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Hightower

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[54] **HAMMER MILL ROTOR ASSEMBLY**

[75] Inventor: **William G. Hightower,** Upland, Calif.

[73] Assignee: **Ferromet, Inc.,** Etiwanda, Calif.

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[51] **Int. Cl.** **B02c 3/04,** B02c 13/28

[58] **Field of Search** 241/191, 194, 195, 197, 241/193

[56] **References Cited**

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Primary Examiner—Roy Lake
Assistant Examiner—E. F. Desmond
Attorney, Agent, or Firm—Christie, Parker & Hale

[57] **ABSTRACT**

In a hammer mill having a rotatable shaft with outwardly extending arms mounted to rotate with the shaft, swing hammers are pivotally secured to the outer ends of the arms and off the radial center line of the arms toward the direction of shaft rotation so that each hammer leads the adjacent portion of its respective arm to protect the arm from wear. A replaceable cap is disposed over the leading edge of the arm to further protect it from wear, and a replaceable head is mounted on each hammer so the head can be quickly replaced when worn to maintain hammer weight.

4 Claims, 2 Drawing Figures

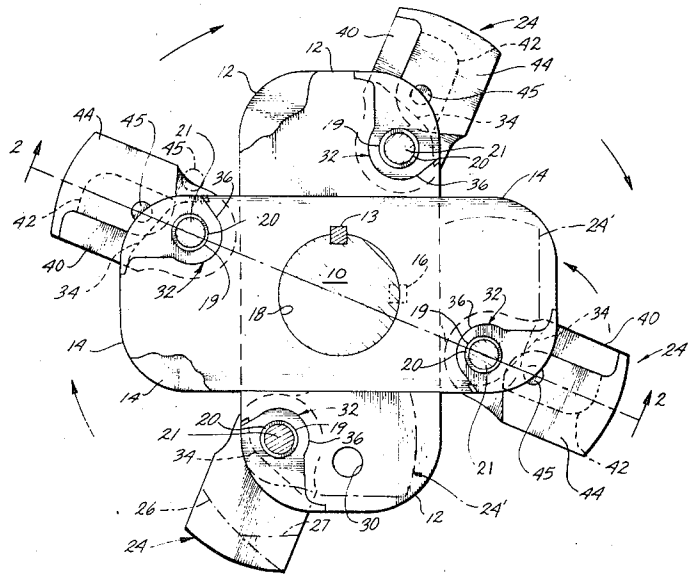


FIG. 1

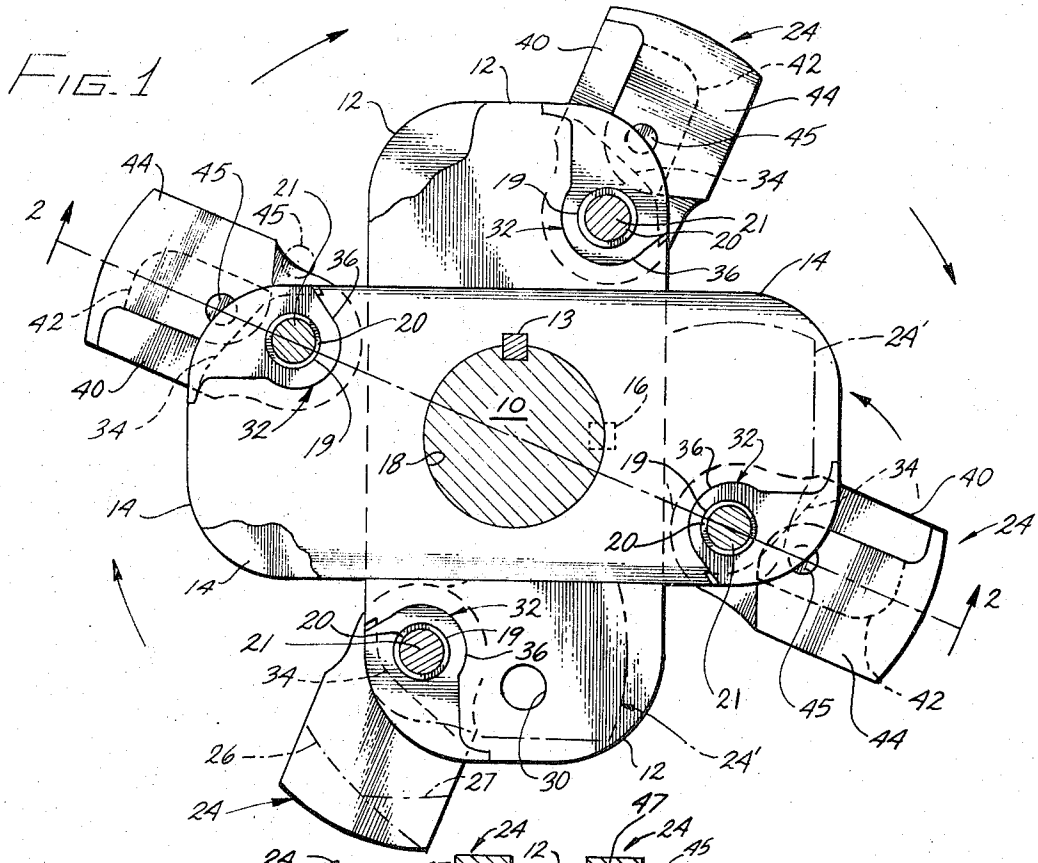
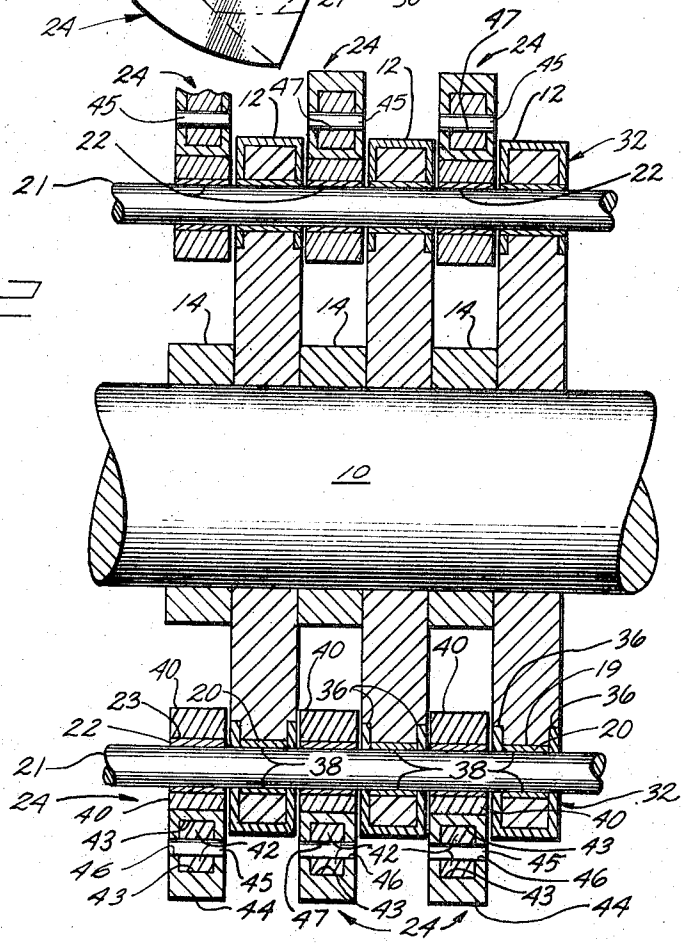

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FIG. 2


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HAMMER MILL ROTOR ASSEMBLY

FIELD OF THE INVENTION

This invention relates to hammer mills used to shred or disintegrate solid materials, and is especially suited to break up scrap automobiles, loose sheet metal, stoves, washing machines, and other appliances which include a substantial amount of steel or sheet metal.

DESCRIPTION OF THE PRIOR ART

