May 5, 1970 B. L. PERDUE 3,510,076

IMPACT DEVICE

Original Filed Dec. 27, 1966 3 Sheets-Sheet 1

FIG. 1

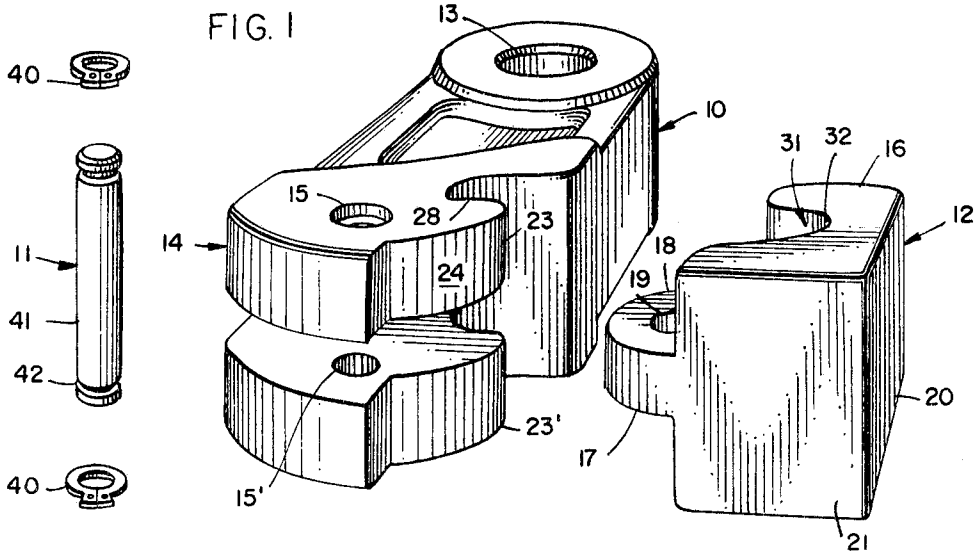


FIG. 2

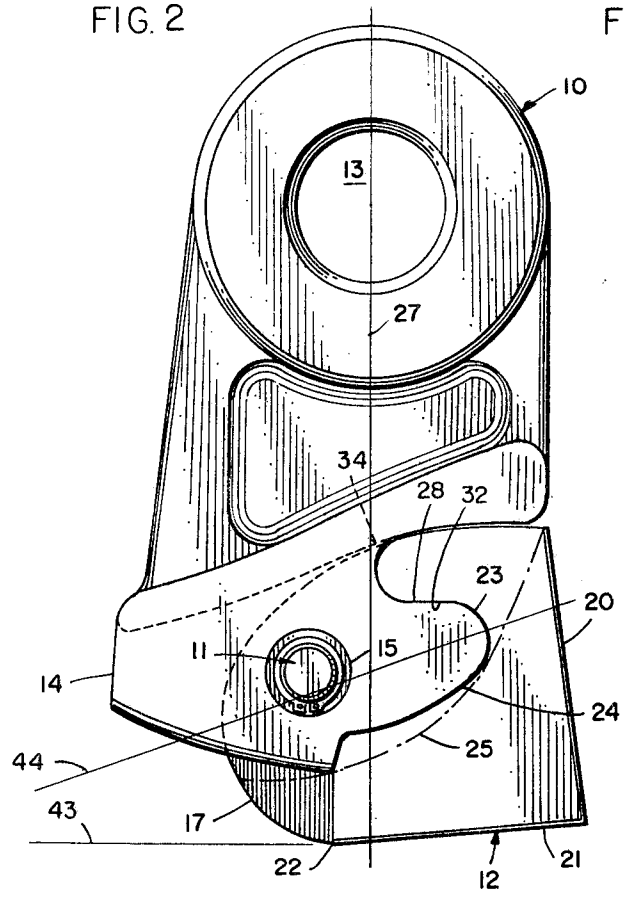


FIG. 3

