July 17, 1956 H. J. WOOCK 2,755,026

FEED FOR IMPACT CRUSHER

Filed Aug. 17, 1953 4 Sheets-Sheet 1

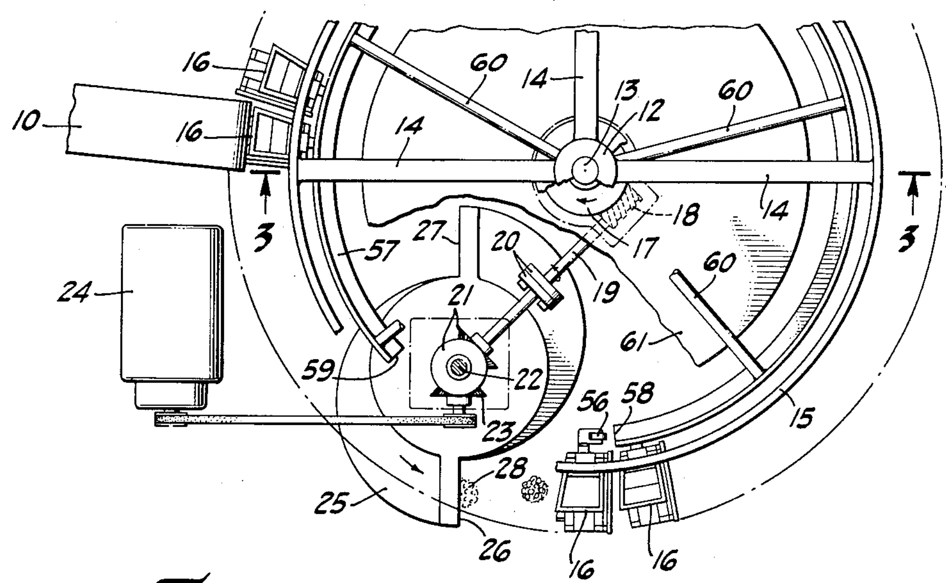

FIG. 1.

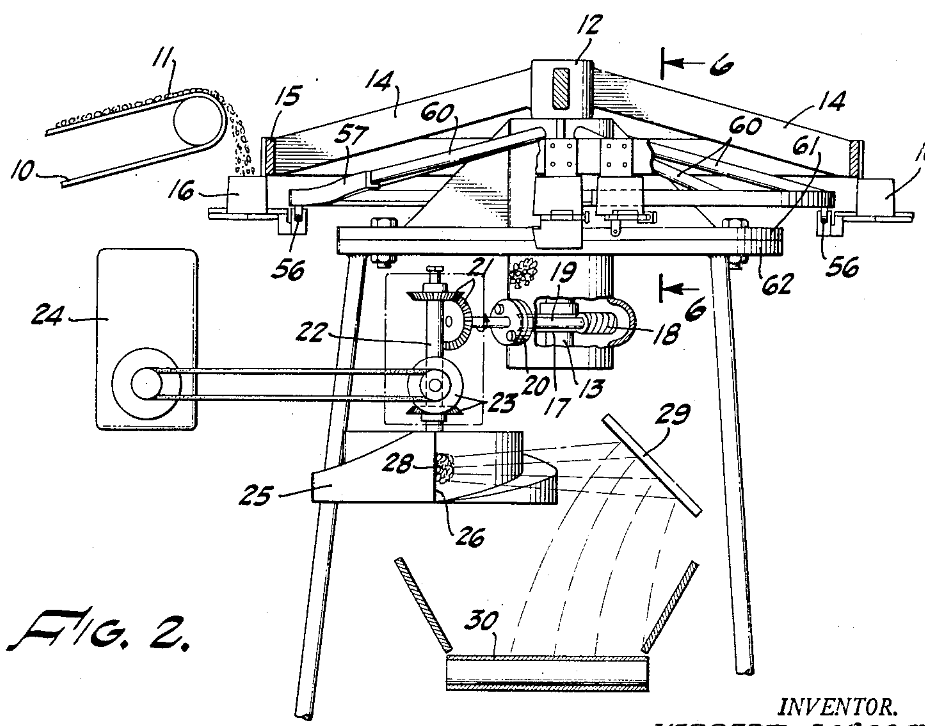

FIG. 2.

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July 17, 1956 H. J. WOOCK 2,755,026

FEED FOR IMPACT CRUSHER

Filed Aug. 17, 1953 4 Sheets-Sheet 2

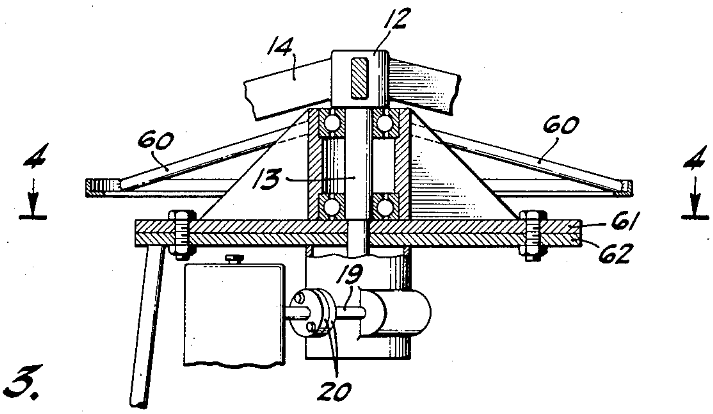

FIG. 3.

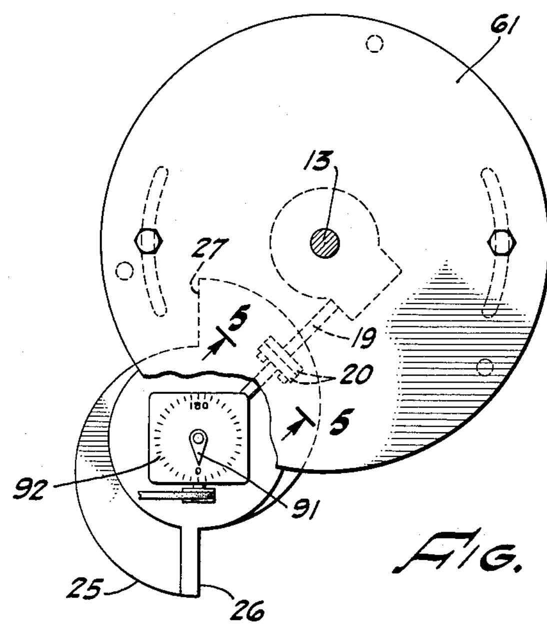

FIG. 4.

