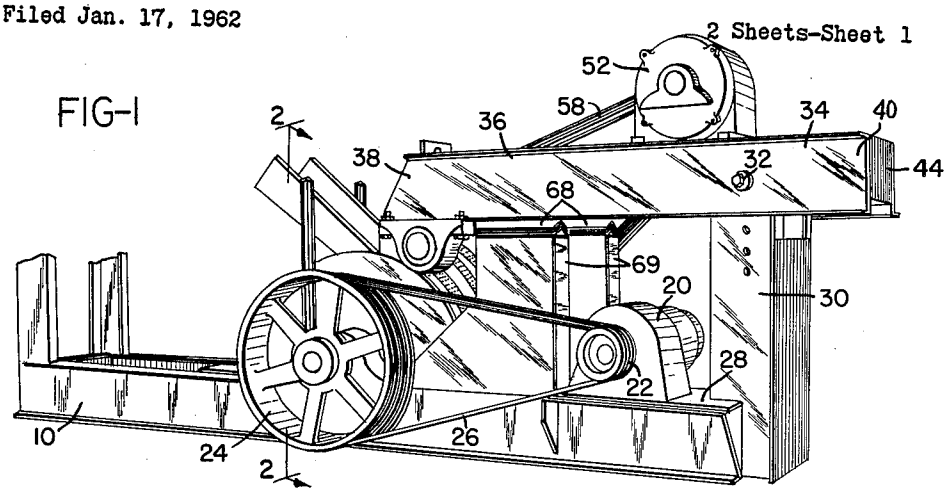
June 22, 1965 H. B. BIEHN 3,190,573

CRUSHER

Filed Jan. 17, 1962 2 Sheets-Sheet 1

FIG-1



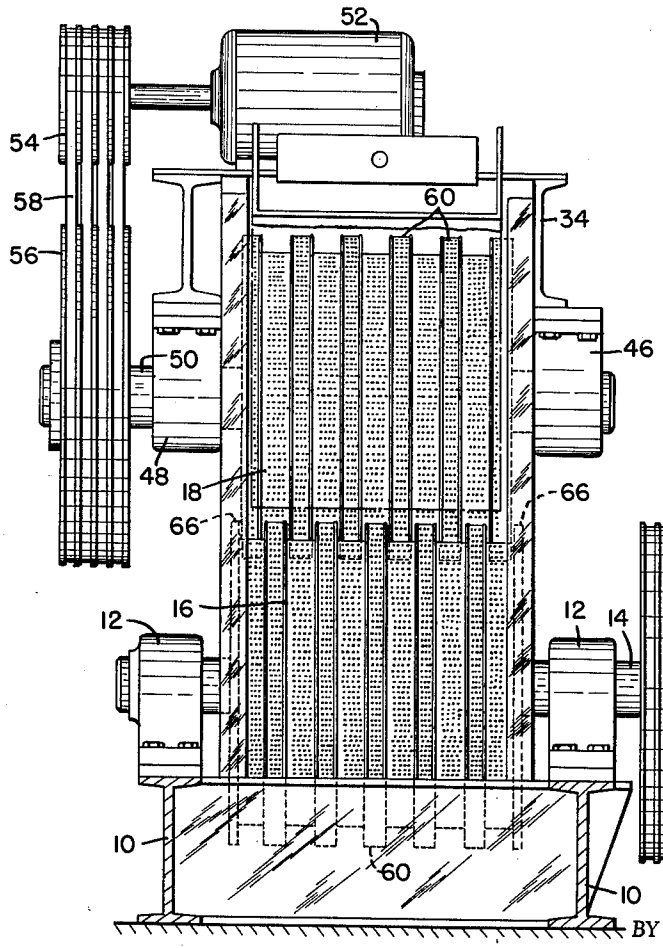


FIG-2

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FIG-3

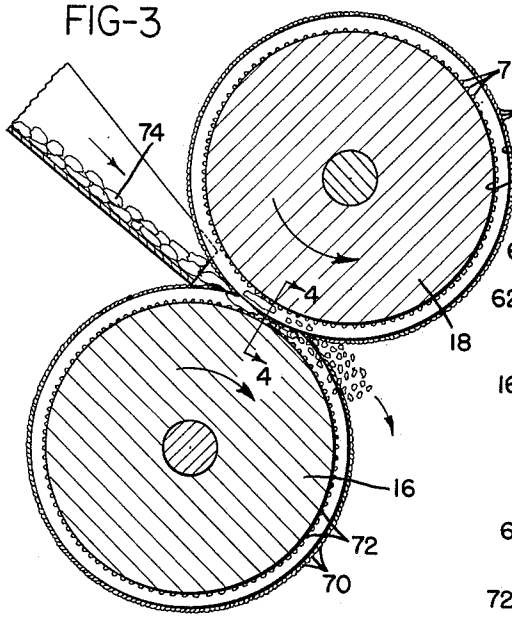
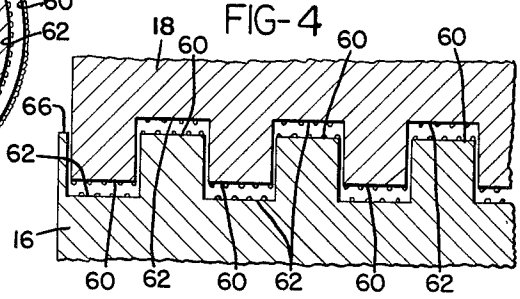


FIG-4



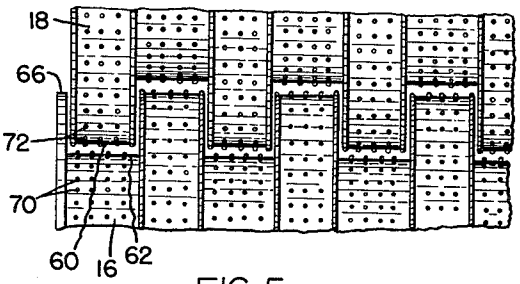


FIG-5

FIG-6

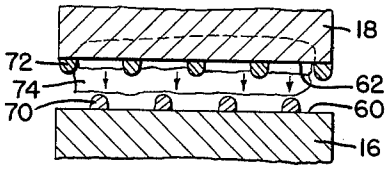


FIG-7

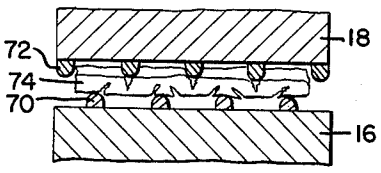


FIG-8

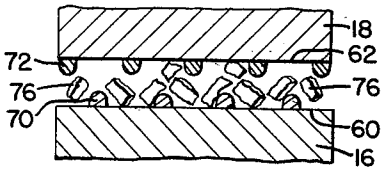
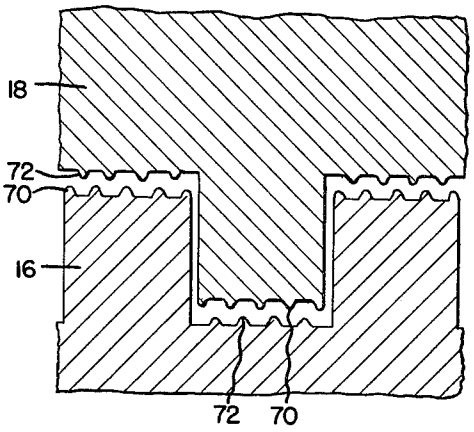


FIG-9



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3,190,573
CRUSHER

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11 Claims. (Cl. 241—236)

This invention relates to a crusher, such as may be used in reducing the size of particles of frangible material, including stone, clinker, slag, and the like, and is an improvement over the crusher of my co-pending application Serial No. 100,236, filed April 3, 1961, now Patent 3,064,907.

An object of the invention is to provide a crusher of improved construction, which will reduce the size of particles of material at high speed, with a minimum production of waste in the form of powder or dust.

Another object is to provide a high-capacity crusher operative at a fraction of the usual expense of power and maintenance costs.

A further object is to provide in a crusher improved structural features whereby a material fed between the crusher elements is fractured by bending and snapping, rather than mashed or ground, so that the reduced particles delivered by the machine are characterized by sharp and irregular natural cleavage facets virtually without the production of dust or powder.

Another object of the invention is to substantially reduce the power requirements of a crusher, and to ensure performance of the machine for unusually long periods of time without need for repairs, replacements, or adjustments, so that down-time is reduced to a practical minimum, with substantial savings of time, labor, and other expense.

Another object is the production of fragmentated materials of high quality and great uniformity, at a minimum of cost.

The foregoing and other objects are attained by the means described herein and illustrated upon the accompanying drawings, in which:

FIG. 1 is an elevational view in perspective, showing one side of the improved crusher.

FIG. 2 is a cross-sectional view taken on line 2—2 of FIG. 1, with the material feed chute omitted.

FIG. 3 is a fragmentary cross-section taken through the crusher rolls and feed chute, with crushable material shown fed to and delivered from the rolls.

FIG. 4 is an enlarged fragmentary cross-section through the crusher rolls, taken on line 4—4 of FIG. 3.

