ANTIROTATION DEVICE FOR A
GYRATORY CRUSHER

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Filed: Aug. 7, 1974
Appl. No.: 495,344

U.S. Cl. ........................................... 241/208; 241/216
Int. Cl. ........................................... B02C 2/06
Field of Search ................................... 241/207–216

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ABSTRACT
Apparatus for limiting the rotation of the head of a roller bearing type gyratory crusher. The crusher includes a frame having a bowl and a head cooperable therewith during crushing action. An eccentric is rotatably mounted on the frame and a head is mounted on the eccentric with roller bearings between the eccentric and the head. When the crusher is operating empty the frictional drag on the bearings will cause the head to rotate with the eccentric. During crushing operations, this frictional drag is overcome by the material in the crusher and the crushing forces will tend to rotate the head in a direction opposite to the rotational direction of the eccentric. Apparatus is provided for reducing the speed of rotation of the head in the direction of the rotation of the eccentric while permitting free rotation of the head in the other direction. This apparatus includes a ring gear fixed to the head, an inner gear rotatably mounted on the frame or main shaft extension and a one-way clutch connecting the inner gear to the frame. The inner gear has at least one less tooth than the ring gear. In the direction of rotation of the eccentric, the inner gear is fixed to the frame, and the ring gear and thus the head rotate about the inner gear. The ratio of number of gear teeth on the inner gear to the number of teeth on the ring gear causes the head to rotate at a lower speed than the eccentric. In the other direction of rotation, the inner gear is free to rotate about the main shaft extension, and thus the head is freely rotatable relative to the frame and the eccentric.

15 Claims, 4 Drawing Figures
3,908,915

ANTIHATATION DEVICE FOR A GYRATORY CRUSHER

BACKGROUND OF THE INVENTION

This invention relates to gyratory crushers of the roller bearing type and in particular to apparatus for use with such crushers for reducing the speed of rotation of the crusher head in the direction in which the eccentric is driven while permitting free rotation of the head in the other direction.

Gyratory crushers employing roller bearings include a rotary means or eccentric rotatably mounted on a main shaft of the crusher. A crushing head is mounted by means of roller bearings on the eccentric and at an angle to the axis of the main shaft and crusher frame. Due to frictional drag on the roller bearings supporting the head, when the eccentric is rotated at high speed, the head will tend to rotate with the eccentric so long as no material is in the crushing chamber. This high rotation of the head is undesirable because when stone is supplied to the crushing chamber the initial stone will tend to be thrown out of the crushing chamber. The stone supplied to the crushing chamber will cause the head to suddenly stop. This sudden stopping of the head will produce high loads on the bearings. Once material is being crushed, the crushing forces on the head will tend to rotate the head in the direction opposite to the rotational direction of the eccentric. This rotation is not harmful as it is usually quite slow.

Prior to the present invention, apparatus for preventing rotation of the head of a roller bearing crusher was known. One such apparatus provides a brake connected to the head for preventing rotation of the head relative to the rotary means in both directions. Such an apparatus will operate efficiently for overcoming the frictional drag of the bearings, but a continued force in the other direction due to crushing action will result in high loads on the brake and eventual failure.

Another known prior apparatus includes a one-way clutch-brake combination which permits free rotation of the head in one direction, i.e., the direction opposite to the direction of rotation of the eccentric, while preventing rotation of the crushing head in the same direction as the eccentric. This prior apparatus works well and accomplishes the function of preventing rotation in one direction and permitting free rotation in the other direction as desired. This apparatus has the disadvantage however that it is complicated in the number of mechanisms employed and the potential wear on the mechanisms.

A further prior arrangement employs a brake which is connected to the head which is spring biased so that sufficient forces are provided to overcome the frictional drag of the bearings in the one direction of rotation but insufficient force is provided to overcome the forces produced by the crushing operation in the other direction. This arrangement has the disadvantage that it will be in need of constant adjustment as the frictional material wears due to slippage in the direction of rotation when crushing operations occur.

By the present invention apparatus is provided which permits a limited amount of rotation of the head with the eccentric and permits free rotation of the head relative to the eccentric in the other direction of rotation. The present apparatus permits the head to rotate in the one direction, i.e., with the eccentric at a substantially reduced speed. Although the head is rotating a limited amount, this slow speed of rotation will not cause rocks to fly out of the crusher, and when the rotation is stopped it will not produce high loads on the bearings. In the other direction of rotation, the head is freely rotatable relative to the frame and the eccentric.

SUMMARY

It is therefore the principal object of this invention to provide apparatus for use with a gyratory crusher which limits the speed of rotation of the head in one direction and permits free rotation of the head in the other direction.