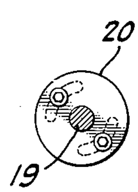

FIG. 5.

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FEED FOR IMPACT CRUSHER

Filed Aug. 17, 1953 4 Sheets-Sheet 3

FIG. 6.

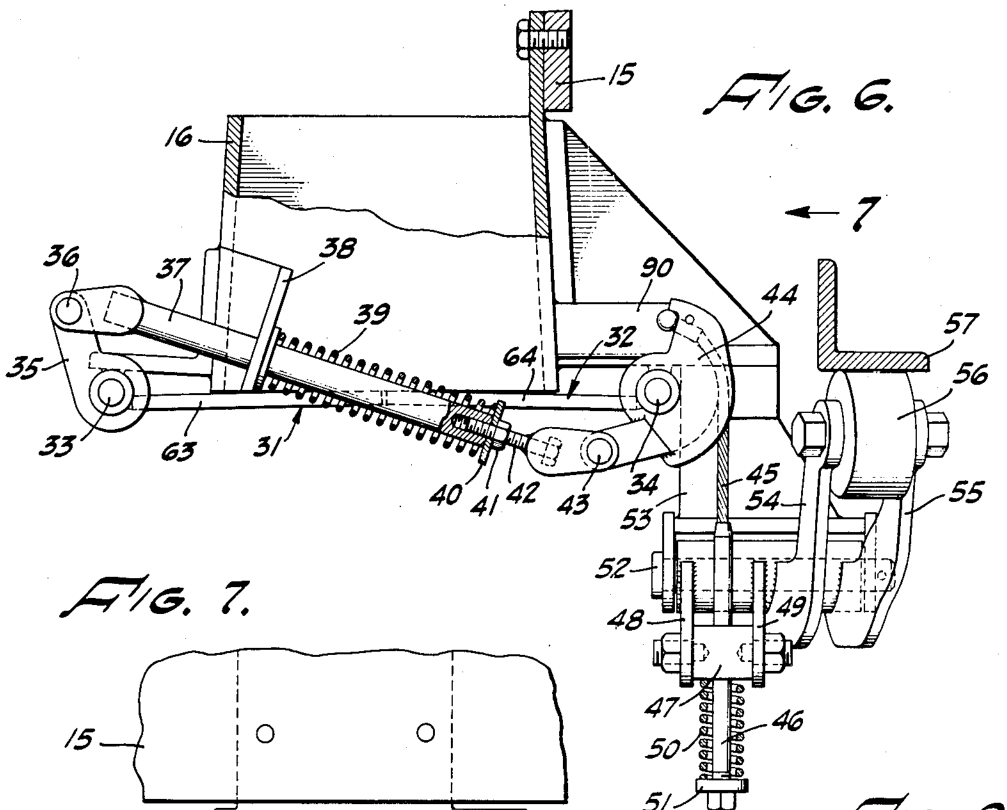


FIG. 7.

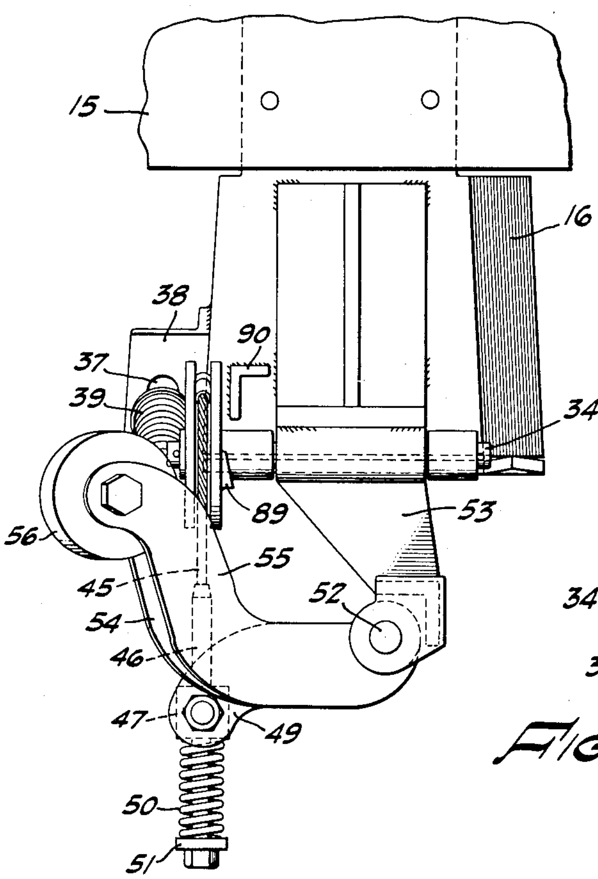
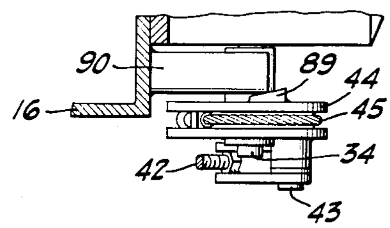


FIG. 9.



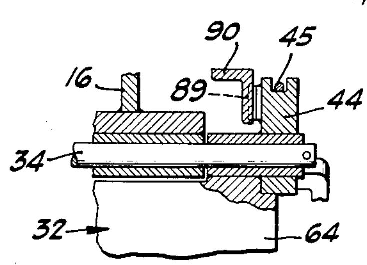


FIG. 10.