FIG. 5 is a fragmentary front elevation of the crusher rolls as viewed upon FIG. 2, the scale being enlarged.

FIG. 6 is a further enlarged view of the crusher rolls of FIG. 5, showing an initial stage of crushing of a rock fragment.

FIG. 7 is a view similar to FIG. 6, indicating an advanced stage of the crushing operation.

FIG. 8 is a view similar to FIG. 7, showing the final crushing stage and indicating the typical sharp edged characteristics of the individual particles produced by the subject device.

FIG. 9 is a fragmental, greatly enlarged cross-section through a pair of crushing rolls, indicating a modification of FIG. 4.

In the drawings, 10 indicates a pair of suitable bed members for the machine, which may be in the form of steel I-beams or the like arranged in spaced parallelism, and upon which the working parts of the machine are supported. The bed conveniently may be of welded construction and disposed substantially horizontally in practice.

At opposite sides thereof, the bed may support a pair of pillow blocks 12 providing heavy bearings for the rotary shaft 14 of the primary crusher roll 16, the shaft being driven in any suitable manner, as by means of an electric motor 20 driving the shaft by means of pulleys 22 and 24, and a belt arrangement 26. The motor may be mounted upon the bed of the machine preferably with the use of a stationary platform 28.

The roll 16 and pulley 24 are fixed upon shaft 14, and as viewed in FIG. 1, the direction of rotation of the shaft and its crusher roll 16 is clockwise.

At the rear end of bed 10 is fixedly mounted an upright post or standard 30, the upper end of which carries a transverse rock shaft 32. The rock shaft carries a tiltable beam or arm 34, movable in a vertical plane under certain conditions, as will be explained.

The beam or arm 34 may be constructed of suitable steel shapes, such as I-beams 36 joined in spaced substantial parallelism at their ends 38 and 40, as by means of struts or plates 44 welded or otherwise suitably secured to the ends of the beam members.

At the forward or working end of beam or arm 34 is fixedly mounted a pair of spaced parallel pillow blocks 46 and 48, providing bearings for a rotatable shaft 50 which supports between them the secondary crusher roll 18. An end of shaft 50 is driven in any suitable manner, as by means of an electric motor 52 driving the shaft through the agency of pulleys 54 and 56, and a belt arrangement 58. The direction of rotation of shaft 50 is opposite to the direction of rotation of shaft 14, as indicated upon FIG. 3.

Crusher roll 18 and pulley 56 are fixed upon shaft 50, and the driving motor 52 therefor may be mounted atop the beam or arm 34 to tilt therewith. Motor 52 may be positioned upon the beam at a location between rock shaft 32 and roll shaft 50, to add its weight to that end of the beam which carries roll 18.

Rolls 16 and 18 are to be driven in opposite directions, and with a peripheral speed differential of about ten percent, for a reason to be explained.

The working areas of crusher rolls 16 and 18 (FIGS. 4 and 5) carry a series of equally spaced parallel ribs 60 which extend peripherally from the mean face 62 of each roll, the ribs being staggered as to location upon the rolls so that the ribs of one roll interfit between those of the other roll, with a running clearance therebetween. The spaces between ribs present grooves or channels of the working face of a roll. The channels of one roller are wider than the interfitting ribs of the other roll, to provide the necessary clearance previously mentioned.

The bight, or the space 64 between the outer peripheral face of one roll rib and the base of a channel of the cooperative roll, is adjustable by reason of movements of beam 34 about its rock shaft 32. That is, shaft 50 and roll 18 may be bodily elevated or lowered to change the bight at 64 where the crushing action occurs.

Crusher roll 16 may be provided with end flanges 66 to close the endmost bights of the rolls.

The depth of the bight at 64 may be adjusted by limiting the tilting movement of beam end 38 toward the bed of the crusher. This may be accomplished by interposing shims 68 between the beam and the fixed stanchions 69 which support it, all as disclosed in the co-pending application aforesaid.

Attention is now directed to certain important characteristics of the working faces of the crusher rolls. Considering FIGS. 6, 7, and 8, the characters 60 and 62 may indicate, respectively, the ribs and the channels of crusher rolls 16 and 18, which constitute the working faces thereof. The working faces are provided with spaced stools, protuberances, or breaker humps 70 and 72, arranged in

staggered relationship upon the working faces so as to act upon a stone 74 to bend or snap it into pieces 76 as suggested by FIGS. 6, 7 and 8. It will be noted that the action here does not involve mashing or compressing of the stone, but instead, resorts to bending and snapping it to pieces.