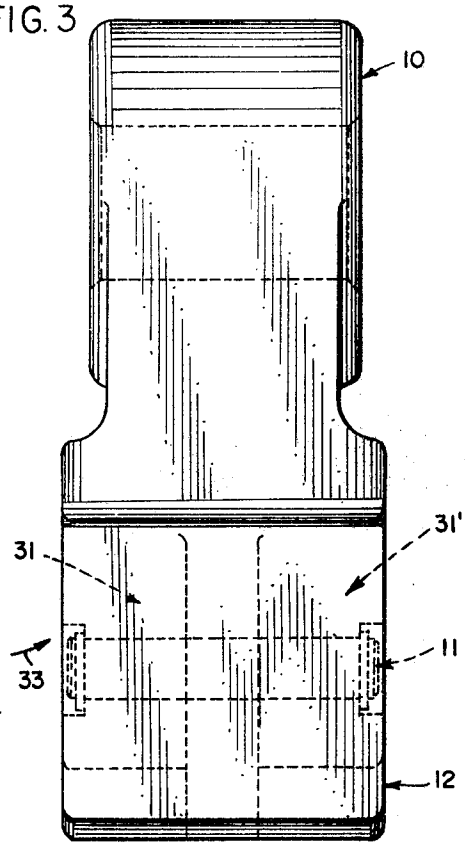
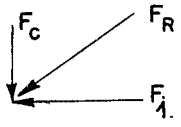


FIG. 2A



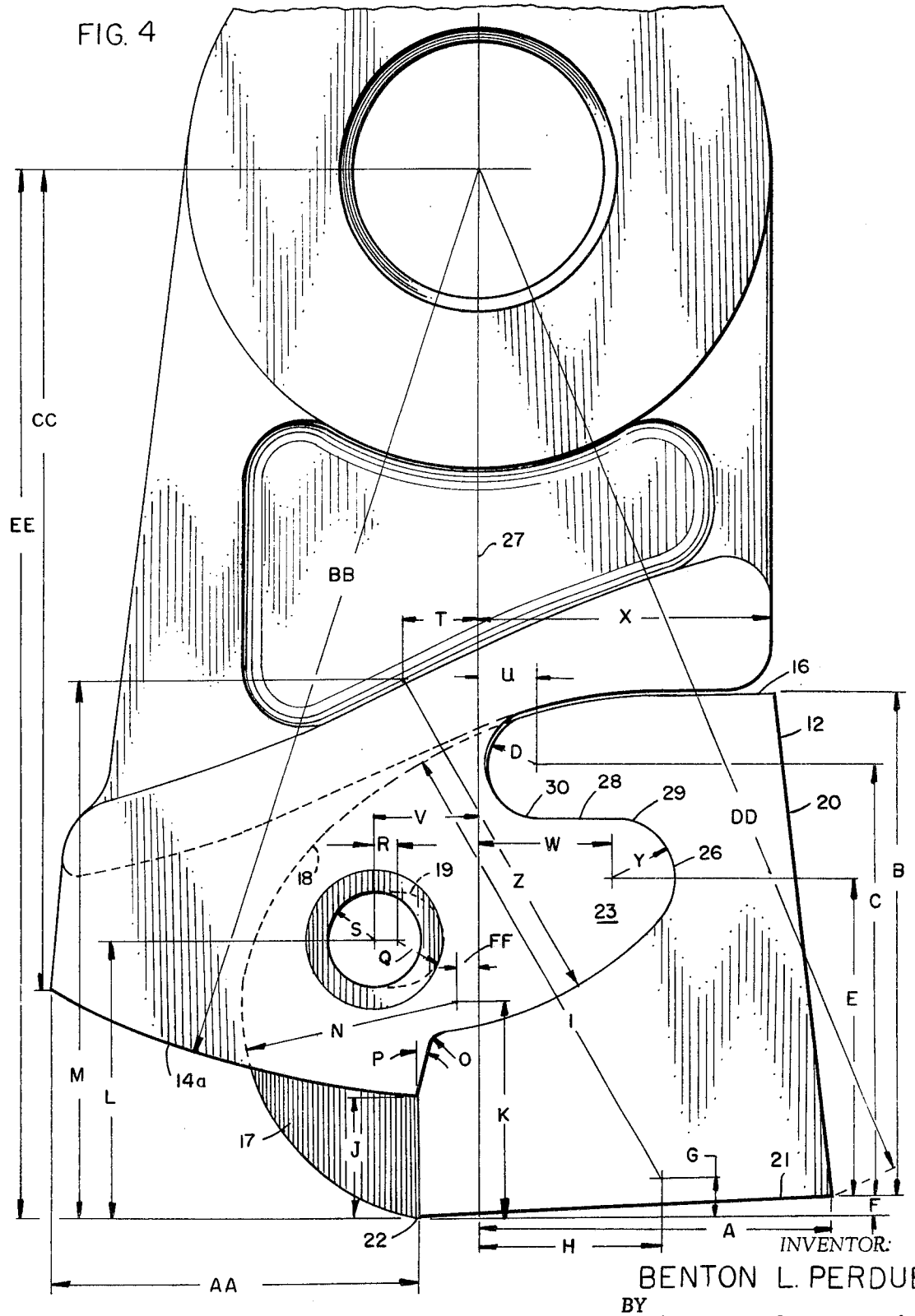
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IMPACT DEVICE