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July 17, 1956 — H. J. WOOCK — 2,755,026

FEED FOR IMPACT CRUSHER

Filed Aug. 17, 1953 — 4 Sheets-Sheet 4

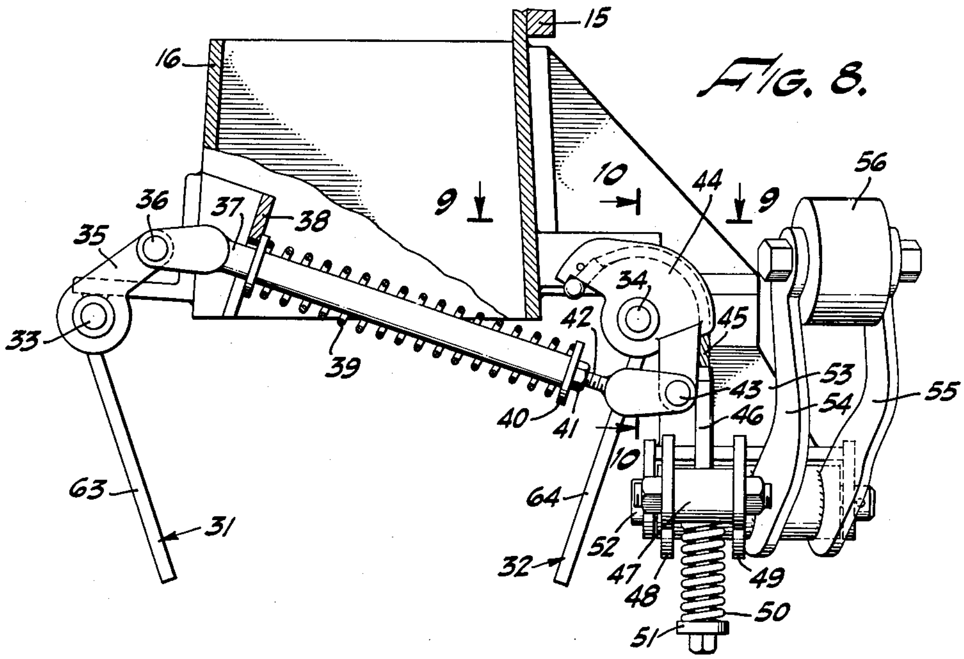

FIG. 8.

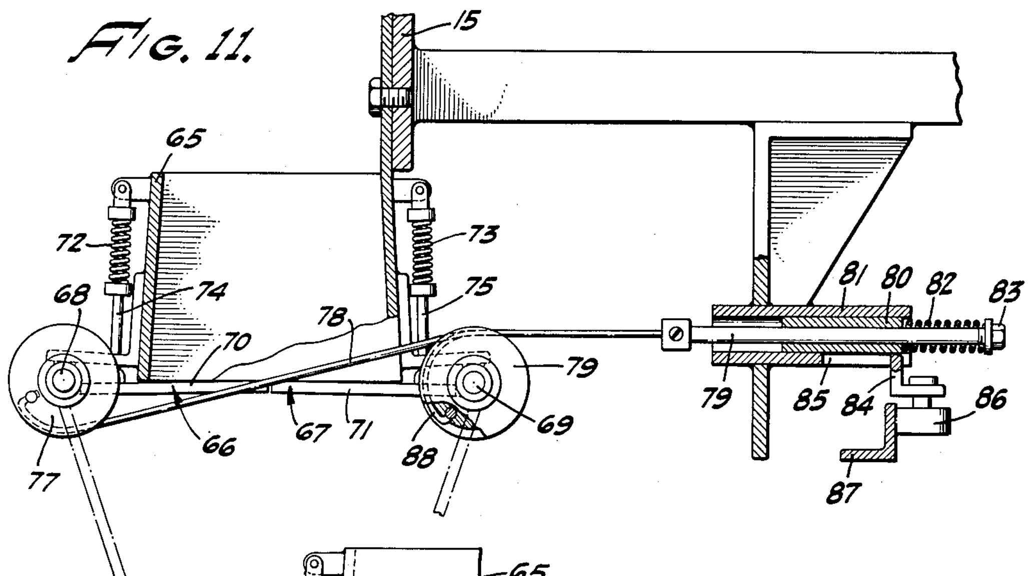

FIG. 11.

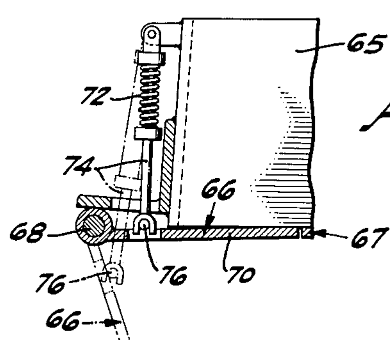

FIG. 12.

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2,755,026
Patented July 17, 1956

2,755,026

FEED FOR IMPACT CRUSHER

Herbert J. Woock, Alhambra, Calif.

Application August 17, 1953, Serial No. 374,703

14 Claims. (Cl. 241—186)

This invention relates to improvements in impact crushers, and particularly to the means and method for feeding the material to be crushed into the path of the striking faces on the hammers of the impact crusher. The application is a continuation-in-part of my copending application Serial No. 68,872, filed January 3, 1949 and now abandoned.

Explanatory of the present invention, impact crushers have heretofore been provided consisting of a rotor driven at a substantially constant speed on which there are one or more striking faces or hammers radially arranged with respect to the rotor. Heretofore, the material that is to be crushed has been fed into the path of the striking faces on the rotor in a continuous stream anticipating that as the rotor rotates the striking faces encounter and strike against successive increments of the stream. This form of construction is objectionable in that edges of the hammers in cutting off successive increments of the stream strike "foul blows." These foul blows cause the edges of the hammers to quickly wear and consequently the hammers must be replaced at relatively frequent intervals. The material struck with a foul blow also is given such a glancing blow that it is not adequately broken or crushed and the overall efficiency of the crusher is consequently reduced.

It has also been proposed heretofore to divide the stream of material fed to the crusher into separated segments or portions. Such divisions have been occasioned by positioning relatively narrow flights on an endless belt that is used to throw the material to be crushed into the path of the hammers on the rotor. In such instances, although the stream is actually divided into segments by the flights the separation between the segments is so small that for all practical purposes the material thrown into the path of the hammers may be regarded as being projected in the form of a continuous stream. Foul blows continue to occur. It has also been proposed to divide the material to be crushed into portions and consecutively release these portions for sliding down a chute or the equivalent into the path of the hammers on the crusher. Such sliding action or interference with the consecutive portions that are thus released causes these portions to string out and to some extent lose their individual or separated identities. The stringing out of the portions that are thus fed to the rotor causes the foul blows to continue to occur.