Rotary hammer mills have been used for a number of years as disintegrators to crush and pulverize solid materials such as ore, coal, asphalt, bone, clam shells, and the like.

More recently, hammer mills have been used to shred scrap steel, particularly automobile bodies because shredded automobile scrap is superior to automobile scrap prepared by other methods, such as, compressing or shearing. The shredded scrap is superior because shredding produces smaller pieces and facilitates the separation of the ferrous material from the non-ferrous, which accounts for about 20 percent of a typical scrapped automobile. U.S. Pat. No. 3,545,690 discloses a hammer mill installation for shredding automobile bodies. As disclosed in that patent, the automobile bodies slide down a chute into a rotary hammer mill which includes a heavy shaft rotated at a relatively high speed by a powerful electric motor. Radially extending arms are secured to the shaft to rotate with it. The arms are usually arranged in two sets, the arms in one set being parallel to each other and mounted on the shaft at longitudinally spaced locations to be perpendicular to the arms in the second set. Arms in each set are located alternately along the shaft. Swing hammers are pivotally secured to the outer ends of the rotor arms to travel at high speed around a circular path known as the "hammer circle." Material fed into the mill enters the hammer circle where the fast moving hammers strike and disintegrate the material. The hammers are free to swing through more than 360° so if they strike material which does not immediately disintegrate, they can swing back out of the way. The free swinging hammers tend to continue to rotate about their respective pivot points after striking a refractory piece of scrap. This wastes power, makes the machine less effective, and subjects the ends of the rotor arms carrying the hammers to excessive wear because the arms, instead of the hammers, strike the material.