Original Filed Dec. 27, 1966 3 Sheets-Sheet 2

FIG. 4



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May 5, 1970 B. L. PERDUE 3,510,076

IMPACT DEVICE

Original Filed Dec. 27, 1966 3 Sheets-Sheet 3

FIG. 5

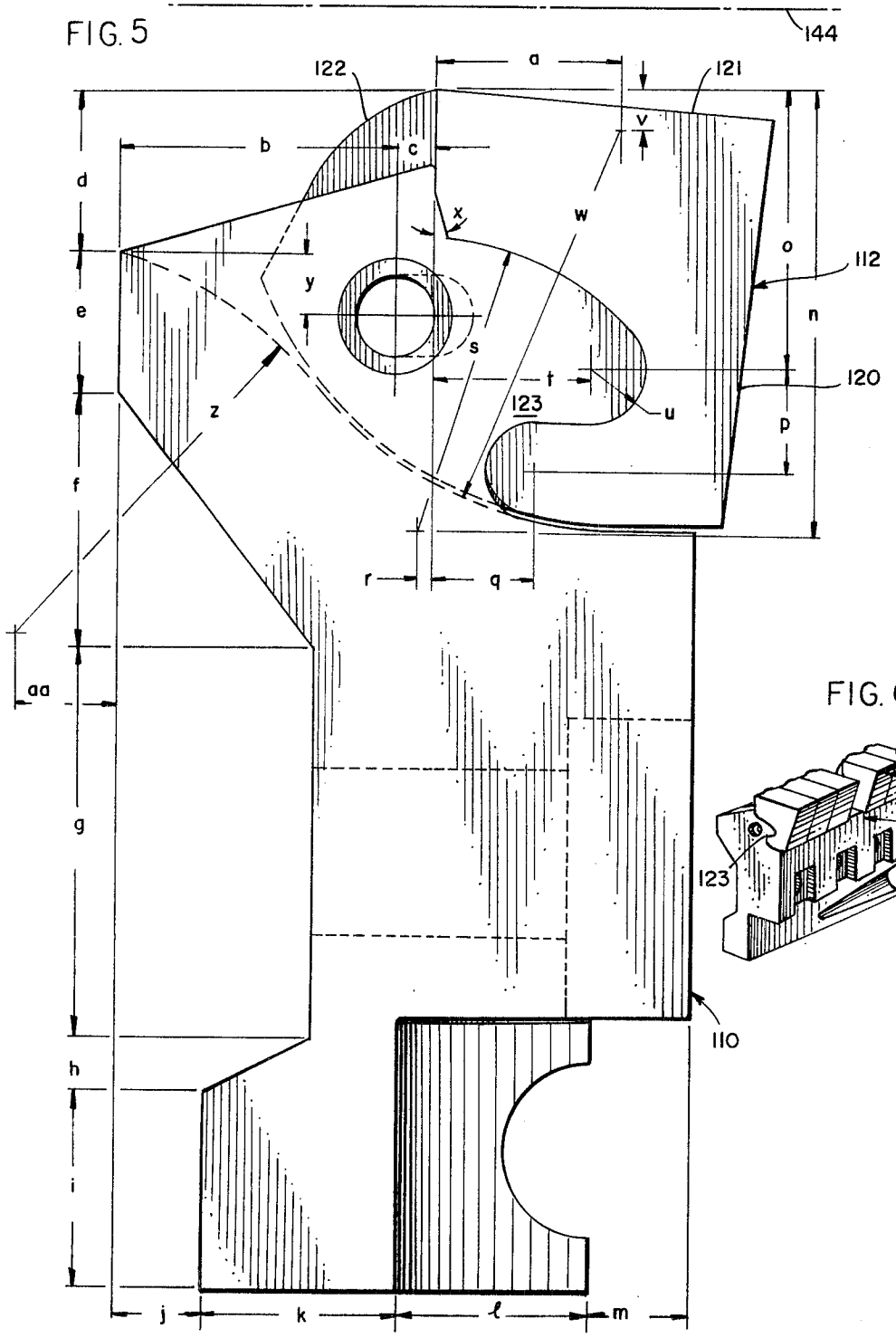


FIG. 6

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3,510,076

IMPACT DEVICE

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Continuation of application Ser. No. 604,685, Dec. 27, 1966, which is a continuation-in-part of application Ser. No. 411,257, Nov. 16, 1964. This application May 23, 1969, Ser. No. 830,200