A primary object of the present invention is to provide a new method and apparatus for feeding material to be crushed into the path of the hammers on an impact crusher wherein the material to be crushed is first divided into separate or individual groups or clusters. These groups or clusters as formed have a cross-sectional size and shape which is smaller than the size and shape of the hammers on the rotor. They are consecutively released and are allowed to freely fall without interference into the path of the hammers and in timed relation thereto in such a manner that each group or cluster as it falls will retain its compact and clustered shape. The spacing between consecutive clusters as they enter the path of the hammers on the crusher is at least as great as the distance across a

cluster. In this manner, each group or cluster can be fed into the path of an oncoming hammer on the rotor so that its center will be positioned approximately opposite the center of the oncoming hammer at the instant of impact. As the cross-sectional size and shape of the cluster is smaller than the size and shape of the hammer foul blows can consequently be entirely eliminated. This avoids frequent replacement of the hammer shoes and causes the overall efficiency of the crusher to be materially increased. The increased efficiency is in some respect due to the fact that at the instant of impact those portions of the material to be crushed which are located near the center of the group or cluster are to some extent confined by other portions of the group or cluster which surround them. Consequently these portions due to their confinement and the inertia of surrounding portions are subject to a greater pulverization than if they were completely exposed at the instant of impact.

It is another object of the invention to provide a novel feeding means for grouping or clustering the material to be crushed and releasing the formed group or cluster in such a manner that its formed shape will not be disturbed. In this manner stringing out of the group or cluster and the creation of stragglers can be avoided.

Another object of the invention is to provide an impact crusher which, if the apparatus stops due to a power failure, will not become filled or clogged with uncrushed material. Also, to provide a construction wherein adjustments may be readily made to compensate for varying conditions.

With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Figure 1 is a top plan view, parts being broken away, showing an impact crusher embodying the present invention;

Fig. 2 is a view in side elevation, parts being broken away and shown in vertical section of the apparatus disclosed in Fig. 1;

Fig. 3 is a partial view in vertical section taken substantially upon the line **3—3** upon Fig. 1;

Fig. 4 is a horizontal section taken substantially upon the line **4—4** upon Fig. 3;

Fig. 5 is a vertical section taken substantially upon the line **5—5** upon Fig. 4;

Fig. 6 is a sectional view taken substantially upon the line **6—6** upon Fig. 2, to illustrate details of a bucket structure;

Fig. 7 is a partial view taken substantially in the direction of the arrow **7** upon Fig. 6;

Fig. 8 is a view similar to Fig. 6, but illustrating the doors of the bucket in open position;

Fig. 9 is a horizontal section taken substantially upon the line **9—9** upon Fig. 8;

Fig. 10 is a partial view in vertical section taken substantially upon the line **10—10** upon Fig. 8;

Fig. 11 is a partial view in vertical section illustrating an alternative form of bucket structure; and

Fig. 12 is a partial view in vertical section of a portion of the bucket structure shown in Fig. 11.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, rock or other material to be crushed may be fed to the apparatus disclosed in any suitable manner, such as for example on an endless belt **10**. The rock **11** shown thereon may be regarded as being supplied in the form of a continuous stream. Other means for feeding the rock to the apparatus may be employed, such as for example a chute leading from a hopper in which the rock is contained.

The endless belt **10** or equivalent feed means feeds the rock to a converter which divides the stream into individual groups or clusters. The converter may therefore be regarded as converting the continuous stream into separate, individual portions. The converter is shown as consisting of a wheel having a hub **12** mounted on a vertical shaft **13**. Radial arms or spokes **14** connect the hub with a felly **15** on which buckets or containers, generally indicated at **16**, are mounted. These buckets are consecutively carried beneath the stream of rock **11** that is discharged from the belt **10** so that each bucket will be filled or substantially filled with a portion of the rock to be crushed.

The vertical shaft **13** has a worm wheel **17** keyed thereto and this worm wheel meshes with a worm **18** that is on a shaft **19** having companion flanges **20**. These companion flanges divide the shaft **19** into two portions. They are bolted together with the bolts extending through arcuate slots in one of the companion flanges so that it is possible to rotatably adjust one portion of the shaft **19** relatively to the other on loosening the bolts. After such adjustment is made the bolts are tightened and the two parts of the shaft **19** are thereafter rigid with each other. The shaft **19** is connected by means of bevel gears **21** to the shaft **22** which is driven by bevel gears **23** from a source of power, such as a motor or engine indicated at **24**. On the shaft **22** there is a rotor **25** of an impact crusher. This rotor has one or more striking faces or hammers substantially radially arranged thereon. As illustrated, the rotor is shown as having two striking faces **26** and **27** arranged on diametrically opposite sides of the rotor. These striking faces during rotation of the rotor consecutively pass through a location of impact, such location being indicated by the reference character **28**. By means of the geared connection between the shaft **13** and the shaft **22**, the carrier of the converter is caused to rotate in timed relation to the rotor. The motor or engine **24** may be assumed to be operated at constant speed or substantially so, and consequently the rotor **25** will be so driven. However, for each position of the rotor the carrier or converter will have a correspondingly definite position or location. As the rotor is driven at constant speed the carrier of the converter will have a correspondingly definite position or location. As the rotor is driven at constant speed the carrier of the converter will likewise be similarly driven but the gear reduction afforded by the worm **18** and the worm wheel **17** causes the carrier to be rotated at a much lower speed than that of the rotor.

The rotor in the present construction preferably rotates about a vertical axis so that the striking faces **26** and **27** are disposed in vertical planes. These striking faces, upon impact with the material to be crushed, drive it against a striker plate **29** from which the crushed material may fall onto an endless conveyor belt **30** and conducted away thereby.

