Nov. 8, 1960 R. F. ANDERSON ET AL 2,959,364

COMMINUTION APPARATUS

Filed Aug. 15, 1956 3 Sheets-Sheet 1

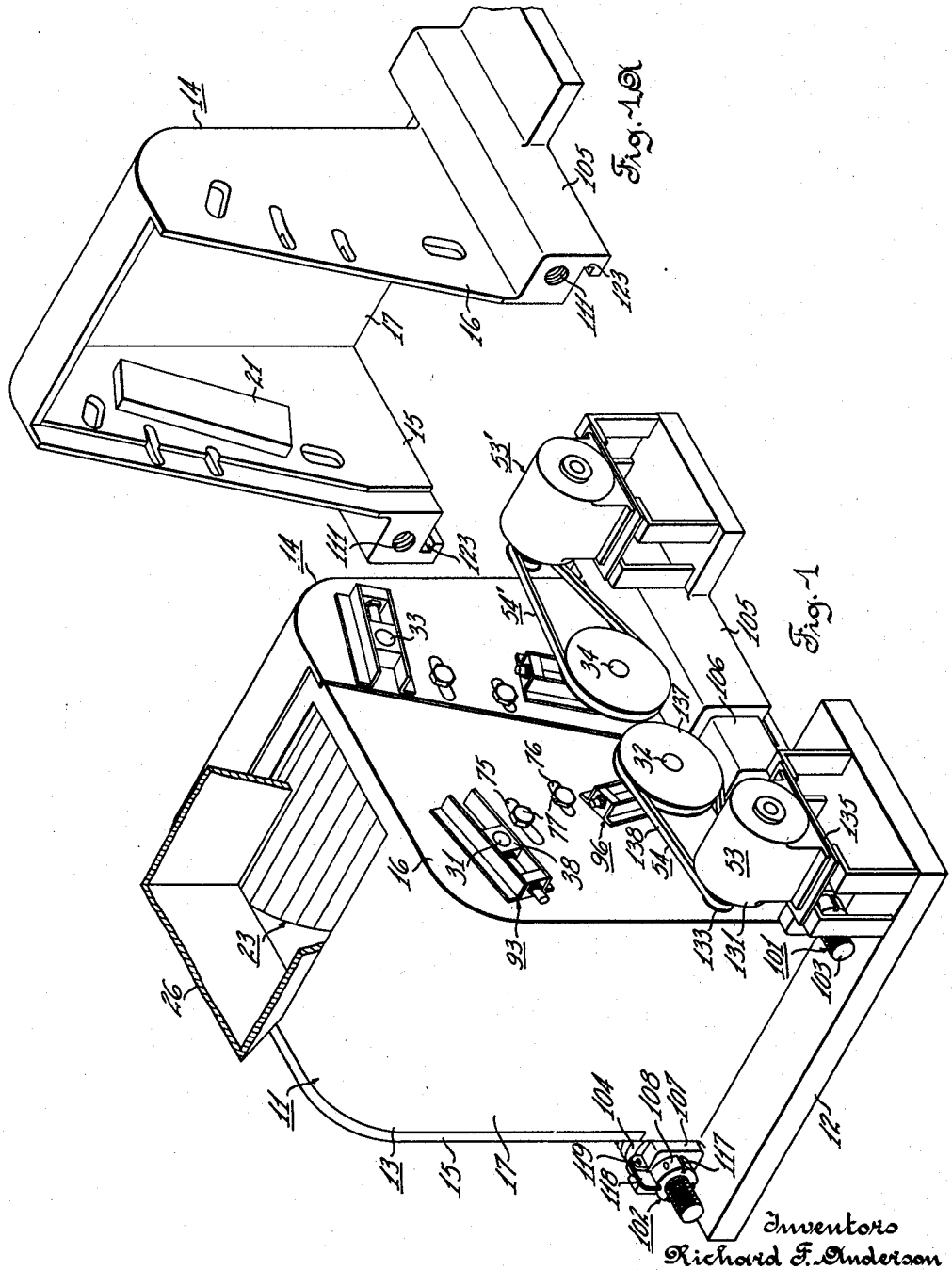


Fig. 1A

Fig. 1

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COMMINUTION APPARATUS

Filed Aug. 15, 1956 3 Sheets-Sheet 2

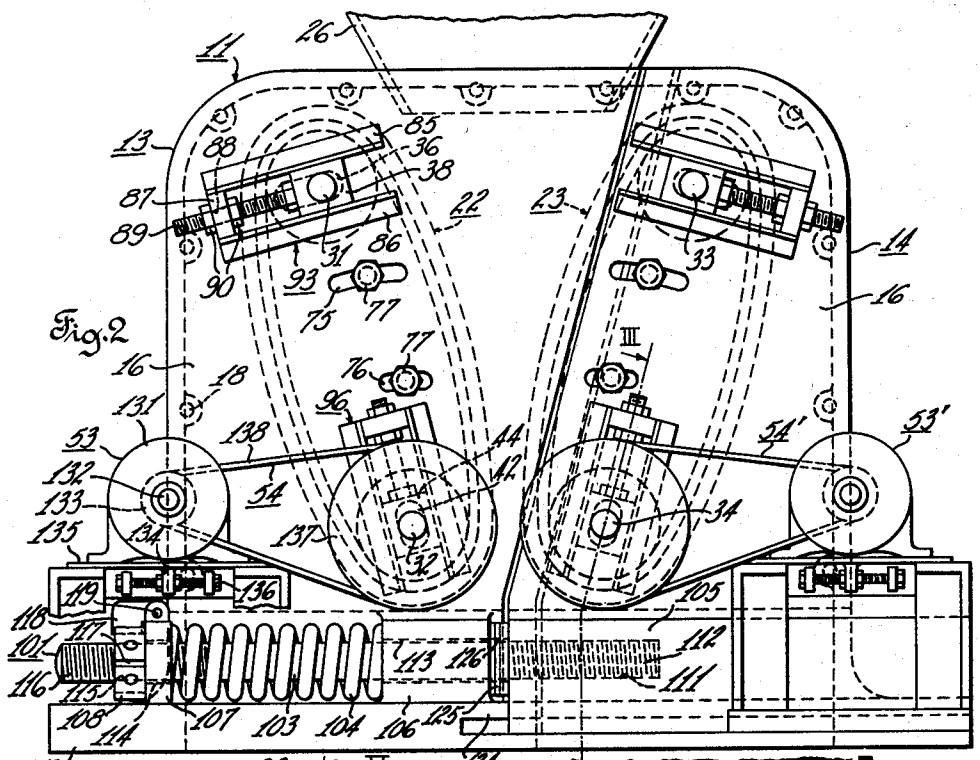


Fig. 2

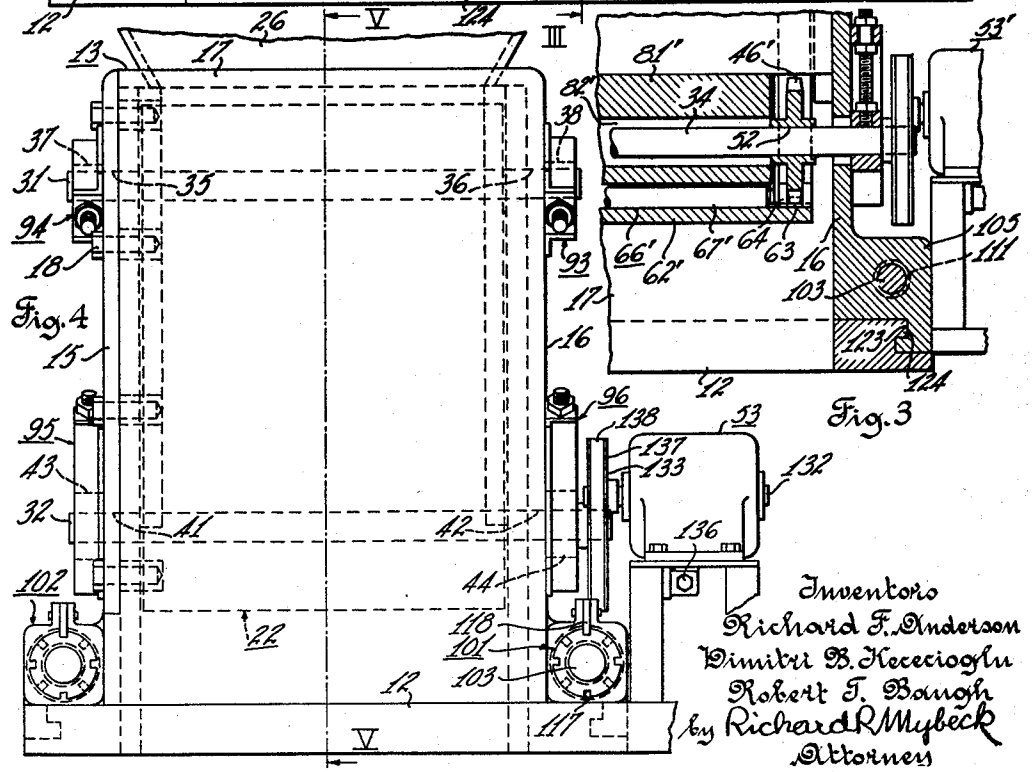


Fig. 4

Fig. 3

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COMMINUTION APPARATUS

Filed Aug. 15, 1956 3 Sheets-Sheet 3

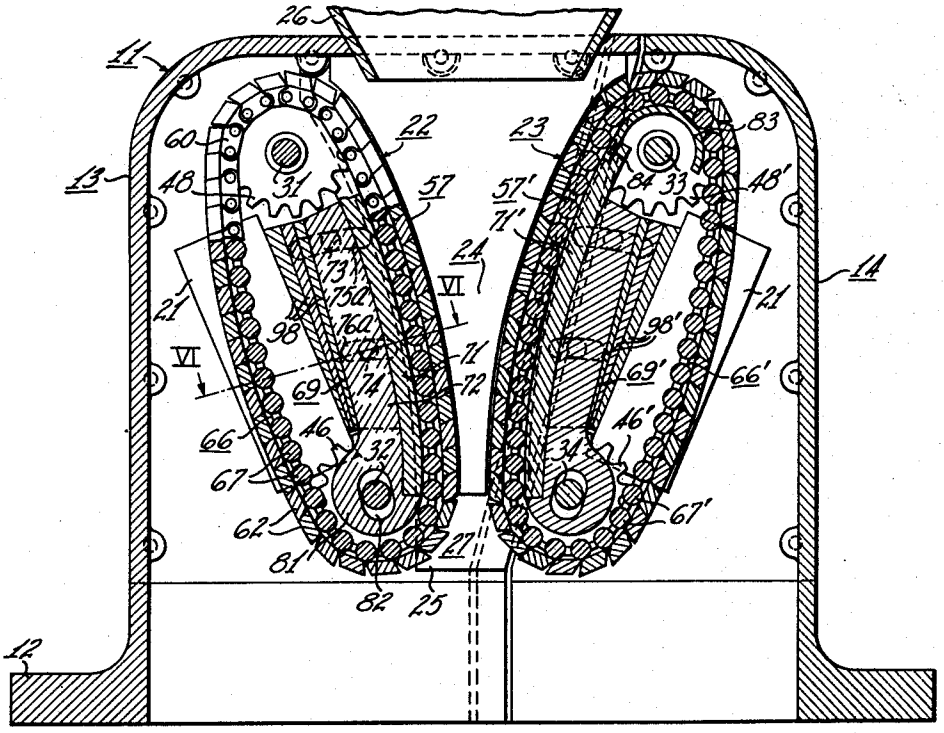


Fig. 5

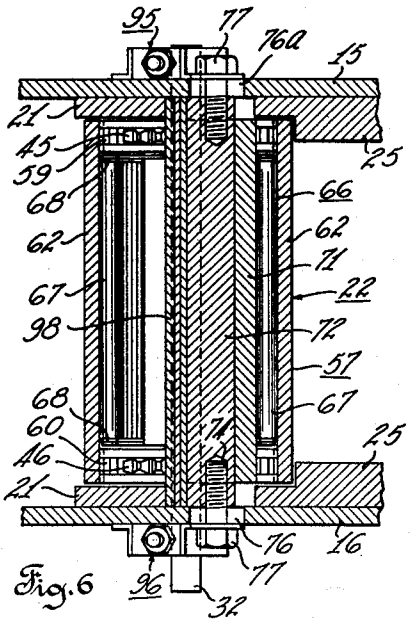


Fig. 6

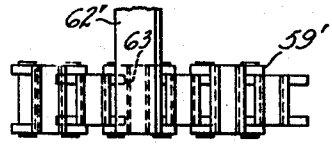


Fig. 8

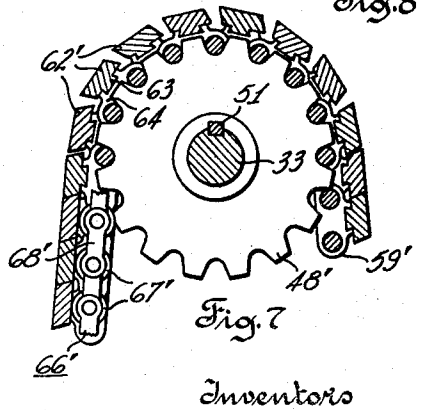


Fig. 7

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2,959,364

COMMINUTION APPARATUS

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Filed Aug. 15, 1956, Ser. No. 604,223

17 Claims. (Cl. 241—200)

This invention relates to the art of comminution and more particularly to apparatus therefor.

In the prior art usage, the concepts of crushing, grinding and pulverizing have taken on commonly accepted definitions. The concept of crushing embraces the size reduction of large pieces of material down to nut and egg size, the concept of grinding embraces the size reduction of nut and egg size pieces of material down to a coarse powder, and the concept of pulverizing embraces the size reduction of coarse powders down to a powder so fine that individual particles cannot be discerned when rubbed on the fingers.

This distinction has not only been drawn of the unit operations themselves, it has been extended to include the apparatus involved in performing the unit operation. Thus, a "crusher" is usually a ruggedly built machine of the gyratory or jaw type capable of taking massive boulders and reducing them in size down to the relatively smaller rocks. A "grinder" is usually a less massive machine of the ball and rod mill type, capable of taking rocks of the size discharged from the "crusher" and further reducing their size down into very small pebbles or coarse powders. Finally, a "pulverizer" is usually the least massive of the size reduction machines and is capable of taking material of the size discharged from the "grinder" and further reduces its size down until individual particles can no longer be discerned.

