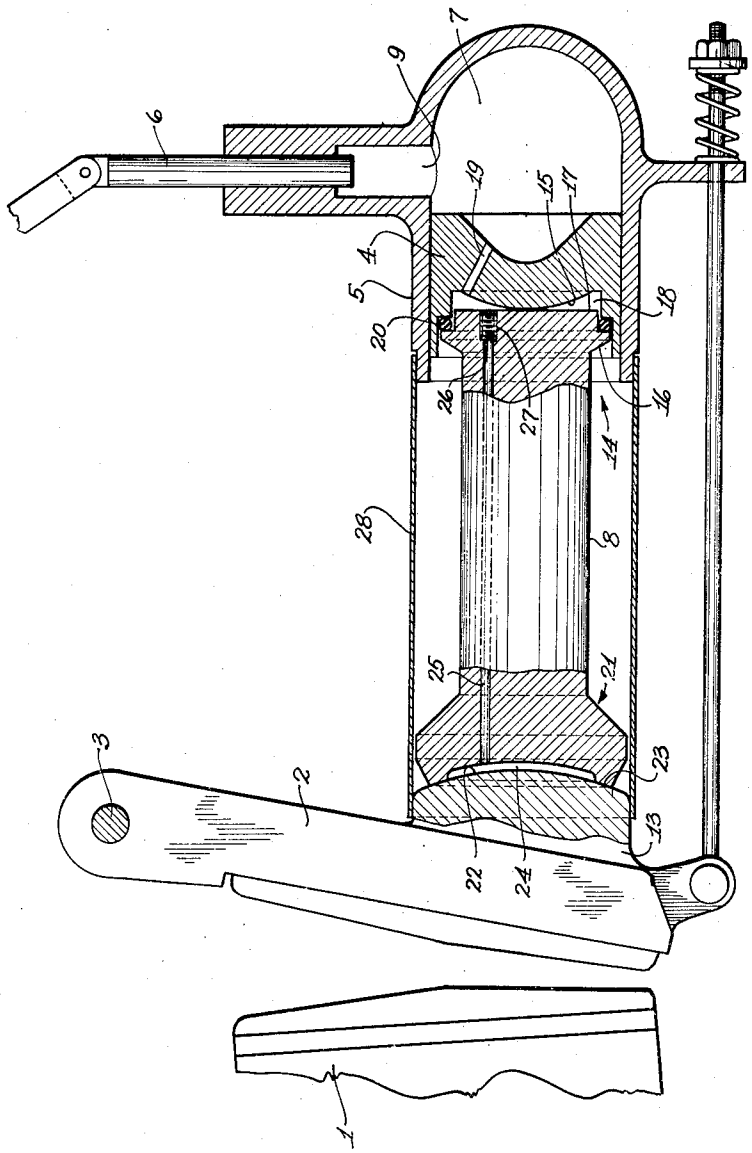
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THRUST TRANSMITTING MEANS FOR HYDRAULIC JAW CRUSHERS

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THRUST TRANSMITTING MEANS FOR HYDRAULIC JAW CRUSHERS

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This invention relates to hydraulically-operated jaw crushers of the kind comprising a power-driven, reciprocating plunger communicating hydraulically with a ram through which crushing forces are transmitted to the moving jaw.

In crushers of this kind, the hydraulic pressure developed during crushing strokes of the plunger and ram varies from instant to instant according, among other conditions, to the nature and amount of the material being crushed between the jaws; and the forces transmitted to the jaw vary in proportion. An object of this invention is to utilize that varying hydraulic pressure to transmit that varying thrust hydraulically between the mating bearing surfaces involved and, to the extent that thrust is transmitted by liquid pressure in the running, or other clearances between these mating surfaces, to minimize or eliminate thrust transmission by actual contact between these surfaces and so to minimize or eliminate wear arising from metal to metal contact.

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

The single figure is a sectional elevation of means in accordance with this invention for transmitting thrust from ram to jaw in a hydraulically operated jaw crusher.