Referring to Figs. 6 to 10, inclusive, each bucket or container **16** is preferably a four-sided structure, opposed sides of which converge upwardly so that the sides may be regarded as upwardly and inwardly inclined. Each bucket or container is mounted on the felly **15** of the carrier, and has at the bottom thereof two opposed doors **31** and **32**. These doors are mounted for downward swinging movement about pivots **33** and **34**, respectively, which are disposed outwardly with relation to the inner and outer sides of the buckets or containers. The outer doors **31** have cranks **35** mounted thereon which are pivotally connected as at **36** to actuate rods **37** that loosely extend through brackets **38** on the sides of their respective buckets. A compression spring **39** is disposed about each rod **37** and is compressed between the bracket **38** and a washer or spring seat **40** retained on the end of the rod by a jamb nut **41** on a screw **42**. The screw **42** is, in turn, pivotally connected as at **43** to a quadrant **44** which is rigid with the door **32** and rotates therewith on the pivot **34**. The quadrant **44** has a small section of cable **45** secured thereto and trained thereover. This cable is in turn connected to a rod **46** that slidably extends through a crank pin **47** that is rotatably supported between crank arms **48** and **49**. A compression spring **50** is compressed between the crank pin **47** and a cap **51** on the rod **46**. This compression spring is considerably stiffer than the spring **39**. The crank arms **48** and **49** form part of a double crank that is pivotally mounted at **52** on a bracket **53** and this crank has a similar pair of crank arms **54** and **55** between which a roller **56** is rotatably mounted. This roller is engageable with the under side of a cam **57** in the form of an angle iron that extends around the major portion of the carrier. The cam terminates at **58**, see Fig. 1, which is located some distance in advance of the impact location **28**. The starting point of the cam indicated at **59** is located some distance behind the impact location **28** and as will be observed from Fig. 2, the starting point **59** is somewhat higher than the remainder and major portion of the cam. The cam **57** is supported by radial arms **60** which, in turn, are mounted on a plate **61** which is rotatably adjustable about the shaft **13** with relation to a supporting plate **62**. The plates **61** and **62** are connected by bolts which extend through arcuate slots in one of the plates so that the cam may be rotatably adjusted, and on tightening the bolts, the cam may be held in its adjusted position. This adjustment is for varying the location of the terminal **58** of the cam with relation to the impact location **28**.

It will be appreciated that as long as the roller **56** is depressed by the cam **57** that the crank pin **47** will be urged downwardly against the compression spring **50** and as this spring is a relatively stiff spring, the cable **45** will swing the quadrant **44** in a clockwise direction as shown in Fig. 6, and cause the two doors **31** and **32** to be held in horizontal or closed position across the bottom of the bucket against the action of the compression spring **39**. However, whenever the roller **56** passes from beneath the terminal **58** and is thus released by the cam, the spring **39** becomes effective to move the rod **37** from left to right as illustrated in Fig. 6, causing the doors to swing downwardly and to open in the manner illustrated in Fig. 8. As the carrier continues to rotate the roller **56** will ultimately pass beneath the starting end **59** and will be forced downwardly thereby. This causes the crank pin **47** to be swung downwardly and causes the cable **45** to return the quadrant **44** from the position shown in Fig. 8 to the position shown in Fig. 6, thus reclosing the doors before the buckets are re-filled with rock **11** from the belt **10**.

In the usual situation, the spring **50** performs no function but should some rock or other material become interposed between a closing door and the bottom edges of the buckets or containers, the spring **50** is yieldable and will compress even though a door may be held open by the interposed rock. Consequently, the spring **50** functions as a safety spring preventing the machine from destroying itself due to an interposed rock between a door and a bucket.

In feeding the rock to a rotary impact crusher in timed relation thereto, it is important that the group or cluster of rock formed within each bucket drop freely and without any interference which would tend to disturb the cluster or to string it out in a manner that would produce stragglers. It will be appreciated that as the walls of each bucket are upwardly and inwardly inclined that when the doors **31** and **32** are swung open the group or cluster of rock in the bucket will merely fall away from these inwardly inclined sides and will not slide or rub thereon, which sliding or rubbing would tend to disturb the positions of rocks that form the group or cluster. It is also important that the doors **31** and **32** swing downwardly with an acceleration greater than that of gravity. In other words, when the doors are opened these should swing downwardly well in advance of the falling rock so that, as the rock falls, it will not be merely spilled across the doors or engage the doors which action would modify or alter the shape of the cluster. Consequently, the pivots 33 and 34 are located outwardly with relation to the sides of the buckets so that the portions 63 and 64 of the doors 31 and 32 which lie immediately adjacent the side walls of the buckets will swing downwardly with an acceleration greater than that of gravity. Consequently, even these portions of the doors will descend or fall away ahead of the falling rock that is falling out of the bucket. The spring 39 is of sufficient strength to cause the doors to snap downwardly with the required acceleration whenever it is freed to do so by the passage of the roller 56 from beneath the terminal 58 of the cam. In this manner, each group or cluster of rock formed in each bucket can be consecutively released by the roller 56 associated with the bucket passing beneath the end of the cam, and when the cluster is released it falls freely without interference and without any sliding or spilling action. Consequently, the cluster or group of rock retains its initial size and shape that is given to it by the walls of the bucket, and except for the negligible resistance or impedance of the air through which the cluster falls, the cluster retains this shape throughout its entire fall toward the impact location 28.

In Fig. 11, an alternative form of construction is disclosed wherein each bucket or container 65 on the carrier has upwardly and inwardly inclined walls and is closed at its bottom by two doors 66 and 67. These doors are pivotally mounted for swinging movement about their respective pivots 68 and 69. These pivots are disposed outwardly with respect to the bottoms of the side walls so that the portions 70 and 71 which are located immediately adjacent the side walls, can be caused to swing downwardly and outwardly with an acceleration greater than that of gravity. The doors are urged to swing downwardly and outwardly about their respective pivots 68 and 69 by compression springs 72 and 73. These compression springs are seated at their tops on spring seats pivotally mounted on the walls of the buckets. The lower ends of the springs are seated on forks 74 and 75 which, in turn, are seated on bars 76 that extend across openings in the doors 66 and 67 outwardly of the walls of the buckets. These forks merely transmit the pressure exerted by the springs 72 and 73 to the doors 66 and 67, urging them to swing downwardly. A pulley 77 is rigidly connected to the door 66 so as to be movable therewith. This pulley has a section of cable 78 anchored thereto which is trained over one side of a double pulley 79 that is rigidly associated with the door 67. The cable 78 is adjustably connected to a slidable rod 79 that is slidable within a bushing 80 disposed in a journal 81. A compression spring 82 surrounds the rod and is seated at one end against the bushing 80. This spring has its other end seated on a washer and nut indicated at 83. On the bushing there is an arm 84 that is slidable in a slot 85 in the journal and this arm carries a roller 86 that engages the cam 87. The cam 87 corresponds to the cam 57. The other half of the double pulley 79 has a section of cable 88 secured thereto and trained thereover. This cable is also adjustably connected to the rod 79.