In the prior art hammer mill, the hammers are relatively small and located on the center line of the rotor arms, where they provide little or no protection for the arms, especially after the hammers lose weight by attrition and are more frequently knocked backward around the pivot point where they are secured to the arms. Thus, the more worn the hammers, the less effective the machine, and the faster the wear of the rotor arms. After an arm is sufficiently worn to threaten structural failure, the machine must be shut down, and the arm rebuilt. This is often done by welding a "hard facing" material on the leading edge and outer end of the arm until the arm is substantially restored to its original dimension. The hard facing material is expensive, and so is the labor required to apply it. The lost production during the shutdown of the machine also adds to the final cost of the product.

Machine efficiency is improved by replacing worn hammers, but in the prior art hammer mills, a hammer is replaced by withdrawing a retaining rod or pin which extends through collinear holes in the set of arms on which the worn hammer is mounted. This requires the removal and reinstallation of all hammers, whether they are worn or not. Consequently, worn hammers are often left in operation beyond the optimum because of the extra work involved in handling hammers which may not be worn. This not only reduces the effectiveness of the machine, but also accelerates rotor arm wear.

This invention overcomes the disadvantages of the prior art hammer mills by using much larger hammers, and mounting them off the radial center line of the rotors in the direction of shaft rotation. In operation, centrifugal force holds the large hammers extended out to a working position where they cover and protect the leading edges of the rotors. The greater mass of the hammers increases the disintegrating power of the equipment, and results in less swinging back of the hammers. The larger hammers are secured to the rotor arms so the hammers cannot swing freely. Instead, the backface of a recoiling hammer strikes an adjacent arm, and is not only prevented from rotating through more than about 120°, but is immediately bounced back into the working or disintegrating position. This makes the machine more effective, and reduces wear of the rotor arms. A replaceable shoe is disposed over the leading edge of each rotor arm to provide additional protection from random contact with disintegrated pieces within the hammer mill, and to protect the arm when the hammer may be momentarily driven away from the working position. When the shoe is sufficiently worn, it is quickly and easily replaced, thus eliminating the more expensive hard facing process previously used to rebuild a worn rotor arm.

This invention also provides a replaceable head which can be removably secured to and removed from the leading portion of a hammer body without having to disturb any other hammer in the machine. This facilitates quick replacement of only the worn hammer or hammers, so machine efficiency stays high and labor is minimized.

The improved rotor assembly of this invention has reduced operating, labor, and material costs by about 62 percent compared to the hammer mill described in U.S. Pat. No. 3,545,690. The location of the larger hammers to protect the leading edges of the rotor arms has increased the shredding machine rotor life by at least 40 percent. The heavier hammers have also made the prior art shredding machine capable of producing about 25 percent more scrap in the same amount of time and using less electrical power than with the smaller hammers.

Thus, the improved rotor assembly of this invention enables the production of more tons of scrap per pound of weight loss of hammers and rotor arms. These results are obtained because the larger hammers are much heavier and do not swing as freely away from the work load, therefore cutting more material in the same motion than the smaller hammers, and at the same time protecting the leading edge of the rotor arms. Moreover, the larger hammers wear less because they soon become work hardened due to the impact of the work. Consequently, the larger hammers have a much longer

life than would be expected just from the increase in weight.

SUMMARY OF THE INVENTION

Briefly, this invention provides an improved rotor assembly for a hammer mill which has a rotatable shaft. The improvement includes an elongated rotor arm mounted on the shaft to extend radially from the shaft and rotate with it. The arm includes means for securing a swing hammer to the arm to pivot about an axis substantially parallel to the axis of shaft rotation. The pivot axis of the hammer is located off the radial center line of the arm towards the direction of shaft rotation. The hammer is secured to the arm to pivot about the pivot means, and be held by centrifugal force, when the shaft rotates, in a position where the hammer is ahead of the leading edge of the arm and thereby protects the arm during operation of the mill.

Preferably, a replaceable shoe is mounted on the leading edge of the rotor arm at its outer end to provide additional protection for the arm. The preferred form of the invention also includes a replaceable head mounted on the hammer so that when the head is worn it can be removed and replaced with a new head without removing the hammer from its pivot point, and without disturbing any other hammers in the mill.