Because of peculiar refinements of the aforementioned concepts, the present invention is drawn to the art of "communition," i.e., size reduction per se, for it is intended to perform and is capable of performing crushing, grinding and pulverizing. The distinct flexibility of the present device is a direct result of a novel and ingenious engineering concept which is utilized therein, and which will be fully explained in the paragraphs that follow.

Accordingly, it is one of the primary objects of the present invention to provide apparatus which may be easily and well adapted for the unit operations of crushing, grinding and pulverizing.

Another object of the present invention is the provision of comminuting surfaces which are movable relative to and uniformly with each other to provide a constant agitation upon the material being comminuted and means whereby forces applied to the material by which comminution is effected may be varied at will.

A further object of the present invention is to provide size reduction apparatus in which spaced endless belts define comminuting surfaces which bear direct upon the comminutable material to effect the comminution of the material.

A still further object of the present invention is to provide size reduction apparatus having means for easily varying the angle included between two bearing surfaces to provide the apparatus with the optimum pinch angle for a given material, feed size, feed rate and comminution speed.

A still further object of the present invention is to provide new apparatus for size reduction which has a larger capacity per unit volume of comminution chamber and a potentially faster crushing rate than any of the heretofore acceptable devices of the prior art.

A still further object of the present invention is to provide improved comminution apparatus which is easily controlled and which produces a substantially uniform size of comminuted product.

It is even another object of the present invention to provide improved apparatus which may be easily and quickly cleaned and which, if jammed, is adapted to have any jamming material easily and readily moved without necessitating costly and time consuming shut down.

A still further object of the present invention is to provide apparatus for comminution in which the shear and compressive forces exerted upon comminutable materials thereby may be easily and readily varied.

A still further object of the present invention is to provide improved comminution apparatus in which the size of the pieces of comminutable material is progressively reduced in a single pass through the apparatus because of the multiple crushing action effected by the movable bearing surface belts of the apparatus.