It is another object of this invention to provide an antirotation device for use with a gyratory crusher which will compensate for the sudden loads on the apparatus.

In general the foregoing and other objects will be carried out by providing a rock crusher of the type having a bowl and a head cooperative with the bowl in crushing operation, rotary means rotatable in a first direction for causing said head to gyrate relative to said bowl, means mounting said head for rotary movement relative to said rotary means; and means operatively connected to said head for limiting the speed of rotation of said head in said first direction and permitting free rotation of said head in the other direction.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in connection with the annexed drawings wherein:

FIG. 1, is a sectional view of a roller-bearing gyratory crusher in accordance with the present invention;

FIG. 2, is a section view taken on the line 2—2 of FIG. 3 of the antirotation device of the present invention;

FIG. 3 is a sectional view taken on the line 3—3 of FIG. 2 looking in the direction of the arrows;

FIG. 4, is a sectional view of the antirotation device taken on the line 4—4 of FIG. 2, looking in the direction of the arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown a gyratory crusher including a frame generally indicated at 1. The frame includes a lower shell 2 and an upper shell 3 which includes a bowl 4 having mantle material 5 secured thereto by means of suitable bolts 6. Suitable adjusting means generally indicated at 7 are provided for adjusting the position of the bowl, and apparatus generally indicated at 8 is provided for tramp iron relief. This apparatus is well known in the art and need not be discussed in detail. The frame also includes a main shaft 9 extending up through the center of the bowl 4. The main shaft 9 is on the longitudinal axis 10 of the crusher which corresponds with the longitudinal axis of the bowl 4.

A rotary means or eccentric generally indicated at 11 is rotatably mounted on the main shaft 9 and the frame 1 by means of roller bearings 12 and 13, respectively. Means 15 are provided for rotating the rotary means 11 and include a counter-shaft 16 mounted in the frame 1.
by means of bearings 17. The shaft 16 includes a pinion 18 which engages with a gear 19 secured to the rotary means 11. A motor (not shown) is operatively connected to the shaft for driving the eccentric 11.

A crushing head indicated at 20 is rotatably mounted on the eccentric 11 by means of bearings 22 and 23. The head 20 is provided with mantle material 25 which cooperates with mantle material 5 for crushing rock in the crushing chamber 26. The head 20 has an axis 28 which is at an angle to the axis 10 of the frame 1 and main shaft 9. The axis 28 and the axis 9 intersect at an apex 30 located above the crusher head 20. Suitable seals 32 are provided for preventing oil which lubricates bearings 23, 28, 13 and 12 from entering the material discharge area 35 and prevent dust from the crushed rock from entering the bearings.

As is conventional with crushers, in operation the means for rotating the rotary means 11 drives the rotary means 11 which causes the head 20 to gyrate relative to the bowl 4. This gyration serves to crush rock supplied to the crushing chamber 26 from a suitable feeder (not shown). The crushed rock enters the chamber 35 where it is discharged to a conveyor belt.

When the rotary means 11 is being driven at a high speed of rotation, there is no material in the crushing chamber 26, the frictional drag on the bearings 22 and 23 will result in the head 20 rotating with the eccentric 11. When the material is in the crushing chamber 26, the frictional load on the bearings 22 and 23 will be overcome, and the rotation of the head 20 in the same direction as the eccentric 11 will be stopped. The crushing action of the head and the stone in the crushing chamber 26 will tend to rotate the head 20 in a direction opposite to the rotational direction of the eccentric 11.

As stated herein before, the high speed rotation of the head 20 is not desirable, but the low speed rotation of the head will have substantially no effect. By the present invention, apparatus has been provided which substantially reduces the speed of rotation of the head 20 in the direction of rotation which is the same as the eccentric 11, but will permit free rotation of the head in a direction opposite to the rotary direction of the eccentric 11. This apparatus is generally indicated at 40 and shown diagrammatically in FIG. 1. For the details of this apparatus reference should be had to FIGS. 2 to 4.

Referring to FIG. 2, the main shaft 9 includes an extension 28 having an upper end 41 which passes up through the eccentric 11 and the head 20 (FIG. 1). The head 20, is provided with a first gear means 42 which is a ring gear having internal beveled teeth 43. The gear 42 is secured by means of suitable fasteners 44 to the head 20. A second gear means 45 is rotatably mounted on the main shaft extension 41 by means of suitable bearings 46. This inner gear includes external beveled teeth 47.