The bending and snapping of the stone or material to be fragmentized are productive of a minimum of fines in the process. It results also in producing very sharp edges and points on the particles delivered by the rolls, this being an objective long sought but rarely accomplished to any appreciable degree in the operation of crushers or hammer mills.

It will be evident from a study of FIGS. 6, 7 and 8 that the bending action performed upon the material undergoing processing requires much less power than would be required to mash the material between the crusher rolls by pressure alone. Also, the bending and snapping action obviously will not produce unwanted dust and powder to the extent resulting from conventional mashing of the material under high pressure.

The protuberances or breaker humps 70, 72 may be formed upon the working faces of the rolls in various ways. In FIG. 9 is suggested the expedient of casting them integrally with the material of the rolls as the rolls are manufactured. In the remaining drawing figures is suggested the idea of forming the protuberances or humps by welds applied to the working faces, or by welding small steel slugs or pieces of metal onto the working surfaces.

In one satisfactory construction, the protuberances are about one-fourth inch in diameter, and extend from the working face of the roll a like distance, or less. They may be spaced apart on the roll face a distance of one inch, more or less.

It is highly desirable that the protuberances of one roll will not strike or align with those of the mating roll, but will instead project between those of the mating roll, as suggested by FIG. 6. In producing the rolls, therefore, the protuberances may best be arranged in straight rows peripherally of the working faces, as in FIG. 5, with all the protuberances of a row resting in a plane which is normal to the roll axis. Such a row of protuberances on one roll should fall approximately midway between adjacent rows of protuberances on the other roll, as clearly suggested by FIG. 5.

It has been found desirable as a means of increasing productivity of the crusher, to rotate one of the crusher rolls about ten percent faster than the other. This has the effect also of clearing the reduced particles from the roll channels immediately prior to discharge. By preference, the upper roll 18 is the roll driven at the higher peripheral speed. The rolls preferably are mounted with their shafts offset from a vertical plane, as suggested by FIG. 3 of the drawings.

It is to be understood that various modifications and changes may be made in the structural details of the apparatus, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed is:

1. A breaker for frangible material comprising in combination, a pair of rotatable rolls each having alternate peripheral ribs and channels, the ribs of one roll fitting into the channels of the other roll with a running side clearance, and said ribs and channels having working faces spaced apart for the passage of fragible material therebetween, cooperating pressure applying elements on and projecting from the working faces of the rolls, said elements on one roll being misaligned with the elements on the other roll, whereby is effected the bending and the clean snapping of the material into pieces as distinguished from mashing it under roll pressure, and means for feeding frangible material between the working faces of the rolls.

2. A breaker as set forth in claim 1, including means for rotating one of the rolls at a peripheral speed greater than that of the other roll.

3. A breaker for chunks of frangible material comprising in combination, a pair of rotatable rolls each having alternate circumferential peripheral ribs and channels, the ribs of one roll fitting into the channels of the other roll with a running side clearance, and said ribs and channels having working faces spaced apart for the passage of frangible material therebetween, and radially directed individual protuberances on the working face of at least one of the rolls and extending from such face a distance such as to relatively closely approach, without contacting, the working face of the opposing roll to apply point pressure at spaced locations on and effect bending and snapping of the frangible material chunks into smaller pieces as distinguished from mashing them under roll pressure, to produce sharp-edged pieces and minimize production of dust and powder.

4. A breaker for chunks of frangible material comprising in combination, a pair of relatively movable spaced pressure applying elements between which the chunks are fed, separate and individual spaced stools on one of said pressure applying elements for supporting the chunks at spaced areas of contact thereon, and means on the other of said pressure elements for applying concentrated point pressure to the chunks at points intermediate the supporting areas provided by said stools, for fracturing the chunks by bending as the pressure applying elements approach one another, and means operative upon the pressure applying elements for advancing the stools of one pressure applying element toward the stools of the other pressure applying element, a distance short of intermeshing of the stools of said elements.

5. The device as set forth in claim 4, wherein the movable spaced pressure applying elements are in the form of rolls rotatable relatively to one another.

6. A breaker for chunks of frangible material comprising in combination, a pair of rotatable rolls each having alternate peripheral ribs and channels, the ribs of one roll fitting into the channels of the other roll with a running side clearance, and said ribs and channels having working faces spaced apart for the passage of frangible material therebetween, a plurality of rows of spaced individual stools on and extending across the working faces of the rolls, the stools extending therefrom outwardly to provide spaced supports for the chunks of material fed between the rolls, the stools of the rows on one roll being staggered relative to those of the rows of the other roll, whereby upon rotation of the rolls the stools of one roll support a chunk of material at spaced points of contact while the stools of the other roll apply a bending force to the chunk at points intermediate the spaced points of contact provided by the stools of said one roll, to induce fracture of the chunk by bending.