A still further object of the present invention is to provide improved comminuting apparatus utilizing the forces of two powerful moving bearing surfaces upon comminutable material which has been positively and forcibly entrapped therebetween.

These and still other objects are fulfilled in a manner which will become apparent from the following detailed description when read in conjunction with the accompanying drawings.

Generally, the concept of the present invention comprises the disposition of a pair of endless bearing surfaces having opposed portions movable relative to and uniformly with one another and in adjustable spatial relationship to each other which cooperatively coact with each other for receiving, comminuting and discharging comminutable material.

In the drawings in which like parts bear like numerals:

Fig. 1 is an isometric view of comminution apparatus embodying the present invention;

Fig. 1A is an isometric view of the movable end portion of the housing of the apparatus of Fig. 1;

Fig. 2 is a side elevation of comminution apparatus embodying the present invention;

Fig. 3 is a partial view in section of the apparatus of Fig. 2 taken along line III—III of Fig. 2;

Fig. 4 is an end elevation of the apparatus of Fig. 2;

Fig. 5 is a side elevation, partially in cross section of the apparatus of Fig. 1, taken along line V—V of Fig. 4;

Fig. 6 is a partial view in section taken along the line VI—VI of Fig. 5;

Fig. 7 is an enlarged view, partially in section with parts broken away for clarity, of a sprocket wheel, chain and bearing plates of the present invention; and

Fig. 8 is a plan view, with parts broken away for clarity, showing a bearing plate and chain of Fig. 7.

In the apparatus illustrated in the accompanying drawing, which has been chosen to exemplify the present invention, a housing **11** is mounted upon a base **12**. Housing **11** comprises two end portions **13**, **14** of which one (for example, end portion **14** in Fig. 1) is movable relative to base **12** and the other end portion to provide a feature of the present invention which will become clearly apparent from the paragraphs that follow.

Each end portion comprises a pair of opposed spaced side portions **15**, **16** and an end plate **17** which joins side portions **15**, **16** to complete the end portion. End plate **17** may be secured to side portions **15**, **16** by any suit-

able means such as by detachable fasteners or bolts **18** (shown with respect to side portion **15** in Fig. 4). Side portions **15**, **16** are mounted upstanding from and generally transverse of base **12** (and preferably generally normal thereto) and in substantial abutting relationship therewith. As can be seen from Fig. 1, when a curved posterior contour is given side portions **15**, **16**, end plate **17** further provides a dust cover for the end portion. Of course, two separate members can be used in lieu of the single member plate **17** with equal facility.

Of side portions **15**, **16**, at least one (see side portion **15** in Fig. 4) is removable to permit communication with the interior of the end portions for reasons which will become apparent in the following paragraphs. Thus, the removal of bolts **18** from an assembled end portion permits ready communication with the interior of housing **11**.

Each of the side portions **15**, **16** of each of the end portions **13**, **14** further has an integral internal flange **21** (see Figs. 1 and 5) defined thereon. The exact purpose of flange **21** and the cooperative coaction it enjoys with respect to the several elements comprising the present invention will likewise be deferred momentarily to permit such description in a clearer setting.

Inside of housing **11**, a pair of comminution units **22**, **23** are mounted in opposed spaced generally converging relationship to each other. The angle at which the units converge will be herein described as the pinch angle or included angle. Its role will be more fully explored henceforth.

Comminution units **22** and **23** are disposed generally transverse of side portions **15**, **16** and cooperate with the side portions **15**, **16** to define an unobstructed and uninterrupted comminution chamber **24**. It is in the chamber **24** that comminution occurs. For this reason, it is sometimes desirable, such as when comminutable feed material is particularly abrasive, to line chamber **24** with wear plates **25**, which are integrally secured to side portions **15**, **16** by any suitable means, such as by weldments. Thus abrasive wear is placed on the wear plates **25** rather than upon the housing **11** itself. This has the further advantage of permitting the wear plates to be made of specially high wear resistant materials which ordinarily would not be used in the fabrication of the complete housing as a simple matter of economics.

Suitable means, such as hopper **26**, are provided for introducing comminutable material into comminution chamber **24** for presentation to comminution units **22**, **23** for comminution thereby. Likewise, suitable means, such as gravity drop **27** through base **12**, are provided for withdrawing the comminuted material from chamber **24**. Other well known means which will get the "raw" material into chamber **24** and get the "finished" material out of chamber **24** may be used with the present invention.

Each of the comminution units **22**, **23**, as shown, comprises a pair of spaced shafts **31**, **32** and **33**, **34**, respectively. All of the shafts when operatively disposed within housing **11**, extend between and through side portions **15**, **16** of the housing end portions **13**, **14**. Though it is not critical, it is desired that the shafts be substantially similar in circumferential dimension and that the shafts be mounted in the substantially parallel relationship shown in Fig. 4 to provide for more uniformity in their cooperative rates of rotation, the reasons for which will become clearer as this specification proceeds.

To more clearly understand the structure of the comminution units **22**, **23**, unit **22** will be singled out and freely described. It is of course understood that comminution unit **23** is substantially a mirror image of unit **22** as illustrated although it need not be as shall be explained.

As was stated, comminution unit **22** has a pair of spaced shafts **31**, **32** of which shaft **31** is the shaft illustrated as uppermost and shaft **32** is the shaft illustrated as the lower of the two.

Shaft **31**, as indicated, passes through side portions **15**, **16** of housing end portion **13** and particularly through apertures **35**, **36** defined in side portions **15**, **16**, respectively, and into bearings **37**, **38**. In a similar manner, shaft **32** passes through apertures **41**, **42** defined respectively in side portions **15**, **16** and into bearings **43**, **44**. Bearings **37**, **38**, **43**, **44** may be of any suitable type such as the roller type shown.

Fastened adjacent each end of the shafts, for example shaft **32**, are suitable driving means such as sprockets. As seen in Figs. 5 and 6, sprocket **45** is disposed adjacent the end of shaft **32** nearest side portion **15** while sprocket **46** is disposed adjacent the end of shaft **32** nearest side portion **16**. Similarly, sprocket **48** is disposed adjacent the end of shaft **31** nearest side portion **16** while a second sprocket, which cannot be seen from the drawing, is disposed adjacent the end of shaft **31** nearest side portion **15**. (Where practicable, odd numerals have been used to designate the "rear" parts and even numerals have been used to designate the "front" parts as may be seen in Figs. 1, 2 and 5.) The various driving means or sprockets are integrally secured at their respective stations on the shafts by any suitable means such as by a keyway **51** (in Figs. 7), a shrink fit **52** (in Fig. 3), etc.

The lowermost shaft of comminution unit **22**, i.e., shaft **32**, is mechanically coupled to a suitable power source means **53** by a suitable coupling means **54** for responsive operation therewith in a manner to be more fully described. Because of this relationship, however, it has been found convenient to refer to the shaft associated with the power means, e.g., shaft **32** in unit **22**, as the driving shaft and the other shaft, e.g., shaft **31** in unit **22**, as the driven or idler shaft.

Comminution unit **22** further comprises an endless bearing surface or bearing surface belt **57** having a pair of endless belts such as chains **59**, **60** or the like mounted in generally parallel relationship to each other. Each of the chains circumscribes and operatively connects the two drivable means or sprockets which are adjacent a common side portion of housing **11**. Thus, chain **59** circumscribes and operatively connects sprocket **45** with the sprocket correspondingly positioned on shaft **31** while chain **60** circumscribes and operatively connects sprocket **46** with sprocket **48**.

Each chain provides means for transmitting motion from the driving sprockets, i.e., those associated with driving shaft **32** to the driven sprockets, i.e., those associated with driven shaft **31**. As shown in Fig. 2, the lower shaft or shaft **32** is the driving shaft and the upper shaft or shaft **31** is the driven shaft. It is understood, of course, that the described positions of the shafts are relative and when the exigencies of operation so demand, the power source means may be coupled to the "upper shafts which would then become driving shafts. If is further understood that the driven or idler shaft may be replaced by other equivalent means for permitting the free movement of endless bearing surface **57** relative to housing **11** for reasons which shall hereinafter be apparent. Thus, to briefly recapitulate, the actuation of power source means **53** transmitted via coupling means **54** causes driving shaft **32** to rotate which by means of a mechanical coupling comprising the aforesaid sprockets and chain causes the driven or idler shaft **31** to move (as in Fig. 2).