When the roller 86 passes off of the cam 87 the rod 79 is released so that the springs 72 and 73 are effective to swing their respective doors 66 and 67 downwardly and outwardly drawing the rod 79 and the bushing 80 and the spring 82 from right to left as viewed in Fig. 11. The rock contained in the bucket 65 can then drop therefrom, and due to the shape of bucket and the acceleration at which the doors are opened the rock will fall as a group or cluster without being drawn out or disturbed in such a manner as to produce stragglers. When the roller 86 re-engages the cam 87 the cam is effective to cause the roller to move the rod 79 from left to right as viewed in Fig. 11, thus forcibly closing the doors 66 and 67 against the action of the compression springs 72 and 73. The spring 82 like the spring 50 merely provides a yieldable means that can give in the event that either of the doors is held in open position or partially open position. The cam 87 is circumferentially adjustable with relation to the frame of the machine in the same manner as the cam 57 is adjustable as previously described.

It is desirable to limit the opening movement of the doors and to prevent rebound of the doors from their fully open positions. Rebound of the doors might interfere with falling group or cluster. To this end I have illustrated the quadrant 44 as having a wedge or cam surface 89, see Figs. 9 and 10, which will engage a friction plate 90 that may be mounted on the bucket. This cam or wedge surface engages the friction plate when the doors approach their fully open position. As the cam wedges itself against the friction plate it will frictionally hold the doors against rebound from their fully open positions. The pulleys 77 and 79 may be similarly equipped to prevent rebound of their respective doors.

The conditions under which crushers of this type are operated vary considerably. In fine crushing, such as crushing paint pigments, cement, and similar materials, the rotor of the impact crusher is rotated at relatively high speed. That is, a speed as high as 26,000 feet per minute. In coarser crushing, such as in producing road gravel the speed of rotation of the rotor may be considerably reduced and is usually in the neighborhood of 6000 to 7000 feet per minute.

A description of what takes place in the course of the operation of the mechanism herein disclosed can be understood from the following example. Usually in crushers of this type no attempt is made to have each hammer or striking face on the rotor strike the material to be crushed every time that it passes through the impact location 28. Frequently, only every third striking face passing through the impact location is required to make a hit. That is, after the striking face 26 has made a hit the striking faces 26 and 27 reverse their positions during the ensuing half revolution. They again reverse their positions and return to the position shown during the next half revolution, still without making a hit. The striking face 27 then makes another half revolution and strikes a group or cluster that has been fed to the rotor. In this manner the hits are evenly distributed between the striking faces 26 and 27 but two striking faces will have passed through the impact location 28 without hitting and the third striking face to reach the impact location makes a hit. Under these circumstances the hit ratio may be expressed as 1:2 in that there is one hit followed by two misses. The hit ratio may be increased to 1:4 or to 1:6. As an example of the apparatus herein disclosed the striking faces on the rotor may be in the form of squares whose dimensions are 10″ x 10″. Under such circumstances a suitable bucket size is a bucket whose width in a radial direction of the carrier is 5″ and whose height is 6″. The diameter of the rotor is 54″ and the total number of boxes or containers on the converter is 32. A 40″ drop occurs from each box to each hammer, such drop being measured in a vertical direction. The gear reduction between the worm 18 and the worm wheel 17 is 48:1. If the rotor is rotated at 450 R. P. M., nine hundred striking faces will pass per minute through the impact location 28. If the hit ratio is 1:2 this means that there will be three hundred hits per minute by the rotor which necessarily involves three hundred releases or openings of the boxes per minute. As there are thirty-two boxes equally spaced on the converter and the speed of rotation of the converter is 1/48 of the speed of rotation of the rotor it will be apparent that three hundred boxes per minute will pass the end of the cam and there will consequently be three hundred releases of individual groups or clusters per minute. Consequently the time between consecutive releases is ⅙ of a second.

The constantly rotating carrier of the converter causes the contents of each bucket or container to have an initial velocity in a horizontal direction at the instant of release. Consequently, each bucket load when released will continue laterally during its drop at a velocity equal to that of the peripheral velocity of the carrier. From the rotor speed of 450 R. P. M. and the gear reduction of 48:1, the speed of rotation of the carrier can be computed. If the mean diameter of the bucket loads on the carrier is 77½" the lateral distance that each group will travel during the drop of 40" can be computed. Under the circumstances given the lateral movement during the drop or projection at the mean diameter is 17.30". This means that with the striking face **26** disposed exactly at the impact location **28** the terminal **58** on the cam must be so adjusted that the release of the load in each bucket will take place at a point 17.30" in advance of the face **26**. The cam is consequently adjusted to cause a release of the buckets to take place at such a location.

The time required for the rock to drop a distance of 40" under the influence of gravity is .4552891 second and it is apparent that during this interval of time the rotor must rotate so that at the end of this interval one of its striking faces **26** or **27** is exactly at the impact location **28**. The time required for the rotor to go through a half revolution which is the time for one striking face such as the striking face **27**, to reach the impact location **28** from the position shown in Fig. 1 may be called an interval. It is the time required for the rotor to go through one-half of a revolution. It is apparent that with the rotor rotating at 450 R. P. M. each interval is of .066666 second in duration. Consequently, during the 40" drop which requires .4552891 second there will be .4552891 divided by .066666 or 6.829404 intervals during the drop. In other words, during the 40" drop the rotor will have been required to rotate 6.829404 half revolutions in the case of a two-hammer rotor. It is necessary however that the intervals terminate so that one or the other of the striking faces will be at the impact location **28** at the end of the 40" drop. Consequenly, the rotor is adjusted so that one of its striking faces will be displaced from the impact location **28**, a distance corresponding to .829404 of an interval. An interval in the case of a two-hammer rotor is 180°. Consequently the rotor is adjusted so that one of its striking faces is .829404 of 180° in advance of the impact location **28** and is then locked temporarily in such position. To facilitate such an adjustment a pointer **91** may be rigid with the rotor and rotatable therewith and a protractor **92** may be rigidly mounted on the machine so as to be traversed by the pointer and the proper location of the rotor obtained. The cam **57** is then adjusted so that its terminal end **58** will be spaced from the impact location a horizontal distance equal to the lateral movement or projection of the group or cluster that is occasioned by the velocity of the carrier. The companion flanges **20** are then loosened and the carrier is adjusted so that one of its buckets will just be in the act of opening at the proper distance from the impact location that will allow for the required lateral movement or projection. When this adjustment is made companion flanges **20** are tight. Consequently, for the given speed of operation a group or cluster will be released from the bucket and commence to fall, and during the fall it will proceed laterally from the bucket location toward the impact location **28**. During the fall the rotor will rotate its six complete intervals plus the fraction of the interval and a striking face on the rotor will reach the impact location simultaneously with the group or cluster. In the above illustration the seating of the rotor so that its striking face is a fraction of an interval in advance of the impact location locates the striking face 149.29° in advance of the position shown in Fig. 1.