Int. Cl. B02c *13/28*

U.S. Cl. 241—197 4 Claims

ABSTRACT OF THE DISCLOSURE

An impact element for a rotary crusher having a holder member and a tip member secured together by means of a transversely extending pin, the pin lying within the rearward projection of the striking face of the tip element.

This application is a continuation of my copending application Ser. No. 604,685 filed Dec. 27, 1966, now abandoned, which is in turn a continuation-in-part of my copending application Ser. No. 411,257, filed Nov. 16, 1964, also abandoned.

The inventive device finds utility in connection with rotary crushing of ore, and the like. A rotary-type impact crusher is one consisting of a hammer, impeller impact bar or throw shoe-carrying rotor, either of which is mounted or a rotor shaft and encased within a generally surrounding encasement which usually employs breaker blocks, breaker bars, anvils, or, in some cases, particularly in hammermills, discharge grates.

Although impact crushers have been known and used widely for a long time, a basic dilemma in this art has remained unsolved. The dilemma or apparently irreconcilable objectives consists of obtaining maximum power utilization while minimizing the amount of throw-away metal after the impact device has been used to a point necessitating replacement or repair.

The problem has been approached through the use of replaceable tips, which, of course, reduce the amount of throw-away metal. However, the assembly of the shank and replaceable tip is less efficient from the standpoint of power utilization than a solid or one-piece hammer. I have noted that this stems from the fact that the prior art two-piece constructions are characterized by a "sponginess" in the interconnection between the tip and shank. This looseness in connection is responsible for limiting the amount of power useful in crushing by virtue of absorbing a portion of the power. Thus, the attainment of one objective—reduction of throw-away metal—has resulted in frustrating the achievement of the other objective.

In the past, attempts have been made to avoid this difficulty of power loss by using elaborate locks. However, the heretofore-employed bolts, nuts, pins, wedges, etc., generally have worn faster than the material employed for the abrasion-resistant wearing parts. This stems from the fact that if the locking means is not completely protected from the abrasive forces involved, it wears out before the parts it connects together the locking means necessarily being less abrasion-resistant in order to be more shock resistant. If the locking means is not completely worn out, it is generally worn beyond safe use when the wearing parts are changed.

With the relatively large mass of the shank or adapter, it has become increasingly apparent that a solid or single-piece hammer is uneconomical. The relative economics dictate a two-piece hammer, irrespective of the diminution in efficiency. However, the prior expedients in two-piece hammers not only have fallen short of the optimum because of power inefficiency, but also have not minimized throw-away metal. The exemplary arrangement would develop a worn tip having the same wear pattern or contour as the solid hammer, but I have found that this is frustrated because of the relative movement between the parts of the hammer.

The instant invention solves the problem by approaching it from a new direction. Rather than relying upon sturdier and sturdier locks to maintain the renewable tip on the shank (be it of a hammer, impeller bar, etc.), I make use of the resultant operating force acting on the tip to hold the wear tip or head in position on the shank or adapted. Thus, the instant invention eliminates the necessity for fasteners or couplings between the tip and shank or adapter, except only to provide a generally unstressed lock for resisting the force of gravity. In the instant invention, the confronting bearing or mating surfaces of the parts are arranged to take advantage of the operating forces by using these forces to keep the replaceable tip in place on the less expendable shank or adapter. In operation, therefore, there is no stress applied to the lock—the lock being provided only to maintain the tip in place upon acceleration or deceleration when gravity might tend to unseat the mating parts.

By an arrangement of interacting bearing surfaces to avoid loading the locking means, and relying upon the resultant operating forces to maintain the hammer parts as an integral unit, I not only avoid the disadvantageous power loss, but also achieve what might be considered a "normal" wear pattern which results in an even smaller amount of throw-away metal than previous expedients.