A one-way clutch generally indicated at 50 is mounted on and fixed to the main shaft extension 41. This clutch includes a plurality of spring biased pawls 51 mounted on a plate 52 which is secured to the extension 41 by means of suitable fasteners 53. The pawls 51 are secured to the plate 52 by means of fasteners 54 and a ring member 55. The inner gear 45 includes a flange 48 having ratchet teeth 49 therein which are adapted to be engaged by the pawls 51. Thus, the one-way clutch 50 will permit rotation of the second gear means 45 relative to the extension 41 in one direction of rotation by the pawls 51 sliding over the ratchet teeth 49. In the other direction of rotation, the pawls 51 engage the ratchet teeth 49 to prevent the second gear means 45 from rotating relative to the frame 41.

As shown in FIG. 4, the second gear means 45 has at least one less tooth than the first gear means 42. In the embodiment shown, the gear 42 has 17 teeth and the gear 45 has 16 teeth. The gear teeth 43 and 47 are inclined at an angle such that an upwardly extending line along the gear teeth 43 and 47 will pass through the apex 30 which is the intersection of the axis 10 of the crusher and the main shaft 9 and the axis 28 of the head 20. This arrangement permits the head 20 and the ring gear 42 to gyrate relative to the internal gear 45 while permitting engagement of the gear teeth 43 and 47.

In order to seal the antirotation mechanism 40, a cap 58 may be provided over the entire mechanism. In addition, the cap permits lubrication to be supplied to the antirotation apparatus 40 without being sprayed into the crushing chamber 26.

The antirotation apparatus of the present invention operates as will now be described. If the crusher is stopped and no material is supplied to the crushing chamber 26, frictional drag on the bearings 22 and 23 will result in the rotary motion of the eccentric 11 being transferred to the head 20, and the head 20 will rotate in a first direction which is the same as the rotational direction of the eccentric 11. This rotation will rotate the gear 42 with the head 20. The gear 42 will engage the teeth 47 of the gear 45 causing the gear 45 to rotate in a clockwise direction as viewed in FIG. 3. This rotation of the second gear 45 will cause the ratchet teeth 49 to engage the pawls 51. The pawls 51 will prevent further rotation of the gear 45. Thus, the gear 45 is now fixed to the extension 41 and thus the frame 1. The head 20 and the gear 42 will continue to rotate but will rotate around the gear 45. Because there are fewer teeth in the gear 45 than in the gear 42, the speed of rotation of the head 20 will be reduced in accordance with the ratio of the number of gear teeth in the internal gear 45 to the number of teeth in the first gear means 42. In the embodiment shown there are 16 teeth in the second gear means 45 and 17 teeth in the gear 42. With this gear ratio, and with the gear 45 fixed to the frame 1 through the one-way clutch 50, the gear 42 and head 20 will rotate around the second gear means 45 and thus the frame 1 at a speed of one seventeenth of the speed of rotation of the rotary means 11.

If for any reason the gear 42 is caused to rotate at a speed slower than one seventeenth of the speed of rotation of the rotary means 11, or if the rotation of the gear 42 is stopped, or if the gear 42 is caused to rotate in the direction opposite of the rotation of the means 11, the effect of the gear ratio is to cause the second gear means 45 to rotate in a direction opposite to the direction of rotation of the means 11. In this direction the gear 45 is not held by the one-way clutch 50 as the pawls 51 slide over the ratchet teeth 49. Thus the gear 45 is freely rotatable relative to the extension 41 and the frame 1. When the crusher is supplied with material to the crushing chamber 26 the rotation of the head 20 in the same direction as the eccentric 11 will stop due to the external forces overcoming the frictional drag of bearings 22 and 23. In fact, it has been observed in practice that the crushing action will tend to rotate the head 20 slowly in the other direction. Rotation of the
head 20 in a direction counterclockwise as viewed in FIG. 3 will cause the second gear means 45 to rotate in a counterclockwise direction. Since the gear 45 is not held by the clutch but is freely rotatable in this direction, it is obvious that the head 20 will be free to rotate in this direction.

Occasionally, during crushing operations, a piece of tramp is encountered which will cause a sudden rotation of the head 20 in either direction. Obviously, a sudden rotation in a counterclockwise direction as viewed in FIG. 3 will have no effect because the head 20 is freely rotatable in that direction. Since during crushing operation the head 20 is rotating counterclockwise most of the time, sudden rotation in the clockwise direction will occur less frequently, at lower speed, and with shorter duration than counterclockwise rotation. For reasons previously explained, the head 20 is also free to rotate at any speed which does not exceed one-seventeenth of the rotational speed of the eccentric 11 in the first direction, or clockwise as viewed in FIG. 3. Should a sudden clockwise rotation of the head 20 occur which is faster than one-seventeenth of the speed of eccentric 11, the duration of such a rotation is expected to be limited. The spacing of paws 51 is sufficient to permit limited rotation of the gear 45 in the clockwise direction, before paws 51 fully engage the ratchet 49 and thereby prevent further rotation of the gear 45. It is believed that this limited rotation will compensate for all shock loads which may be encountered. If desired, some means may be provided for absorbing greater shock loads such as a spring biased brake means. However, it is not believed that such an arrangement is necessary.