Referring to the drawing, the jaw crusher elements illustrated comprise a fixed jaw **1**, a swing or moving jaw **2** pivotally mounted on an overhead shaft **3**, a ram **4** for applying movement to the moving jaw, a ram cylinder **5** in which the ram **4** is reciprocally mounted, and a reciprocating plunger **6** having communication with the ram chamber **7** through opening **9** for developing fluid pressure therein.

In accordance with the invention, a thrust link **8** is provided to transmit thrust from the ram to the jaw. The thrust link **8** is interposed between the ram and a portion **13** of the moving jaw and thrust is transmitted therein wholly or in part by liquid pressure developed in the ram cylinder.

A bearing structure **14** between the thrust link and the ram comprises a convex surface **15** in a socket **16** in the ram and an opposed contacting flat surface **17** on the end of the thrust link. A clearance space **18** is thus provided between the ram and thrust link and, in order to reduce the force transmitted mechanically between the surfaces **15** and **17**, the clearance **18** is connected to the ram cylinder by a passage **19** in the ram. Leakage from the clearance between the opposing surfaces **15** and **17**, through which the thrust of the ram is transmitted, is prevented by a suitable sealing device such as the O ring **20**.

A forward or leftward thrust is therefore developed on surface **17** by the hydraulic pressure transmitted from the ram cylinder to the said flat face **17**; and an equal backward or rightward thrust force is exerted on the convex surface **18** of the ram **4**.

The total leftward thrust developed on ram **4** from the oil pressure created by plunger **6** is equal to the unit pressure multiplied by the vertical cross section of cylinder **5**. This total thrust is transmitted to the thrust link **8** mostly by hydraulic pressure, but is, in part, transmitted mechanically by direct contact between the convex surface **15** of the ram and the flat face **17** of the thrust link. The unit liquid pressure exerted towards the left on the face of the ram is the same as that in the same direction on the face **17** of the thrust link. The portion of the thrust transmitted hydraulically to the thrust link is that unit pressure multiplied by the area of the face **17**; and the portion transmitted mechanically is that unit pressure multiplied by the difference between the areas of these two faces. If the area of the face **17** were equal to that of the ram the whole thrust would be transmitted hydraulically to the thrust link. Should the areas of the two faces differ only to relatively slight extent, only a minor proportion of the total thrust would be transmitted mechanically, and the local stresses developed in the materials of ram and thrust link at their point of contact would be correspondingly low.

It will be appreciated that the to-and-fro movement of the thrust link is nearly straight-line in the direction of its axis and that its angular movement relative to the ram is very small indeed. Thus, the thrust bearing structure **14** described is quite suitable.

It will also be apparent that the relative movement of the thrust link in relation to the moving jaw will be quite appreciable and thus a somewhat different bearing structure **21** is provided at such end of the thrust link.

Bearing structure **21**, as shown, comprises a convex, spherical surface **22** on the jaw portion **13** and a closely mating opposed concave spherical surface **23** on the end of the thrust link. A recess **24** in the surface **23** constitutes a space or clearance of appreciable width in the axial direction; and this space is connected through a passage **25** in the thrust link to the space **18** and thence to the ram cylinder. A restriction, or hydraulic resistance, **26**, which may be a screw loosely fitting in a tapped hole **27** at the end of the passage **25** controls the flow of liquid through that passage.

The diameter of the recess **24** may be greater or less than the diameter of the ram. In the figure the recess diameter is indicated as being slightly greater than that of the ram; and in such case it will be evident that if the mating surfaces **22** and **23** were held in absolute contact no flow could take place between them and through the channel **25** and the hydraulic resistance **26**. No pressure drop between the ram cylinder and the recess **24** would, therefore, occur; and the full pressure existing in the ram cylinder would be transmitted to the recess and would be exerted on the opposing surfaces **22** and **23**.