It is, therefore, an object of this invention to provide a novel impact device construction wherein the resultant operating force assumes the duty of maintaining disconnectable parts together. Another object is to provide a novel replaceable tip for the shank or adapter of a hammer or impeller bar wherein the tip is characterized by novel bearing surfaces, developed by unique mass distribution, so as to achieve a solution to the previously mentioned longstanding dilemma. Here, it will be appreciated that an important difference between a hammer and an impeller bar type of crusher resides in the mounting of the shank or adapter. In either case, the tip rotates at high speed to perform the crushing operation, but in the hammer, the shank itself is pivotal, while in the impeller bar the adapter (carrying the replaceable tip) is fixed to the rotor.

Other objects and advantages of the invention may be seen in the details of construction and operation set down in this specification.

The invention is explained in conjunction with an illustrative embodiment in the accompanying drawing, in which:

FIG. 1 is an exploded perspective view of the three elements of an impact hammer constructed according to the teachings of this invention;

FIG. 2 is an enlarged side elevational view of the assembled hammer seen in FIG. 1;

FIG. 2A is a diagram of the forces applicable to FIG. 2;

FIG. 3 is a front elevational view of the hammer of FIG. 2;

FIG. 4 is a fragmentary side elevation, in enlarged scale, of the operating end portion of the impact hammer seen in FIG. 2;

FIG. 5 is a fragmentary side elevational view of the operating end of an impeller bar and associated tip, constituting a modified form of the invention; and

FIG. 6 is a partially exploded perspective view of an impeller bar constructed according to the teachings of this invention.

Referring now to FIG. 1, the three parts of a conventional hammer, the shank, locking pin and tip are

designated generally by the numerals **10**, **11** and **12**, respectively. Where the shank of holder member **10** is designed for use in a hammermill, the inner end of the shank is cored as at **13** for the receipt of a pivot shaft (not shown). The pivot shaft is conventionally provided as part of a rotor (also not shown), which has an axis of rotation some distance away from the axis of the cylindrical cored opening **13**. Where the impact device is used in an impact crusher, the tip-engaging portion generally designated **14** remains the same (see FIG. 5), but the mounting is different—pivoting not being required. Inasmuch as the instant invention is not concerned with the inner end portion of the shank or adapter, the invention applies with equal facility to both stationary and pivotally-mounted holder members **10**. In either case, the tip-engaging portion **14** is similarly contoured as is the tip **12**.

The tip-engaging portion **14** is seen to be equipped with aligned openings as at **15** and **15'** for the receipt of the pin **11**. The tip **12** is characterized by an enlarged head portion **16** and a rearwardly-extending (relative to the direction of rotation) tang portion **17**. The tang **17** adjacent its rear edge **18** (relative to the axis of rotation) is equipped with a hole **19** alignable with the openings **15** and **15'** for engaging the pin **11**.

The tip **12** in the head portion **16** thereof is equipped with an impact or striking surface **20** (also so designated in FIG. 2). The impact surface **20** is essentially planar and intersects with a relatively planar outer surface **21** which functions also in the crushing operation—normally being a "wiping" surface. In the inventive arrangement, it is advantageous to terminate the outer surface **21** short of the rear end of the tang **17** as at **22** (designated only in FIG. 2).

For the purpose of mounting the tip member **12** on the holder member **10**, I provide a pair of forwardly-extending noses **23** and **23'**. It will be appreciated that the noses **23** and **23'** are identical and serve to flank the tang **17** of the tip **12**. In some instances, it may be advantageous to reverse the mounting means as by having a pair of spaced tangs on the tip member **12** flanking a nose portion on the holder member **10**. Such also is within the purview of the invention.

The nose **23**, for example, is arcuately contoured along its lower or outer surface **24** to conform to the ultimate wear pattern that will be developed in the tip **10** when replacement is indicated. The wear pattern is shown in chain line in FIG. 2 and is designated by the numeral **25**. The forward portion **26** (see FIG. 4) of the nose **23** is rounded—on a radius Y (of 9/16" where the hammer is sized for use in a 33" hammermill). Proceeding rearwardly from the tip **26** along the nose upper or inner surface **28** is generally planar (and normal to the construction line **27** in FIG. 4) between the points **29** and **30**. In effect, the surface **28** diverges from the lower surface of the nose **23** in proceeding rearwardly, developing a wedge-like action in supporting the tip member **12**.