From the foregoing it should be apparent that the objects of the present invention have been accomplished. Apparatus has been provided which permits the head to rotate at a limited speed in the direction of rotation of the rotary means 11. This limited speed of rotation will not be harmful because it is not fast enough to cause rocks to be thrown out of the crushing chamber when they are first supplied thereto and is slow enough so that a sudden stopping of the head 20 will not create excessive loads on the bearings 22 and 23. The apparatus of the present invention permits free rotation of the head relative to the frame and the eccentric 11 in the other direction. This will compensate for crushing forces tending to rotate the head. Shock loads tending to rotate the head in either direction will be compensated for by the present invention.

The invention has been described as a preferred embodiment. It is intended, however, that the invention be limited solely by that which is within the scope of the appended claims.

I claim:

1. In a rock crusher of the type having a bowl and a head operatively connected to the bowl in crushing operation; rotary means rotatable in a first direction for causing said head to gyrate relative to said bowl; means mounting said head for rotary movement relative to said rotary means; and means operatively connected to said head for limiting the speed of rotation of said head in said first direction and permitting free rotation of said head in the other direction.

2. In a rock crusher according to claim 1 wherein said means operatively connected to said head includes first gear means fixed to said head, one-way clutch means fixed to said crusher, and second gear means operatively connected to said clutch and said first gear means for permitting said head to rotate with said rotary means in said first direction at a speed less than the speed of rotation of said rotary means and permitting free rotation of said head in the other direction.

3. In a rock crusher according to claim 2, said first gear means having at least one more tooth than said second gear means.

4. In a rock crusher according to claim 3 wherein said one-way clutch means includes a ratchet and pawl mechanism with the pawl connected to said crusher and the ratchet forming part of said second gear means.

5. In a rock crusher according to claim 2 wherein said first gear means is a ring gear having internal teeth and said second gear means has external teeth, and said first gear means has at least one more tooth than said second gear means.

6. A rock crusher comprising: a frame; a bowl mounted on said frame; a head cooperable with said bowl in a crushing operation; rotary means rotatably mounted on said frame; means for rotating said rotary means in a first direction for causing said head to gyrate relative to said bowl; means mounting said head for rotary movement relative to said rotary means; and means operatively connected to said head and said frame for permitting said head to rotate in said first direction at a speed less than the speed of rotation of said rotary means when said head is rotating in the first direction and for permitting free rotation of said head in the other direction.

7. A rock crusher according to claim 6 wherein said means operatively connected to said head and said frame includes a one-way clutch for permitting free rotation of said head in the other direction.

8. A rock crusher according to claim 7 wherein said means operatively connected to said head and said frame includes a one-way clutch mounted on said frame.

9. A rock crusher according to claim 7 wherein said means operatively connected to said head and said frame further includes first gear means mounted on said head and second gear means rotatably mounted on said frame and said one-way clutch is operatively connected between said frame and said second gear means whereby said second gear means is fixed against rotation relative to said frame in said first direction and free to rotate relative to said frame in said other direction.

10. A rock crusher according to claim 7 wherein said first gear means has at least one more tooth than said second gear means.

11. A rock crusher according to claim 6 wherein said means operatively connected to said head and said frame includes first gear means mounted on said head and second gear means mounted on said frame and said head is free to rotate relative to said frame in the other direction.

12. A rock crusher according to claim 11, wherein said head is mounted on said rotary means so that its axis is at an angle to the axis of said frame, and the axis of said frame and the axis of said head intersect at an apex above said head, and said first gear means is a ring gear having beveled internal teeth and second gear means has beveled external teeth and a line extending...
upwardly from said first and second gear means along said beveled teeth passes through said apex.

13. A rock crusher according to claim 12 wherein said first gear means has at least one more tooth than said second gear means.

14. A rock crusher according to claim 12 wherein said means operatively connected to said head and said frame further includes a one-way clutch fixed to said frame and operatively connected to said second gear means whereby said second gear means is fixed against rotation relative to said frame in said first direction and free to rotate relative to said frame in said other direction.

15. A rock crusher according to claim 14 wherein said first gear means has at least one more tooth than said second gear means.

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