Endless bearing surfaces belt **57** further comprises a movable bearing surface mounted to the chains **59**, **60** for movement therewith. Each bearing surface belt **57** further comprises a plurality of treads **62** which may be mounted upon chains **59**, **60** in any suitable manner such as by sliding tread flange **63** into chain link **64** as shown in Fig. 7. (Throughout this description, those parts of unit **23** which correspond to identified parts of unit **22**, for clarity of views, have been identified with prime numbers, e.g., chain **59'** in Figs. 7 and 8).

The treads **62**, which come into actual contact with the comminutable material during operation of this inven-

tion, may have any of the known crushing surface configurations, such as waffle grid, diagonal grid, corrugated, etc., impressed upon them for it has been found that the present invention is not limited to any particular tread surface of configuration.

Comminution unit **22** further comprises an endless idler belt **66** which circumscribes shafts **31, 32** and is bounded laterally by chains **59, 60**. Idler belt **66** comprises a plurality of rotatably mounted rollers **67** connected at their ends by linking means **68** which flexibly secure each roller in substantially parallel spaced relationship to each adjacent roller as is particularly shown in Fig. 6. Thus treads **62**, when in mounted position to define bearing surface belt **57**, circumscribe the idler belt **66** and ride thereupon. Idler belt **66** provides antifriction means whereby treads **62** may ride easily across an adjustable supporting assembly **69** which will hereafter be more fully described.

Idler belt **66** provides antifriction means by its particular characteristic of being intermittently movable with bearing surface belt **57** while each individual roller **67** continuously rotates upon its rotatable mounting, i.e., linking means **68**, in much the manner that conventional roller conveyers operate. It thus becomes apparent that the antifrictional characteristic of the rotatably mounted rollers **67** greatly reduces the friction which would otherwise exist if bearing surface belt **57** were operatively dragged directly against the substantially rigid surface of the adjustable supporting assembly **69** disposed adjacent belt **57**. Linking means **68**, which are disposed on each end of roller **67**, define the side boundaries of idler belt **66**.

Idler belt **66** further enables the forces of comminution to be readily transferred from the treads **62** to the adjustable supporting assembly **69** and hence to the housing **11** in a manner which will be even more fully explored henceforth. The load is more uniformly distributed and therefore more easily transferred because of the uniform ladderlike arrangement which idler belt **66** presents bearing belt **57** for receiving its loads. The extended area provided by idler belt **66** diminishes unit loads by further distributing random point loads in more or less "snowshoe" fashion.

While idler belt **66** has been chosen to exemplify antifriction means which aid in load transfer, the present invention is intended to include such equivalent means as will obtain substantially the same result.

Comminution unit **22** further comprises, as was previously stated, an adjustable supporting means assembly **69** (shown particularly in Fig. 5). Assembly **69** is operatively disposed between opposed runs of idler belt **66** between side portions **15, 16** of housing **11**. Assembly **69** comprises a supporting shoe **71** and a shoe mounting plate **72**. Supporting shoe **71** is positioned adjacent that portion of idler belt **66** which is adjacent comminution chamber **24** in such a manner that idler belt **66** is sandwiched between bearing surface belt **57** and supporting shoe **71**. Thus the comminution forces created upon bearing surface belt **57** and transferred to idler belt **66** are further transferred to supporting shoe **71**.

Supporting shoe **71** may be rigidly secured to shoe mounting plate **72** by any suitable means such as by bolts or rivets (not shown). Supporting shoe **71**, when in assembled position is thus interposed between idler belt **66** and shoe mounting plate **72**, and the complete assembly is disposed generally transversely of side portions **15, 16** of housing **11**.

The unique coaction of bearing surface belt **57** with supporting shoe **71** gives rise to further advantages the extent of which have not been completely explored even at this date. During operation the general contour of bearing surface belt **57** will be that of supporting shoe **71** since the act of comminution forces belt **57** back from chamber **24** until its backward movement is resisted by supporting shoe **71**. Thus as research into the various

contours of comminution chambers advances, the most efficient contour of the time can be readily utilized in the present invention merely by the selection of a supporting shoe having the desired contour.

Fastener receiving means **73, 74** are provided in each end of and are defined by mounting plate **72** generally normal to the planes described by side portions **15, 16**. Side portions **15, 16** of end portion **13** which houses comminution unit **22** are provided with openings, such as openings **75, 76** in side portion **16**, which, when in register with the fastener receiving means **73, 74** permit the insertion of suitable fasteners, such as bolts **77**, through the openings **75, 76** into the fastener receiving means **73, 74**. Thus mounting plate **72** may be rigidly and detachably secured to housing **11**. Similar openings **75*a***, **76*a*** are of course provided in side portion **15** for register with similar fastener receiving means defined in the other side of mounting plate **72** and cooperating with similar detachable fasteners to similarly detachably secure the other side of mounting plate **72** to housing **11**.

Mounting plate **72** further comprises a depending portion **81** having an orifice **82** defined therethrough for receiving and circumscribing a portion of shaft **32**. Depending portion **81** assists in reinforcing supporting shoe **71** and hence bearing surface belt **57** by providing a greater mass in the most constricted portion of chamber **24** and aids in the transmission of comminution forces resulting therein. Depending portion **81** further cooperates with bearing surface belt **57** by guiding idler belt **66** as it passes from one of its runs to the other.

It has been found that by defining openings **75, 76**, and the corresponding openings in the rear of mounting plate **72**, so they are substantially arcuate as shown in the drawing, adjustability is provided mounting plate **72** so that supporting assembly **69** can be positioned with respect to the peculiar characteristics of the particular substance to be comminuted. Where the ability to comminute a variety of substances is not an operating factor, obviously the openings as well as other openings which have been or will be herein defined for adjustment purposes can be defined in terms of the single operation and circular openings will be adequate.

Supporting means assembly **69** further comprises an idler belt guide plate **83** (this member is shown with respect to comminution unit **23** in order to eliminate congestion from the drawing of unit **22**) which maintains the idler belt (indicated by number **66′** in unit **23**) in spaced relationship to the driven or idler shaft **33** (which corresponds, of course, to shaft **31** in unit **22**) and routes the upper transverse portion of the idler belt **66′** in its change of linear direction during rotation. As particularly shown in Fig. 5, guide plate **83** is arcuate and is disposed more or less concentrically of and partially circumscribes shaft **33**. One end of guide plate **83** is secured to the uppermost end of the supporting shoe (indicated as number **71′** in unit **23**) by any suitable means such as by weldments **84**.

As previously stated, similar construction is present in both unit **22** and unit **23** as shown so that unit **23** will not be further described in detail. Units **22** and **23** are further substantially identical in operation, having like parts performing like functions and being only in reflected relationship to each other, an understanding of the foregoing description of the mechanism of comminuting unit **22** renders it unnecessary to further describe the mechanism of unit **23**.

In the previously described relationship of shafts **31, 32, 33, 34** to housing **11**, further discussion of the bearings by which the shafts are supported for rotation was intentionally deferred becuse of a second relationship which each of the bearings enjoy. As the reader will recall, each shaft is mounted for rotation in a pair of suitable shaft bearings, such as bearings **37, 38** and **43, 44** of shafts **31** and **32**, respectively. These bearings perform

their conventional function of diminishing antirotational friction and, as will be recalled, may be of any suitable type such as the ball bearing shown.

These bearings are further adapted to perform an additional function. Referring to Figs. 1 and 2 and considering bearing **38** of shaft **31** in comminution units **22** as typical, bearing **38** is adapted to fit in sliding engagement with and between a pair of parallel tracks **85**, **86** which are secured to side portion **16** of housing **11**. Interposed between tracks **85**, **86** and secured thereto in generally normal relationship therewith is a rigid cross bar member **87** having a threaded aperture **88** defined therein. Threaded through aperture **88** of member **87** and suitably secured to bearing **38** is a suitable adjustment means such as threaded bolt **89**. Thus by turning bolt **89**, the spatial displacement between bearing **38** and member **87** is varied by riding bearing **38** on tracks **85**, **86**. Bolt **89** may be further locked to fix a desired displacement between bearing **38** and member **87** by utilizing suitable locking means such as lock nuts **90** although under normal conditions, the interaction of the threads defined in aperture **88** and on bolt **89** should sufficiently restrain involuntary movement of the bolt **89**. The assembly comprising the pair of tracks, cross piece, adapted bearing and adjusting means as described or any substantial equivalent thereof will be hereinafter called an "adjustment assembly" although such assemblies are sometimes known to the art as "take-up bearings."