7. A breaker for chunks of frangible material comprising in combination, a pair of rotatable rolls each having alternate peripheral ribs and channels, the ribs of one roll fitting into the channels of the other roll with a running side clearance, and said ribs and channels having working faces spaced apart for the passage of frangible material therebetween, a plurality of spaced individual stools on the working faces of the rolls, extending therefrom outwardly to provide spaced supports for the chunks of material fed between the rolls, the stools of one roll being staggered relative to those of the other roll, whereby upon rotation of the rolls the stools of one roll support a chunk of material at spaced points of contact while the stools of the other roll apply a bending force to the chunk at points intermediate the spaced points of contact provided by the stools of said one roll, to induce fracture of the chunk by bending, the combination including means for rotating the rolls at different peripheral speeds.

8. A breaker for chunks of frangible material comprising in combination, a pair of rotatable rolls each having alternate peripheral ribs and channels, the ribs of one

roll fitting into the channels of the other roll with a running side clearance, and said ribs and channels having working faces spaced apart for the passage of frangible material therebetween, a plurality of spaced individual stools on the working faces of the rolls, extending therefrom outwardly to provide spaced supports for the chunks of material fed between the rolls, the stools of one roll being staggered relative to those of the other roll, whereby upon rotation of the rolls the stools of one roll support a chunk of material at spaced points of contact while the stools of the other roll apply a bending force to the chunk at points intermediate the spaced points of contact provided by the stools of said one roll, to induce fracture of the chunk by bending, the combination including means for rotating the rolls at different peripheral speeds and in opposite directions of rotation.

9. A breaker for chunks of frangible material comprising in combination, a pair of rotatable rolls each having alternate peripheral ribs and channels, the ribs having peripheral working faces narrower than the channels, and a multiplicity of individual outwardly projecting spaced stools on and aligned in rows extending across the working face of each rib, the channels of the rolls each having a peripheral base area, and a multiplicity of individual outwardly projecting spaced stools on and aligned in rows extending across the base area of each roll channel, means supporting the rolls in substantial parallelism, with the ribs of one roll fitting into the channels of the other roll with a running side clearance, and the working faces of the ribs of each roll spaced from the base areas of the channels of each roll, the stools of the rows on the ribs being staggered relative to the stools of the rows in the channels, whereby upon rotation of the rolls in opposite directions, the stools of one roll support a chunk of material at spaced points of contact while the stools of the other roll apply a bending force to the chunk at points intermediate the spaced points of contact provided by the stools of said one roll, to induce fracture of the chunk by bending.

10. A breaker for chunks of frangible material comprising in combination, a pair of rotatable rolls each having alternate peripheral ribs and channels, the ribs having peripheral working faces narrower than the channels, and a multiplicity of individual outwardly projecting spaced stools on the working face of each rib, the channels of the rolls each having a peripheral base area, and a multiplicity of individual outwardly projecting spaced stools on the base area of each roll channel, means supporting the rolls in substantial parallelism, with the ribs of one roll fitting into the channels of the other roll with a running side clearance, and the working faces of the ribs of each roll spaced from the base areas of the

channels of each roll, the stools of the ribs being staggered relative to the stools of the channels, whereby upon rotation of the rolls in opposite directions, the stools of one roll support a chunk of material at spaced points of contact while the stools of the other roll apply a bending force to the chunk at points intermediate the spaced points of contact provided by the stools of said one roll, to induce fracture of the chunk by bending, the combination including means for rotating the rolls at different peripheral speeds.

11. A breaker for chunks of frangible material comprising in combination, a pair of rotatable rolls each having alternate peripheral ribs and channels, the ribs having peripheral working faces narrower than the channels, and a multiplicity of individual outwardly projecting spaced stools on the working face of each rib, the channels of the rolls each having a peripheral base area, and a multiplicity of individual outwardly projecting spaced stools on the base area of each roll channel, means supporting the rolls in substantial parallelism, with the ribs of one roll fitting into the channels of the other roll with a running side clearance, and the working faces of the rib of each roll spaced from the base areas of the channels of each roll, the stools of the ribs being staggered relative to the stools of the channels, whereby upon rotation of the rolls in opposite directions, the stools of one roll support a chunk of material at spaced points of contact while the stools of the other roll apply force to the chunk at points intermediate the spaced points of contact provided by the stools of said one roll, to induce fracture of the chunk by bending and snapping as distinguished from mashing under roll pressure, and means for rotating said rolls in opposite directions and at different peripheral speeds of rotation.

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