It will be appreciated that the head **16** of the tip member **12** is equipped with a recess generally designated **31** (see FIG. 1) which is complementarily contoured to the nose **23**. A second recess (on the other side of the tang **17**) is provided for coaction with the nose **23'**. Thus, the recess **31** has an upper bearing surface portion **32** (again see FIG. 1) on the tip member **12** which coacts with the surface **28** on the holder member **10**. Thus, the surface **32** is inclined in the fashion of surface **28** to develop a wedging action and removably maintain the tip member **12** in place on the holder member **10**. Advantageously, the surfaces **28** and **32** may be inclined within a few degrees to the direction of rotation **33** (see FIG. 2).

From a consideration of FIG. 1, it will be noted that the major mass or weight of the tip is provided in the

block-like forward portion **16**, and this tends to pivot the tip **12** into the position shown in FIGS. 2 and 4 with the rear side **18** of the tang **17** bearing against an outer surface of the holder **10** as at **34** in FIG. 2. The mass distribution thus further stabilizes and reinforces the engagement of the noses **23** and **23'** within the corresponding recesses **31** (see FIG. 3).

Still further, contributing to the solid seating of the tip **12** on the holder **10** is the location of the locking means consisting of the pin **11** mounted in the aligned openings **15** and the hole **19**. It will be seen that the locking means is comprehended within the rearward projection of the impact or striking face **20**, and further, that the pin **11** is equipped with locking rings **40** on a cylinder **41** annularly recessed as at **42**.

It will also be appreciated that the tang is relatively more effectively by virtue of terminating the wiping outer surface **21** short of the rear of the tang **17**, and having a relief of the trailing face as at **14*a***. I have found that this is particularly effective with wet, sticky material—the horsepower load being substantially less with the relieved trailing face.

Inasmuch as certain contours are particularly advantageous in the practice of the invention, it is believed that a specific illustration of an embodiment of the invention (in terms of an impact hammer) will be helpful to the understanding and practice of the invention. For this purpose, certain specific dimensions are identified in FIG. 4, and the values thereof are set forth in Table I below.

TABLE I

A—3"	I—4 1/16"	Q—13/32"	Y—9/16"
B—4 1/8"	J—1"	R—3/16"	Z—3"
C—3 9/16"	K—1 13/16"	S—13/32"	AA—3 1/8"
D—7/16"	L—2 5/16"	T—5/8"	BB—7 3/4"
E—2 9/16"	M—4 1/2"	U—1/2"	CC—6 7/8"
F—1/4"	N—1 13/16"	V—7/8"	DD—9"
G—5/16"	O—1/8"	W—1 1/8"	EE—8 3/4"
H—1 9/16"	P—15°	X—2 1/2"	FF—3/16"

The confronting or bearing surfaces on the tip **12** and holder **10** are arranged to effectively oppose the resultant of the centrifugal and impact forces which are the two principal forces applied to the inventive impact device. The centrifugal force is created by the revolving rotor and the weight of the hammers and other rotor parts, while the impact force is created by the hammer striking the material being fed to the machine for the purpose of reducing the material in size. Of the two main forces, under normal operating conditions the impact forces is greater by more than double in most cases, again dependent upon rotor speed and feed size. The principal factors contributing to the impact force are the speed of the particles being reduced, the size of the particles, and their specific gravity.

In order for a renewable tip hammer, or, for that matter, a replaceable tip impeller bar of the character seen in FIG. 5 and to be described hereinafter, to be effective, these two main forces must be successfully overcome, either by a positive connecting device as is characteristic of the prior art, or by the interrelationship of the parts to effectively oppose the resultant operating force itself. Because the centrifugal force as at F_c in FIG. 2A is generally the lesser of the two by at least half, the other force being designated F_i, the resultant (which must be opposed by the hammer) varies between approximately 5–45° from the horizontal base line **43**. It will be appreciated that the base line **43** corresponds to the direction of the impact vector, being normal to the radial vector represented by the line **27** extending to the axis of the crushing machine.

Since both main forces will vary depending upon operating conditions and the weight of the hammers involved, the exact vector describing the resolved forces can only be defined if all of the operating data, weights and

other variables are known, and then only in one specific application. I have found that the production of a substantially universally applicable renewable tip hammer is best implemented by arranging the nose **23** at an angle of from about 15° to about 35° relative to the base line **43**, and optimally at an angle of 25°. The angle just referred to is the angle formed by the median line or plane **44**, which divides the nose mass into two approximately equal segments. The angle between the lines **44** and **43** becomes smaller, resulting in a larger inner nose portion when the nose is designed for use with easily-crushed material such as cement clinkers, gypsum or other fine material, and where the impact device operates relatively fast. The contrary is true, i.e., the outer nose portion being relatively larger for crushing slow-moving larger particles such as dense hard limestone, dolomite, and some varieties of coal.