Comminution unit **22** employs four adjustment assemblies in the embodiment illustrated in the drawing as particularly in Figs. 2 and 3. The typical assembly described as associated with one end of shaft **31** and including bearing **38** will be hereinafter referred to as assembly **93**. A second assembly **94** is also associated with the other end of shaft **31** and contains bearing **37**. Likewise similar assemblies **95**, **96** are associated with bearings **43**, **44**, respectively, which bearings, as previously explained, mount shaft **32** for rotation.

Assemblies **93** and **94** associated with the upper or idler shaft **31** are disposed transversely of the axis defined in comminution unit **22** by interconnecting the centers of rotation of shafts **31**, **32**. Assemblies **95** and **96** associated with the lower or driving shaft **32** differ in their location relative to unit **22** in that they are disposed along the aforementioned axis.

Assemblies **93**, **94** can be adjusted to increase or decrease the angle defined by the aforementioned axis with the vertical by moving shaft **31** transversely of the defined axis, thus increasing or decreasing the inclination of bearing surface belt **57**. And assemblies **95**, **96** by appropriate adjustment, can increase or decrease the spatial displacement between shafts **31** and **32** by moving shaft **32** along the aforementioned defined axis, thus increasing or decreasing the spacing between the driving means or sprockets (of which sprockets **46** and **48** are typical) mounted to the shafts thus varying the tension in the chains (of which chain **60** is typical) and therefore varying the rigidity or "tension" of bearing surface belt **57**. The concept of "tension" is used herein with respect to the bearing surface belt. More accurately speaking it is only the chains of the belt which are tensionable and capable of being made taut since, as was explained, the treads are independently mounted to the chains.

Consider for a moment the effect of assemblies **93**, **94** when comminution unit **22** is mounted in spaced opposed relationship to similar comminution unit **23**. As will be seen in Fig. 5, bearing surface belt **57** of unit **22** and bearing surface belt **57'** of unit **23** generally converge toward one another to define an included angle which is substantially equal to the angle defined by projecting the tangent of the belts to a point of intersection. This is the angle of operation or pinch angle of the apparatus of the present invention and can be set for a given operation by adjusting the relative displacement between the idler shafts of the respective units by the adjustment assemblies just described.

Thus both the angle of inclination of the bearing surface belts **57**, **57'** of the respective comminution units **22**, **23** and the pinch angle of the apparatus are adjustable in response to the adjustment assemblies associated with upper shafts **31**, **33**, respectively, and the tension in the respective belts is variable in response to the adjustment assemblies associated with lower shafts **32**, **34** respectively.

Returning to unit **22**, when the desired angle of inclination has been selected and set, mounting plate **72** may be more or less beefed up by support means, such as the plurality of shim plates **98**, inserted between mounting plate **72** and flange **21**. The number of shim plates **98** required is determined by the number necessary to provide firm support for mounting plate **72** between it and internal flange **21** to support shoe **71** against housing **11**. (In Fig. 5 for example, three such plates are shown.) To put it another way, shim plates **98** take up the changes in the pinch angle resulting from the aforementioned adjustment thereof and adjust and support the position of shoe **71** relative to bearing surface **57**. Shim plates **98** may be extended completely across the housing if desired. However, it appears desirable that they be smaller in width and particularly of a width that will readily slip into the housing **11** and between flange **21** and mounting plate **72**, without causing disassembly of the apparatus. The plates will extend, of course, substantially the complete lnegth of mounting plate **72**, to assure a lower unit force distribution, i.e., pounds load per square inch of supporting area. Of course, in operations where the unit force distribution is not a material factor, intermittent plugs can obviously serve equally well.

Support means, such as the aforesaid shim plates **98**, thus inserted between the side portions **15**, **16** of the housing **11** and the shoe mounting plate **72** reinforce the mounting plate **72**, by taking load from bolts **77** and compensate shoe **71** for the variation of inclination in bearing surface belt **57** in response to angle adjustment assemblies **93**, **94**. Alternative support means found to be suitable comprise a single adjustable shim plate which may be inserted between mounting plate **72** and flanges **21** which may be actuated and supported by a screw, hydraulic means or any other suitable adjustable support with equally satisfactory results. The type of reinforcement and the support means utilized is, of course, dependent upon the exigencies of operation and to a large extent reflective of the characteristics of the particular comminutable material being fed to the apparatus.

Discussion of the lateral movement of housing end portion **14** relative to housing end portion **13** which may result from the introduction of noncomminutable foreign matter into comminution chamber **24** was previously deferred. As can be seen in Figs. 1 and 2, lateral biasing means **101** are mounted to the apparatus adjacent side portion **16**. Similar biasing means **102** are likewise mounted to the apparatus adjacent side portion **15** as can be seen in Fig. 4.

Each biasing means, for which means **101** will be described as typical, resiliently connects end portion **13** to end portion **14** and comprises connecting means **103**, recoil means **104**, stationary securing means **105**, guide means **106**, stop means **107** and adjustable locking means **108**.

In the illustrated embodiment, stationary securing means **105** is integrally formed with or mounted to side portion **16** of end portion **14** and adapted to connecting means **103** in any suitable manner such as by having a threaded aperture **111** for receiving and holding a threaded end portion **112** of a suitable connecting means such as bolt **103**.

Adjacent stationary securing means **105** is disposed guide means **106** which is integrally formed with or mounted to side portion **16** of end portion **13** and has an aperture **113** defined therein in substantial register with

aperture 111 of stationary securing means 105. Aperture 113 is adapted to receive and circumscribe a portion of connecting means 103 and generally guide it during recoil in a manner which will become apparent.

When connecting means 103 has been passed through aperture 113 of guide means 106 and secured to end portion 14 of housing 11 by suitable means such as by screwing threaded end portion 112 into threaded aperture 111 of stationary securing means 105, suitable recoil means, such as spring 104 is then disposed about a portion of connecting means 103 adjacent guide means 106 and in abutting relationship thereto. When recoil means 104 is in position, a suitable independent stop means, such as washer 107 having an aperture 114 defined therein for circumscribing connecting means 103, is placed on connecting means 103 abutting recoil means 104.

An adjustable locking means, such as lock nut 108 having a threaded aperture 115 defined therein for receiving and circumscribing threaded end portion 116 of connecting means 103, is positioned on and circumscribes connecting means 103 adjacent and abutting stop means 107 to lock recoil means 104 in a relatively compressed position. Locking means 108 is of a dimension sufficiently larger than aperture 114 of stop means 107 to prevent the passage of locking means 108 through aperture 114.

In the illustrated embodiment, adjustable locking means 108 has a plurality of notches 117 defined on the outer periphery thereof for cooperation with lock bar 118, which is pivotably connected to stop means 107 by suitable means such as pin 119, to prevent locking means 108 from moving relative to connecting means 103 once it has been positioned. Stop means 107 is of any suitable shape such as rectangular which will not clear base 12 for rotation in response to torsion induced in locking means 108 by connecting means 103. Thus stop means 107 is free for movement longitudinally with connecting means 103 but is restrained from rotational movement relative to connecting means 103. Stop means 107 further cooperates with recoil means 104 to hold adjustable locking means 108 stationary relative to stop means 107 when lock bar 118 is disposed within one of the plurality of notches 116 (see Fig. 4). Any given compression can be established in recoil means 104 simply by adjusting locking means 108 so that for a given material a given break away force, i.e., the force at which the comminution units will be repelled, can be readily established. Thus in operation when noncomminutable foreign matter causes end portions 13, 14 to be repelled from each other, recoil means 104 is resistively compressed. When the obstruction has passed through the apparatus, recoil means 104, no longer being held in severe compression, returns to its original position.

While a particular biasing means has been here described, the present invention is not intended to be so limited. Any suitable structure which provides substantially equivalent means for permitting instantaneous expansion of comminution chamber 24 by floating the movable comminution unit (for descriptive purposes comminution unit 23 has been depicted as movable, although either may be) away from the stationary unit and then recoils the movable comminution unit to its original position is equally suitable.