DESCRIPTION OF THE DRAWING

FIG. 1 is a transverse sectional elevation taken perpendicular to the axis of shaft rotation of the preferred rotor assembly of this invention; and

FIG. 2 is a fragmentary view taken on line 2—2 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A horizontal rotatable shaft **10** mounted in a hammer mill (not shown), which may be of the conventional type disclosed in U.S. Pat. No. 3,545,690, carries a first set of radially extending arms **12** spaced at equal intervals longitudinally along the shaft and secured by a key **13** to rotate with the shaft. A second set of radially extending arms **14** are mounted on the shaft so that each arm in the second set is disposed between a pair of adjacent rotor arms in the first set. The arms in the second set are secured by a key **16** to the shaft so the arms rotate with the shaft. The arms in each set are parallel to each other, and are perpendicular to the arms in the other set. Each arm is a generally rectangular and rigid plate with a hole **18** in its center making a close fit around the shaft. The corners of the arms are slightly rounded.

As viewed in FIG. **1**, the shaft and rotor arms turn in a clockwise direction. A separate mounting hole **19** extends through each arm adjacent its leading edge, and is thus displaced from the radial center line of the arm toward the direction of shaft rotation, and located about one-third of the arm radius in from the outer end of the arm. The mounting holes in each set of arms are collinear, lined with a hardened bushing **20**, and receive a mounting rod or pin **21** which extends through mounting holes and through a hardened bushing **22** in a hole **23** in the inner end of a respective hammer **24** pivotally secured between adjacent arms in each set. Each hammer is generally bell-shaped as viewed in FIG. **1**, and extends a substantial distance beyond the adjacent ends of the respective set of arms to which it is mounted.

The hardened bushings in the rotor arms and the hammers extend the operating life of those components because the bushings help prevent "spreading" of the metal due to the force which is applied in substantially the same direction during the operation of the equipment. This is particularly true when manganese alloy is used for the hammers, because it tends to spread until it is sufficiently "work hardened."

When the shaft is turned at a relatively high speed, say 600 to 800 r.p.m., the hammers are held outwardly in the solid line positions shown in FIG. **1** with a strong centrifugal force which ordinarily makes them perform as though they were rigidly secured to the arms in the positions shown, and the tips of the hammers sweep at high speed through a circular path known as the "hammer circle." Material to be shredded is fed down a conventional chute (not shown) into the path of the swinging hammers. The typical prior art hammers weigh about 250 pounds each, but by mounting the hammers of this invention somewhat back from the ends of the rotor arms, the size of the hammers can be increased to where they weigh about 380 pounds each without changing the overall dimensions of conventional mills. This increase in hammer mass greatly improves the disintegrating power of the machine. However, if one of the hammers strikes a portion of scrap which resists immediate disintegration, the hammer is free to rotate backwards (counterclockwise about its pivot, as viewed in FIG. **1**) approximately 100° about its pivot point to the phantom line position **24'** shown for the hammer on the right side of FIG. **1.** The hammer does not swing back more than about 100° because its rear face strikes the edge of the arm **12** sandwiched between the pair of arms **14** which carry the hammer. Thus, the hammer is bounded back immediately into the working position instead of ineffectively rotating in a counterclockwise (as viewed in FIG. **1**) direction around its pivot point. Moreover, the hammers in their respective working positions are ahead of the forward and outer edges of the rotor arms so that those portions of the rotor arms are protected from substantial direct or initial contact with the material fed into the mill. If the hammers were free to rotate freely about their pivot points through 360°, the rotor arms would be subjected to substantial wear, which not only would result in inefficient shredding, but would also subject the arms to excessive wear, requiring early replacement or repair of the arms.

Eventually, the leading and outer end portion of each hammer is worn away. The shape of a worn "one-piece" hammer is indicated by phantom line **26** for the hammer shown at the bottom of FIG. **1.** The hammer can then be turned so that its previously trailing edge becomes its leading edge. The hammer is then operated until it has a shape indicated by the combined phantom lines **26** and **27.** Once the hammer reaches this condition, it is relatively short and does not track the "hammer circle." The hammer is then secured to the rotor by suitable rod or pin (not shown) passing through a hole **30** located on the radial center line of the rotor arm. Since a securing pin (not shown) passing through hole **30** would interfere with the partial rotation of hammers still mounted to pivot about holes **20,** worn hammers are not moved to the outer holes **30** until an entire set is available so that all hammers mounted on