The diameter of this recess being greater than that of the ram there would, however, be a net force tending to separate the mating surfaces **22** and **23**. These would, therefore, move slightly apart; and flow of oil through the slight clearance between them and through the hydraulic resistance **26** would take place. A pressure drop would, therefore, occur at that resistance, the amount of which would depend on the rate of flow through it. The amount of the separation of the closely mating surfaces **22** and **23** would depend on the same rate. It follows, therefore, that the more-or-less uniform liquid pressure in the relatively wide clearance constituted by the recess **24** and the mean-pressure in the film of oil flowing through the slight running clearance between the closely mating surfaces must so adjust themselves that the total force transmitted hydraulically between the opposing surfaces of the bearing, to the jaw will be equal to the thrust transmitted from the ram through the thrust link.

Any proportion of the total thrust may, of course, be carried by the hydraulic pressures in the film of oil escaping through the running clearance between the closely mating surfaces; and all of it would be so carried if, in a

bearing of adequate outer diameter, the opposing surfaces were closely mated throughout.

The flow of hydraulic oil of ordinary viscosity needed to keep the bearing surfaces **22** and **23** out of actual contact is very slight and is under the control of the restriction **26**.

The thrust link may be enclosed in a dust seal **28** of oil-resistant rubber or like material, such seal extending loosely between the moving jaw and the ram cylinder.

It will be apparent that the surfaces **22** and **23** may be cylindrical rather than spherical. However, spherical bearing surfaces have the advantage that they are inherently self-adjusting to transverse and torsional movements of the jaw.

I claim:

1. In a jaw crusher having a swing jaw, a ram cylinder, a ram for moving said jaw reciprocally mounted in said cylinder, and a reciprocating plunger for developing liquid pressure in said ram cylinder to actuate said ram, thrust-transmitting means interposed between said ram and said jaw and having opposing surfaces defining a bearing, said opposing surfaces being separated to provide a space therebetween, and means for supplying liquid under pressure developed by said plunger to said space whereby force exerted through said thrust-transmitting means to said jaw is applied through said liquid under pressure in said space.

2. Thrust transmitting means as defined in claim 1, said space having restricted hydraulic communication with said ram, the area of each of said opposing surfaces being not in excess of the cross-sectional area of said ram, and including a bearing comprising surfaces in direct contact with each other for transmission towards said jaw any proportion of thrust not transmitted by hydraulic pressure exerted on said opposing surfaces.

3. Thrust transmitting means as defined in claim 1, wherein the area of each of said opposing surfaces exceeds the cross-sectional area of the ram, said opposing surfaces having outer parts mating closely with each other, said space having a hydraulic connection with said ram comprising a passage and a resistance in said passage through which reduction occurs in the pressure of liquid flowing to said clearance.

4. Thrust transmitting means as defined in claim 3, said closely mating surfaces being spherical.

5. In a jaw crusher having a moving jaw, a ram for moving said jaw, and a reciprocating plunger for developing liquid pressure to actuate said ram, thrust transmitting means comprising a thrust link interposed between said ram and said jaw, said thrust link and jaw having opposing surfaces defining a bearing, said opposing surfaces having a clearance therebetween, and means for supplying liquid under pressure developed by said plunger to said clearance whereby force exerted through said thrust link to said jaw is applied through said liquid under pressure in said clearance.

6. Thrust transmitting means as defined in claim 5, the area of each of said opposing surfaces exceeding the cross-sectional area of said ram, said opposing surfaces being of closely mating form, said thrust link having a passage therein constituting said means for supplying liquid under pressure to said clearance, said passage having a restriction therein to reduce the pressure of liquid flowing through said passage to the clearance between said opposing surfaces.

7. In a jaw crusher having a moving jaw, a ram for moving said jaw, and a reciprocating plunger for developing liquid pressure to actuate said ram, thrust transmitting means comprising a thrust link interposed between said ram and said jaw, said thrust link and jaw having opposing surfaces defining a bearing, said opposing surfaces being separated to provide a space therebetween, and means for supplying liquid under pressure developed by said plunger to said space whereby force exerted through said thrust link to said jaw is applied through said liquid under pressure in said space.

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