Thus relative positioning of end portion 13 to end portion 14 is maintained by biasing means 101, 102. When, because of the aforementioned operating causes, end portions 13, 14 are repelled from each other, end portion 14 rides base 12 by means of a groove 123 defined in and by side portions 15, 16 and a flange or tongue 124 defined in and by base 12 in complementary relationship to groove 123 as particularly shown in Figs. 1 and 4.

Suitable spacer means, such as spacer plates 125 may be inserted between the abutting surfaces of end portions 13, 14 in any suitable manner to vary and fix the minimum opening in discharge means 27 and to define a predetermined spaced relationship between end portions 13, 14. One such manner of installing the spacer plates includes defining an aperture 126 in spacer plates 125, sliding them over bolt 103 between stationary securing means 105 and guide means 106. Thus spacer plates 125 will be retained in position even when end portions 13, 14 have been compressively repelled from each other by the presence of noncomminutable foreign matter in comminution chamber 24. Spacer plates 125 permit the establishment of a predetermined displacement between bearing surface belts 57, 57' adjacent the discharge means or opening 27 shown at the lower end of chamber 24 in Fig. 2. Thus a control of the discharge size of the comminuted material is readily effected and easily varied by the amount of restriction established in discharge means 27 by spacer plates 125.

Mechanical movement of the comminution units, of which unit 22 will be continued as typical, is provided, as previously mentioned by a suitable power source means 53 and coupling means 54. Power source means 53, having been chosen merely to exemplify a suitable arrangement, comprises a motor 131 having an extended motor shaft 132 upon which is integrally secured a first sheave 133 by any suitable means such as shrunk fitting. To insure stability of motor 131, motor 131 is mounted by its ears 134 to motor table 135 with adjustable bolts 136 which further provides for movement of motor 131 and sheave 133 relative to motor table 135.

Typical coupling means 54 comprises a sheave 137 similar to sheave 133, of appropriate radius to provide a desired mechanical ratio between it and sheave 133, which is secured to shaft 32 in a manner similar to that by which sheave 133 is secured to motor shaft 132. (By varying the mechanical ratio between the respective sheaves, it is possible to alter the speed at which shaft 32 moves in response to the power source means 53 in the conventional manner.) Stretched or otherwise disposed between sheave 133 and sheave 137 is a suitable motion transmitter such as V-belt 138. Varying degrees of tension are provided in V-belt 138 by the aforementioned provision of movement of motor 131 and sheave 133 relative to motor table 135. Since motor table 135 is stationary relative to sheave 137 and shaft 32, motor 131 is likewise movable relative to sheave 137 and shaft 32.

As thus described, power source means 53 provides power for shaft 32 via coupling means 54 and more particularly for unit 22. It is understood that coupling means 54 may be omitted and power source means 53 and particular motor 131 attached directly to the driving shaft 32 with equally satisfactory results.

A similar power source means 53' may also be connected to shaft 34 of unit 23 thus providing separate drives for each of the units.

If desired, the power source means may be connected directly to the shaft and the coupling means eliminated. Also, if desired, a single power source means may be used to actuate both units of the apparatus. But to be as effective as the embodiment shown, the single power source means may necessitate an increase in the number and variety of sizes of sheaves and motion transmitters over those required by the described embodiment since it is desirable, even when a single means is used, to include means for actuating the endless bearing belts 57, 57' relative to each other including reversing the direction of rotation of at least one of the units. Suitable means for effecting the desired control with a single power source means could be effected by interposing a reversing clutch and a gear box between the motor and the first sheave in a conventional manner.

The two variable speed reversible motors as shown in Fig. 2 are preferred in the illustrated embodiment because they will enable the speed and direction of the units to be synchronized and otherwise varied at will without requiring the device to be shut down. However,

it is not our intention to be limited to that particular power sysem. Rather, any power source means which provides both uniform and relative movement of the bearing surface belts so that the shear and compressive forces effected by the belts can be readily varied for particular feed rates and reduction ratios are equally well within the intended scope of this invention.

Thus, by means of the described structure or its equivalent, driving shafts **32** and **34** are driven by power source means **53, 53'** respectively and, by virtue of their cooperative interaction with shafts **32, 34** as previously described, bearing surface belts **57, 57'** respectively are motivated in response thereto.

Before commencing the actual comminution operation, certain adjustments are possible to adapt the apparatus more perfectly to the material being handled.

The discharge size of the comminuted material is regulated to a certain degree by the discharge opening defined by the spatial displacement of the units themselves. Thus, by the insertion of a proper number of spacer plates **125** between housing end portions **13, 14**, and the tightening of biasing means **101, 102**, this adjustment is effected.

The rate of flow of the comminutable material through the apparatus is regulated to a certain degree by the angle of inclination or pinch angle defined by units **22, 23** with respect to the central vertical axis of crushing chamber **24**. Thus by adjusting the relative positions of shafts **31** and **33** with their appropriate adjustment assemblies, in the manner herein described, the desired pinch angle for comminution chamber **24** is established.

The firmness of the bearing surface belts in the present invention is indicative of chain tension and more basically of the displacement between the axis of rotation of the two shafts in a comminution unit. Thus the tension in bearing surface belts **57, 57'**, and more specifically in the chains of the belt, can be set to any desired amount by manipulating their appropriate adjustment assemblies in the manner previously described.

When the various adjustments are established as desired, comminutable material may be introduced into hopper **26** from whence it passes to chamber **24**. In the chamber **24**, bearing surface belts **57, 57'** are adapted to move with and relative to one another by control of the power source means **53, 53'**. Thus in the embodiment described as typical, actuation of motor **131** causes the rotation of motor shaft **132** and the first sheave **133** which in turn actuates motion transmitter **138** and second sheave **137**. Second sheave **137** being integrally secured to shaft **32**, causes shaft **32** to move. The movement of shaft **32** is further reflected by the movement of sprockets **45, 46** which in turn actuate chains **59, 60** which in turn cause sprocket **48** and a second sprocket not seen in the drawing to move which in turn cause shaft **31** to rotate with the resultant movement of bearing surface **57**.

The comminutable material introduced through hopper **26** is immediately met by movable bearing surfaces **57, 57'** which by cooperative coaction comminute the material and force it to the discharge means **27**. Of course as shown, material is primarily motivated through the apparatus by the natural phenomenon of gravity although it may be further assisted in its movement by the movement of the bearing surface belts. During the operation, the bearing surfaces can be moved at the same speed or at different speeds in the same or in different directions depending on the forces that are desired upon the material. Or as an alternative embodiment, one bearing surface could be maintained stationary and its movable parts thereby eliminated.

The comminution is effected in comminution chamber **24** in which it is comminuted by the forces of shear attrition by friction, compression and dynamic impact which originate with the movement of bearing surface belts **57, 57'**. Because of the aforedescribed positioning of the comminution units, multiple breaking is effected during comminution which achieves the progressive size reduction of the feed material during a single pass through the apparatus.

Further, if in the comminution of extremely fine particles, the device becomes "jammed" or "clogged," this condition can be readily alleviated by simply reversing the direction of rotation of a bearing surface by exercising the motor control. This effects a reverse throw on the material and breaks the jam.

The apparatus can be readily adapted to various phases and types of material through the adjustment of the adjusting means and the biasing means. The speed and direction of the individual bearing surfaces are controlled by regulating the speed and direction of the movement transmitted from the power source means.

Having thus described the structure of an apparatus embodying the present invention and its operation, it is understood that the apparatus is so described only to exemplify the invention and not to limit it. Such modifications as may readily occur to one skilled in the art are intended to be included herein, the present invention being limited only by the scope of the appended claims.

What is claimed is:

1. Comminution apparatus comprising in combination: a housing having first and second end portions movable relative to each other; a pair of spaced endless moving bearing surfaces disposed one within each one of said housing end portions and cooperating therewith to define an unobstructed comminution chamber extending vertically therethrough; biasing means operatively associated with said end portions for resiliently maintaining said portions in a predetermined spaced relationship to each other; means associated with said chamber for presenting comminutable material to said bearing surfaces for comminution thereby; adjusting means associated with said surfaces for varying the angular relationship therebetween while said biasing means maintain said lower portions in said predetermined spaced relationship to each other; and means associated with said chamber for withdrawing comminuted material from said chamber.