It is apparent that if the speed of the entire machine is increased but other conditions remain the same, that several adjustmens must be made. The carrier will rotate faster and will impart a higher initial velocity in a horizontal direction to the released rock. Consequently, with an increased speed the terminal **58** of the cam must be disposed farther in advance of the impact location **28**. Also, with the increased speed of rotation of the rotor there will be more intervals or half revolutions of the rotor during the .4552891 second required to make the 40" drop. The rotor would have to be given a new setting in order that one of its striking faces will arrive at the impact location **28** at the same instant that a group or cluster arrives at this locaion. To facilitate comparison I have prepared the following comparison table for speeds of 450 to 500 R. P. M.

[51" diameter rotor; 32 box converter; 40" total drop (.4552891 sec. time required to drop 40").]

R. P. M.	Periphery in Ft. per Min.	Interval of Time	Intervals during Drop of 40"	Hits per Minute	Degrees At Which to Set Rotor	Projection At Mean Diameter
450	6,362	.066666	6+.829404	300.0	149.29	17.30
500	7,069	.060000	7+.588151	333.33	105.87	19.1435

At whatever speed the machine is operating under it is apparent that the group or cluster of rock must have a descending velocity sufficiently high that it may enter the path of the hammers on the rotor between consecutive hammers and without interference. In other words, the bottom of a group falling toward the rotor must fall between consecutive hammers at such a velocity that it will be positioned opposite the center of the oncoming hammer and without striking the preceding hammer. If the group has a 6" height and has an average velocity during its entrance into the rotor equal to that which the group possesses after it has fallen 36", the average velocity during the entrance can be determined and by multiplying this velocity by the duration of time for one interval or one-half revolution of the rotor the maximum drop permissible between consecutive hammers can be ascertained. Thus, under the conditions given the maximum drop during one interval when the rotor is rotating at 450 R. P. M. is 11.11". Similarly when the rotor is rotating at 500 R. P. M., the maximum drop permissible between consecutive hammers is only 10". These maximum drops permissible are more than adequate to obtain a full and complete entry of the group between consecutive hammers without interference. It is obvious, however, that as the speed of the rotor is increased the maximum drop permissible between consecutive hammers decreases and with higher speeds of rotation of the rotor a longer drop than 40" may be necessary in order to have each group possess adequate downward velocity to enter the rotor between consecutive hammers without interference. As will be noted from the drawing the upper side of the back of each striking face or hammer is cut away so that it does not afford any structure that would interfere with the entrance of a group of rock between consecutive hammers.

From the above-described construction it will be appreciated that the method and apparatus herein disclosed contemplates dividing the material to be crushed into separate individual groups or clusters. These are consecutively released in exact timed relationship to the hammers on the rotor so that they will enter between consecutive hammers without interference. Furthermore, each group or cluster having once been given shape by the boxes or containers is released in such a manner as to retain this defined shape during its fall. Rubbing or sliding action tha would tend to string out the group or cluster and thus produce stragglers is avoided. As each group reaches the impact location and is centered with relation to the oncoming hammer, a square blow can be struck by the oncoming hammer and due to the confined shape of the group or cluster, the efficiency of the impact in crushing is quite high. The avoidance of foul blows eliminates frequent replacement of the shoes on the hammers.

In the detailed illustration given it is apparent that as a release of a group occurs each ⅕ of a second and also seven intervals or half revolutions occur between the instant of release and the instant of impact that require .066666 each that there may be two or three clusters or groups simultaneously in flight through the 40" drop. These clusters being only 6" in height during the 40" drop are obviously spaced from each other by distances at least as great and usually greater than the height or vertical dimensions of the individual clusters.

In larger sizes of machines the rotor may have larger hammers and consequently larger clusters may be used. For example, if the hammer or striking face is 16" x 16" the cluster may have a cross-sectional dimension of 12" x 12".

Various changes may be made in the details of construction without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. The method of impact crushing which consists of first grouping or clustering all of the material to be crushed into spaced individual groups or clusters and then consecutively feeding the groups or clusters as such in free flight into the path of the striking faces of the rotor of an impact crusher in timed relation thereto and with such velocity and sufficiently spaced from each other that each entire group or cluster may enter the path of the striking faces as a cluster and have its center disposed approximately opposite the center of the oncoming striking face at the instant of impact thus avoiding straggling of the group and the consequent striking of foul blows between stragglers and the edges of the striking faces.

2. The method of impact crushing which consists of first grouping or clustering all of the material to be crushed into spaced individual groups or clusters and consecutively feeding the groups or clusters as such in free flight into the path of the striking faces of the rotor of an impact crusher in timed relation thereto and with such velocity and spaced from each other by distances at least as great as the distances across the individual clusters so that each entire group or cluster may enter the path of the striking faces as a cluster and have its center disposed approximately opposite the center of the oncoming striking face at the instant of impact thus avoiding straggling of the group and the consequent striking of foul blows between stragglers and the edges of the striking faces.

3. The method of impact crushing which consists of first grouping or clustering all of the material to be crushed into spaced individual groups or clusters and consecutively feeding the groups or clusters as such in flight into the path of the striking faces of the rotor of an impact crusher in timed relation thereto and without any interference tending to retard or string out the cluster and with such velocity and with such spacing therebetween that each entire cluster may enter the path of the striking faces as a cluster and have its center disposed approximately opposite the center of the oncoming striking face at the instant of impact thus avoiding straggling of the group and the consequent striking of foul blows between stragglers and the edges of the striking faces.