Through the use of a tip and holder contoured as described and with the masses distributed in the fashion also set down, the retaining member or pin **11** does not serve as a coupler, since no forces are transmitted to it during normal operation. Instead, the pin merely holds the tip in place during the installation in the assembly of the machine, and if the holder should come to rest in such a position that gravity would tend to dislodge the tip from the holder, the pin then serves to oppose gravity. It will also be appreciated that by virtue of this arrangement the tip **12** is easily removed and a new tip installed with no special tools, all that is necessary being to remove one of the C clips **40** before sliding the pin **11** part way out of the aligned openings **15** and **19** a distance sufficient to clear the tang **17** of the tip **12**.

Reference is now made to FIG. 5, where the holder generally designated **110** is constructed for use in an impeller bar crusher—the holder **110** lacking the pivotal mounting of the holder **10** of FIG. 1. The nose **123** of the holder **110** is seen to be arranged at an acute angle relative to a base plane or line **144**. The tip **112** is again equipped with a slightly inclined striking face **120** and a wiping surface **121** which is relieved as at **122**.

Again, the interrelation of the various bearing and impact surfaces can be appreciated from a consideration of specific dimensions which are set down in Table II below.

TABLE II

a—1 15/16″	*h*—½″	*o*—2 13/16″	*v*—⅜″
b—2⅞″	*i*—2″	*p*—1 1/32″	*w*—4 1/16″
c—⅜″	*j*—1″	*q*—1″	*x*—15°
d—1⅝″	*k*—2″	*r*—⅛	*y*—1 1/16″
e—1 7/16″	*l*—2″	*s*—3″	*z*—4 1/16″
f—2 9/16″	*m*—1″	*t*—1⅝″	*aa*—1 1/16″
g—4″	*n*—4½″	*u*—9/16″	

While in the foregoing specification a detailed description of an embodiment of the invention has been set down for the purpose of explanation, many variations in the details hereingiven may be made by those skilled in the art without departing from the spirit and scope of the invention.

I claim:

1. An impact element for a rotary crusher, comprising a holder member and a tip member mounted on said holder member, an elongated pin releasably fixing said tip member in position on said holder member against forces tending to disengage the same, said tip member being equipped with a head portion having a generally planar, forwardly oriented striking face and an integral tang portion extending rearwardly away from said head portion, said tip member having recesses therein flanking said tang portion, said pin extending generally parallel to said striking face and lying within the rearward projection thereof, said tang portion being flanked by nose portions on said holder member with said nose portions being received in said recesses and with the width of said tang portion being less than the width of either of said nose portions, said members being equipped with mating bearing surfaces arranged to utilize the resultant operating force to maintain said tip member in position on said holder member whereby said pin is substantially unstressed during rotary operation of said element.

2. The structure of claim **1** in which said tang portion extends generally normal to said striking face, said head and tang portions being equipped with surfaces for bearing against confronting surfaces on said holder member, said holder member projecting rearwardly of said tang portion and having an outer surface positioned inwardly of the outer surface of said tip member.

3. A replaceable tip for a rotary crusher holder, said tip being equipped with a head portion having a generally planar, forwardly oriented striking face and an integral tang portion extending generally rearwardly away from said head portion, said tip member having recesses therein flanking said tang portion, said tang portion having a pin-receiving hole extending therethrough generally parallel to said striking face and lying within the rearward projection thereof, said tang portion having a width less than the width of either of said recesses, said tip having an inner end and an outer end flanking said striking face, each recess at its inner end being defined by a surface-providing projection integral with said head portion and extending rearwardly therefrom, said projection at its inner end having another surface, said projection surfaces being rearwardly convergent to develop a wedge shape.

4. The replaceable tip of claim **3** in which each recess at its outer end is defined by an arcuate surface provided by a second projection integral with said head portion and extending rearwardly therefrom, the plane dividing the volume of each recess into two approximately equal parts being arranged at an angle of from about 15 degrees to about 35 degrees relative to the vector representing the impact force applied to said replaceable tip.

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