2. Comminution apparatus comprising in combination: a base; a housing mounted upon said base and having a first and second set of opposed side wall portions extending transversely of said base, said first set of opposed side wall portions coacting with a first end portion to define a first end section, said second set of opposed side wall portions coacting with a second end portion to define a second end section, said first and second end sections being movable relative to each other, longitudinally of said base; a pair of spaced movable endless bearing surface belts interposed one between each set of said side portions ad cooperating therewith to define an unobstructed comminution chamber having throat means at one end thereof; means operatively associated with said bearing surface belts for varying the volume of said chamber while maintaining substantially uniform the dimensions of said throat means; means associated with said chamber for introducing comminutable material into said chamber for comminution by forces originating with said movement of said belts; and means associated with said chamber for discharging said comminuted material therefrom.

3. Comminution apparatus comprising in combination: a base; a housing mounted upon said base and having a first and second set of opposed side portions extending transversely thereof and movable relative to each other longitudinally therewith; a pair of movable endless bearing surface belts mounted in opposed spaced relationship to each other one each intermediate each one of said sets of opposed side portions and coacting therewith to define an uninterrupted comminution chamber, each of said belts having a pair of endless chains mounted for movement in spaced relationship to each other, each of said chains having portions corresponding to portions of the other of said chains, each of said belts further having

a plurality of tread plates connecting the corresponding portions of said chains and cooperating with said chains to provide a substantially continuous bearing surface for movement with said chains; means associated with said belts for obtaining a preselected spaced relationship of said belts to each other; means associated with said belts for maintaining the obtained preselected spaced relationship of said belts to each other; means for introducing comminutable material into said chamber; means operatively associated with said movable bearing surface belts for actuating said movable bearing surface belts to comminute said comminutable material in said chamber; and means for discharging said comminuted material from said chamber.

4. Comminution apparatus comprising in combination: a base; a housing mounted upon said base and having a first and second set of opposed side portions extending upwardly therefrom and movable relative to each other longitudinally thereof; power source means; a pair of movable endless bearing surface assemblies mounted in opposed spaced relationship to each other, one being interposed between each of said sets of side portions and cooperating therewith to define an uninterrupted comminution chamber, each of said assemblies comprising a plurality of driving means, a pair of substantially parallel shafts disposed in spaced relationship to each other, each of said shafts having first and second like end portions, each of said shafts having at least one of said driving means mounted integrally thereto adjacent each end thereof, a first and second endless chain, said first chain circumscribing and operatively connecting said driving means disposed upon said shafts adjacent said first like end portions thereof and said second chain circumscribing and operatively connecting said driving means disposed upon said shafts adjacent said second like end portions thereof, said chains and said driving means cooperatively coacting for transmitting motion from one of said shafts to the other thereof, a plurality of bearing tread plates mounted to said chains transversely thereof and for movement therewith, said treads and said chains cooperatively coacting to define an endless bearing surface; a coupling means operatively connecting said power source means to said movable bearing surface assemblies for moving said assemblies in response to said power source means; means operatively associated with said bearing surface assemblies for controlling the spaced displacement therebetween; means for introducing comminutable material into said chamber for comminution by cooperative interaction of said assemblies; and means for discharging comminuted material from said chamber.

5. Comminution apparatus comprising in combination: a base; a housing mounted upon said base having first and second end portions movable relative to each other, at least one of said end portions being further movable relative to said base; biasing means tending to maintain said end portions substantially immobile relative to each other and to said base; a pair of endless bearing surface belts, one each being operatively mounted for supported movement in each of said end portions and in spaced opposed substantially converging relationship to each other, said belts cooperating with said end portions to define a comminution chamber; power source means operatively associated with said belts for moving said belts in response thereto; means for introducing comminutable material into said chamber for comminution by the cooperative interaction of said moving belts; and means for discharging comminuted material from said chamber.

6. Comminution apparatus comprising: a base, a housing mounted upon said base and having first and second end portions mounted upon said base, said first end portion being movable relative to said base and said second end portion through a minimum to maximum linear displacement range; spacer means interposed between said first and said second end portions to fix said minimum displacement between said first and said second end portions; biasing means operatively associated with said first and said second end portions for defining said maximum linear displacement between said end portions and for recoiling said first portion from a linear displacement greater than said minimum displacement but not more than said maximum linear displacement to said minimum linear displacement; a pair of spaced opposed movable generally converging bearing surfaces of variable tension operatively mounted within said housing to define an included angle therebetween, one of said bearing surfaces being disposed within said first end portion for movement therewith, the other of said bearing surfaces being disposed within said second end portion, each of said bearing surfaces cooperating with said end portions to define an unobstructed comminution chamber; power source means; coupling means operatively interposed between said power source means and said bearing surfaces for mechanically coupling said power source means to said bearing surfaces to actuate said bearing surfaces in response to said power source means; first adjustment means operatively associated with said bearing surfaces for varying the tension in said bearing surfaces; second adjustment means operatively associated with said bearing surfaces for varying the included angle defined by said bearing surfaces; a pair of supporting assemblies disposed within said housing, one being mounted in each of said end portions adjacent said bearing surface for receiving comminution forces from said bearing surface and transferring comminution forces to said housing; a pair of internal flanges disposed within each of said end portions integrally mounted thereto adjacent each of said supporting assemblies for receiving comminution forces from said bearing surfaces; shim means interposed between said mounting plate and said flange for adjusting said supporting plate and receiving comminution forces from said mounting plate and transmitting comminution forces to said flange; means for introducing comminutable material into said comminution chamber for comminution by said movable bearing surfaces; and means for discharging comminuted material from said comminution chamber.

7. Comminution apparatus comprising: a base; a housing mounted upon said base and having first and second end portions mounted upon said base in a predetermined spaced relationship to each other; spacer means interposed between said first and said second end portions to fix said predetermined spaced relationship between said first and said second end portions; a pair of spaced opposed movable generally converging bearing surfaces of variable tension operatively mounted within said housing, one of said bearing surfaces being disposed within said first end portion and the other of said bearing surfaces being disposed within said second end portion, said bearing surfaces cooperating with said end portions to define an unobstructed comminution chamber; power source means; coupling means operatively interposed between said power source means and said bearing surfaces for mechanically coupling said power source means to said bearing surfaces to actuate said bearing surfaces in response to said power source means; first adjustment means operatively associated with said bearing surfaces for varying the tension in said bearing surfaces; second adjustment means operatively associated with said bearing surfaces for varying the angle included between said bearing surfaces by the convergence thereof; a pair of supporting assemblies disposed within said housing, one being mounted in each of said end portions adjacent said bearing surface for receiving comminution forces from said bearing surface and transferring comminution forces to said housing; a pair of internal flanges disposed within each of said end portions and integrally mounted thereto adjacent each of said supporting assemblies for receiving comminution forces from said

bearing surface; shim means interposed between said supporting assemblies and said flanges for receiving comminution forces from said supporting assemblies and transmitting comminution forces to said flange and for adjusting the position of said supporting assemblies relative to said bearing surfaces; means for introducing comminutable material into said comminution chamber for comminution by the cooperative interaction of said movable bearing surfaces; and means for discharging comminuted material from said comminution chamber.

8. Comminution apparatus comprising: a base; a housing mounted upon said base and having a pair of opposed spaced side portions extending generally transversely of said base; a pair of bearing surfaces of variable tension operatively mounted within said housing generally transversely of said side portions and in spaced opposed generally converging relationship to each other, at least one of said belts being adapted for revolving movement relative to said housing, said bearing surfaces cooperating with said side portions to define an unobstructed comminution chamber; spacer means interposed between said bearing surfaces to define the spaced relationship between said surfaces; power source means; coupling means for mechanically coupling said power source means to said movable bearing surface to actuate said movable bearing surface in response to said power source means; first adjustment means operatively associated with said movable bearing surface for varying the tension therein; second adjustment means operatively associated with said bearing surfaces for varying the angle included therebetween defined by the convergence thereof; a pair of supporting assemblies disposed within said housing in spaced relationship to each other, one being mounted adjacent each of said bearing surfaces and remote of said comminution chamber, said supporting assemblies being for receiving comminution forces from said bearing surfaces and transmitting comminution forces to said housing; a pair of internal flanges integrally associated with each said side portions of said housing adjacent each of said supporting assemblies for respectively receiving comminution forces from each of said bearing surfaces; shim means interposed between said supporting assemblies and said flanges for receiving comminution forces from said supporting assemblies, transmitting comminution forces to said flange and adjusting the position of said supporting assemblies relative to said bearing surfaces; means for introducing comminutable material into said comminution chamber for comminution by the cooperative interaction of said movable bearing surfaces; and means for discharging comminuted material from said comminution chamber.