the common ends on the arms in a set rotate about the same pivot axis. With the hammers mounted on the center line holes, the leading edges of the rotors are more exposed to impact with the material being shredded, and are therefore each protected by a separate replaceable U-shaped shoe **32**, which slips over the leading and outer edge of each rotor arm, which is cut away to the position shown by dotted line **34** in FIG. **1**. This dotted line is also the bottom of the shoe, which extends outwardly to make the leading portion of the arm substantially symmetrical with respect to the trailing portion. The shoe includes a pair of inwardly extending side walls **36** which make a close sliding fit against opposite faces of the arm, and which have collinear holes **38** to receive the hammer retaining pin **21**. Thus, each shoe is held snugly in place to protect the rotor and it can be removed when necessary and replaced with a new shoe. Such a replacement is considerably faster and much less expensive than the previous practice of building a worn rotor arm back up by welding on hard facing material. The shoe protects not only the leading edge of the rotor arm, but also the sides of the arm, which are sometimes subjected to abrasion from small pieces of hard material sifting in between the side of a hammer and an adjacent face of the rotor arm.

When a hammer is to be replaced as described above, the retaining pin **21** passing through the collinear holes in the set of arms to which the hammer is secured must be withdrawn to the point where the hammer is free to be removed. If the hammer is in the center of the set of arms, it may be necessary to remove several of the hammers to reach the one to be replaced. This is inconvenient and requires a great deal of work because the hammers may weigh anywhere from 200 to 400 lbs. each. This problem is avoided by the preferred hammer design of this invention as shown by the hammers on the right and left sides of FIG. **1**. The preferred hammer includes an inner or body portion **40** secured to the rotor arm by the retaining pin **21** as previously described. The body is approximately one-half the mass of a conventional one-piece hammer, but includes a forwardly extending boss **42** formed integrally with the central and lower portion of the body to extend into a matching cavity **43** in a hammer head **44** secured to the front face of the hammer body. The adjacent surfaces of the body and head match in area and shape so the two pieces fit together to form what appears to be an integral weight. The two pieces are held together by a pin **45** which extends through a pair of collinear holes **46** in the hammer head, and a bore **47** in the tongue of the hammer body. The pin **45** is substantially parallel to the axis of shaft rotation and is located so that when the shaft is rotated and the hammers are held in their operative positions, the pin **45** is prevented from moving longitudinally by the adjacent rotor arms to which the hammer is secured. After the head of the hammer is sufficiently worn to require replacement, the machine is stopped, and the hammer is rotated about its pivot in the direction of the shaft rotation to the position shown in phantom line for the hammer on the left side of FIG. **1** so that the pin **45** is no longer restrained from longitudinal movement. The pin is then removed so the worn hammer head can be replaced by a new one without having to disturb any of the other hammers. This has the advantage of being faster and easier because only the hammer being replaced need be handled, and the replacement part is substantially lighter than the entire hammer. Moreover, the discarded worn hammer head is substantially smaller than the conventional discarded whole hammer, and thus results in less waste.

I claim:

1. In a hammer mill having a rotatable shaft, the improvement comprising an elongated rotor arm mounted on the shaft to extend radially from the shaft and rotate with it, a hammer disposed adjacent the outer end of the arm, means for securing the hammer to the arm so the hammer projects beyond the outer end of the arm and ahead of the leading edge of the arm when the shaft is rotated, the hammer including separate head and body portions which overlap in the direction of shaft rotation and each have collinear holes extending through them in the direction substantially parallel to the axis of shaft rotation, and a retaining pin extending through the collinear holes in the overlapping portions of the hammer head and body to secure them together, the pin being positioned so that when the shaft is rotated the pin is prevented from movement along its axis by the adjacent motor arms between which the hammer is secured, the location of the retaining pin with respect to the pivot point for the hammer being such that when the shaft does not rotate and the hammer is rotated about its pivot point, the pin moves clear of the rotor arms so it can be moved longitudinally to permit the hammer head to be removed from the hammer body.

2. A hammer mill having a rotatable shaft, an elongated rotor arm mounted on the shaft to extend radially from the shaft and rotate with it, a hammer mounted on the outer end of the arm, and a replaceable shoe secured over the leading edge of the rotor arm and its outer end.

3. Apparatus according to claim **2** in which the arm includes a hole extending in the same general direction as the shaft, and the shoe includes an inwardly extending portion with a hole collinear with the hole in the arm, and a retaining pin extending through the collinear holes to secure the shoe to the arm.

4. Apparatus according to claim **2** in which the shoe covers the leading edge and adjacent sides of the rotor arm at its outer end.

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