4. An impact crusher comprising a rotor having spaced striking faces thereon, means for rotating the rotor, and means for grouping all of the material to be crushed into spaced groups or clusters each of which is smaller in size than the sizes of the striking faces and consecutively feeding the groups or clusters in free flight into the path of the striking faces of the rotor in timed relation thereto and without interference tending to lengthen out the groups or clusters and at such velocity that each group or cluster may enter the path of the striking faces between consecutive faces and have its center positioned approximately opposite the center of an oncoming striking face at the instant of impact thus avoiding foul blows between the edges of the striking faces and stragglers of the group or cluster.

5. An impact crusher comprising a rotor having one or more striking faces thereon, means for rotating the rotor, and feeding means for feeding the material to be crushed in flight into the path of the rotor in the form of spaced clusters of such material, said feeding means being timed in relation to the rotation of the rotor and delivering consecutive clusters sufficiently spaced from each other so that each cluster will be afforded time to reach a position opposite approximately the center of the oncoming striking face upon being struck and the rotor will not have material fed thereagainst between striking faces.

6. In combination, a rotary impact crusher, means for driving the crusher at substantially constant speed, means for grouping the material to be crushed into groups the heights and widths of which are smaller than the heights and widths of the striking faces of the crusher, and means for consecutively releasing the group for free fall as groups into the path of the striking faces of the crusher and in timed relation thereto so that each group will fall as a compact group into the path of the striking faces of the crusher and be located at approximately the center of the oncoming striking face at the instant of impact.

7. In combination, a rotary impact crusher, means for driving the crusher at substantially constant speed, means for grouping the material to be crushed into groups the heights and widths of which are smaller than the heights and widths of the striking faces of the crusher, and means for consecutively releasing the group for free fall as groups into the path of the striking faces of the crusher and in timed relation thereto so that one or more striking faces may pass through the location of impact between consecutive releases and falls without striking foul blows against an oncoming group and each group will be positioned at about the center of an oncoming striking face at the instant of impact.

8. In combination, a rotary impact crusher, means for driving the crusher, means for grouping the material to be crushed into compact groups the height and width of which are smaller than the height and width of the striking faces of the crusher, and means for consecutively releasing the groups for free fall as compact groups into the path of the striking faces of the crusher in timed relation thereto and in such spaced relation to each other that each group may entirely enter the path of the striking faces and be positioned with its center opposite the approximate center of the oncoming striking face at the instant of impact and one or more succeeding striking faces on the crusher may pass through the location of impact before the succeeding group enters the path to be similarly positioned with respect to an oncoming striking face.

9. A crusher comprising a rotary impact crusher having a plurality of striking faces thereon adapted during location of the crusher to consectively pass a location of impact, a carrier, means for driving the carrier and impact crusher in timed relation to each other, a plurality of containers on the carrier adapted to receive portions of the material to be crushed, and means for consecutively opening the bottoms of the containers as they approach positions over the location of impact so that the contents of each container may drop freely as a closely compact group to the location of impact and be positioned with its center approximately opposite the center of the oncoming striking face at the instant of impact.

10. A crusher comprising a rotary impact crusher having a plurality of striking faces thereon adapted during location of the crusher to consecutively pass a location of impact, a carrier, means for driving the carrier and impact crusher in timed relation to each other, a plurality of containers on the carrier adapted to receive portions of the material to be crushed, each container having upward-

ly and inwardly inclined walls so that when the bottoms of the containers are suddenly opened the contents of each container may drop freely away from the walls without sliding or rubbing thereon and will fall as a closely confined group toward the location of impact, and means for suddenly opening the bottoms of the containers consecutively as they approach positions over the location of impact to empty the contents of the containers and allow the contents of the containers to freely fall to the location of impact as a closely confined group in timed relation to the impact crusher and have the center of each group positioned approximately opposite the center of the oncoming striking face at the instant of impact.

11. A crusher comprising a rotor having radially arranged striking faces thereon adapted to consecutively pass through a location of impact, a rotary carrier, means for rotating the carrier and rotor in timed relation to each other, a plurality of containers on the carrier each of which has a height and width less than the height and width of the striking faces of the rotor so that when the containers are filled with portions of material to be crushed each portion will have a cross-sectional size smaller than the size of the striking faces on the rotor, said containers having openable bottoms and upwardly and inwardly inclined side walls so that when the bottoms are suddenly opened the portions of material therein may fall freely from within the side walls without sliding or rubbing thereon and freely fall as a closely compact group toward the location of impact, means urging the bottoms of the containers to fall away from the bottoms of the side walls of the containers with an acceleration greater than that of gravity so that when the bottoms are open they will not impede or interfere with the free fall of each group, and means for temporarily holding the bottoms closed and then releasing them for opening by said means as the containers approach positions over the location of an impact whereby the contents of each container may be released for free fall to the location of impact and arrive at the location of impact in timed relation to the rotor and the striking face thereon.

12. An impact crusher comprising a rotor, a rotary carrier, means for driving the carrier and rotor in timed relation with each other, a plurality of containers on the carrier adapted to receive material to be crushed and grouped into individual compact groups, doors for the containers, a cam extending around the carrier, means by which the cam will normally hold the doors in closed position and consecutively release the doors to release the contents of the containers, said cam being rotatably adjustable with respect to the axis of rotation of the carrier whereby the exact point of release of the material from the containers may be varied.

13. A rotary crusher comprising a rotor having a plurality of striking faces thereon, a carrier, means for rotating the carrier in timed relationship to the rotor, means for adjusting the position of the carrier with relation to the striking faces on the rotor, a plurality of containers on the carrier adapted to receive material to be crushed, and means for releasing the material to be crushed consecutively from the containers for free fall toward the crusher.

14. A rotary crusher comprising a rotary having a plurality of striking faces thereon, a carrier, means for rotating the carrier in timed relationship to the rotor, means for adjusting the position of the carrier with relation to the striking faces on the rotor, a plurality of containers on the carrier adapted to receive material to be crushed, and means for releasing the material to be crushed consecutively from the containers for free fall toward the crusher, the last-mentioned means being rotatably adjustable whereby the exact point of release of each container with respect to the rotor may be varied.

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