9. Comminution apparatus comprising: a base; a housing mounted upon said base and having a pair of opposed spaced side portions extending generally transversely of said base, each of said side portions having a pair of spaced internal flanges integrally associated therewith for receiving comminution forces; a pair of movable bearing surfaces operatively mounted within said housing adjacent said flanges generally transversely of said side portions and in spaced opposed generally converging angular relationship to each other; said bearing surfaces cooperating with said side portions to define a comminution chamber; power source means; coupling means for coupling said power source means to said bearing surfaces to actuate said bearing surfaces in response to said power source means; adjustment means operatively associated with said bearing surfaces for varying the angle of the generally converging angular relationship of said surfaces to each other; a pair of supporting assemblies disposed within said housing in spaced relationship to each other, one supporting assembly being mounted adjacent each of said bearing surfaces and interposed between said bearing surfaces and its adjacent flanges for receiving comminution forces from said bearing surfaces and transferring comminution forces to said flanges; means for introducing comminutable material into said comminution chamber for comminution by said movable bearing surfaces; and means for discharging comminuted material from said comminution chamber.

10. Comminution apparatus comprising: a base; a housing mounted upon said base and having a first and second set of opposed spaced side portions extending generally transversely of said base and movable relative to each other thereupon; a pair of drivable bearing surfaces operatively disposed within said housing transversely of said side portions and in spaced opposed registered relationship to each other, said bearing surfaces being mounted one intermediate each of said sets of said side portions and cooperating therewith to define a comminution chamber; power source means operatively associated with said drivable bearing surfaces for driving said bearing surfaces; a pair of supporting assemblies disposed within said housing in spaced relationship to each other, one supporting assembly being mounted between said side portions of each of said sets adjacent each of said bearing surfaces for receiving comminution forces from said bearing surfaces and for transmitting said comminution forces to said housing; means for introducing comminutable material into said comminution chamber for comminution by said movable bearing surfaces; and means for discharging comminuted material from said comminution chamber.

11. Comminution apparatus comprising in combination: a housing having a plurality of flange members extending inwardly therefrom; a pair of spaced endless movable bearing surface assemblies carried by said flange members within said housing and cooperating therewith to define an unobstructed comminution chamber, each of said bearing surface assemblies comprising an endless idler roller belt having two side boundaries, a pair of endless chains mounted in generally parallel relationship to each other one adjacent each of said side boundaries of said idler roller belt, a plurality of tread plates connected between said chains generally transversely thereof, said treads and said chains cooperatively defining a substantially continuous bearing surface belt which circumscribes and is adjacent of said idler roller belt, power source means, means for connecting said chains and said power source means for moving said bearing surface in response to said power source means whereupon the forces of comminution from said surfaces are transmitted to said housing through said flange members; means for feeding comminutable material into said chamber for comminution therein by said movable bearing surfaces; and means for withdrawing comminuted material from said chamber.

12. Comminution apparatus comprising in combination: a housing, a pair of spaced endless movable bearing surface assemblies disposed within said housing and cooperating therewith to define an unobstructed comminution chamber, each of said bearing surface assemblies comprising support means, an endless idler roller belt reeved about said support means, a plurality of tread plates mounted in circumscribing relationship to said support means freely resting upon said roller belt and defining a substantially continuous bearing surface, power source means, and means for connecting said bearing surface and said power source means for moving said bearing surface in response to said power source means; means for feeding comminutable material into said chamber for comminution therein by said bearing surfaces; flange means extending inwardly from said housing and engaging said support means to receive forces from said surface via said roller belt and said support means and transmit same to said housing, and means for withdrawing comminuted material from said chamber.

13. Comminution apparatus comprising in combination: a housing having a plurality of flange members extending inwardly therefrom; a pair of spaced endless movable bearing surface assemblies disposed in converg-

ing registered relationship to each other within said housing and cooperating therewith to define an unobstructed comminution chamber having a discharge opening of preselected dimension adjacent the bottom thereof, said assemblies including means for varying the angle of convergence therebetween while maintaining said preselected dimension substantially constant, each of said bearing surface assemblies including support means having a portion of preselected contour and engaging said flange members in force transmitting relationship thereto, an endless idler roller belt reeved about said support means and conforming to said portion having said preselected contour, a plurality of tread plates mounted in circumscribing relationship to said support means freely resting upon said roller belt for movement relative thereto and defining a substantially continuous bearing surface, power source means, and means for drivingly connecting said bearing surface to said power source means for moving said bearing surface in response to said power source means; means for feeding comminutable material into said chamber for comminution therein by said bearing surfaces whereupon forces created thereby are transmitted via said roller belt and said support means through said flange members to said housing; and means for withdrawing comminuted material from said chamber.

14. Comminution apparatus comprising in combination: a base; a housing mounted upon said base and having first and second end portions mounted upon said base, said first end portion being movable relative to said base and said second end portion through a preselected minimum to maximum linear displacement range; a pair of spaced moving endless bearing surfaces disposed one within each of said end portions of said housing and cooperating therewith to define an unobstructed upwardly diverging comminution chamber therebetween; means superposed to said chamber for dropping comminutable material thereinto for comminution therein by said moving bearing surfaces; means associated with said chamber for varying the angle of divergence defined intermediate of and by said surfaces while maintaining the lower edges thereof in a predetermined spatial relationship to each other; and means for withdrawing comminuted material from said chamber.

15. Comminution apparatus comprising in combination: a base; a housing mounted upon said base and having first and second end portions mounted upon said base, said first end portion being movable relative to said base and said second end portion through a preselected minimum to maximum linear displacement range; a pair of spaced moving endless bearing surfaces mounted one within each of said end portions and angularly disposed relative to each other, said bearing surfaces cooperating with each other and with said housing to define an unobstructed vertically extending comminution chamber therebetween; means for introducing comminutable material into said chamber; means for actuating said moving surfaces being adapted for adjustable divergence relative to each other and defining therebetween at the lower edges thereof a chamber discharge opening; means operatively associated with said bearing surfaces for adjusting the angular divergence therebetween while maintaining said discharge opening to a substantially constant dimension; means associated with said chamber for presenting comminutable material to said moving bearing surfaces for comminution thereby; and means associated with said chamber discharge opening for withdrawing comminuted material therefrom.

16. Comminution apparatus comprising in combination: a housing having first and second end portions movable relative to each other; a pair of spaced endless moving bearing surfaces disposed one within each of said housing end portions and cooperating therewith to define an unobstructed vertically extending upwardly diverging comminution chamber; means operatively associated with each of said bearing surfaces for adjusting the tautness thereof; means connected to said chamber for introducing comminutable material into said chamber for comminution by said moving bearing surfaces; and means connected to said chamber for discharging comminuted material therefrom.

17. Comminution apparatus comprising: a base; a housing mounted upon said base and having a pair of opposed spaced side portions extending generally transversely of said base, each of said side portions having spaced flange members extending internally therefrom and integrally formed therewith; a pair of movable bearing surfaces operatively mounted within said housing adjacent said flanges generally transversely of said side portions and in spaced downwardly converging relationship to each other, said bearing surfaces cooperating with said side portions to define a generally vertical comminution chamber therebetween; power source means; coupling means connected between said power source means and said bearing surfaces to actuate said bearing surfaces in response to said power source means; a pair of supporting assemblies disposed within said housing in spaced relationship to each other, one supporting assembly being mounted adjacent to and carrying each of said bearing surfaces and intimately interposed between said bearing surfaces and said flange member adjacent thereto, said supporting assemblies receiving comminution forces from said bearing surfaces and transferring said forces to said flange members; means for introducing comminutable material into said comminution chamber for comminution by said movable bearing surfaces; and means for discharging comminuted material from said comminution chamber.

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