United States Patent [19]

Coulter et al.

[11] **3,868,064**

[45] **Feb. 25, 1975**

[54] **APPARATUS FOR REDUCING AUTOMOBILE BODIES AND OTHER WASTE TO USABLE SCRAP**

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[73] Assignee: **Dravo Corporation**, Pittsburgh, Pa.

[22] Filed: **Feb. 23, 1973**

[21] Appl. No.: **335,001**

[52] **U.S. Cl.** .... **241/186.4**, 241/152 A, 241/186, 241/196, 241/285 R

[51] **Int. Cl.** **B02c 13/16**

[58] **Field of Search** .... 241/134, 138, 152 R, 154, 241/185 R, 186 R, 186.2, 196, 285 R, 285 A, 194, 186.4

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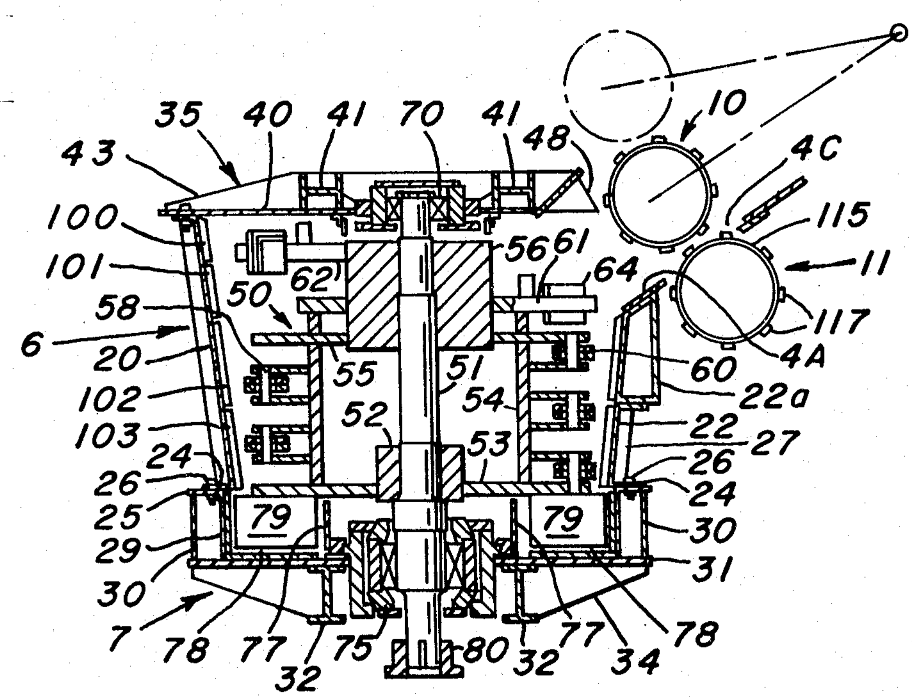
Primary Examiner—Roy Lake
Assistant Examiner—E. F. Desmond
Attorney, Agent, or Firm—Parmelee, Miller, Welsh & Kratz

[57] **ABSTRACT**

In an apparatus for reducing automobile bodies to scrap suitable for use in metallurgical furnaces, automobile bodies, front end forward are placed on an inclined chute, one behind another, the chute accommodating two bodies in tandem. Power-driven feed rolls, the upper one of which is vertically movable, control the rate of feed of the lead body into a reducing mill having an upright rotor with a shell of downwardly decreasing diameter having a replaceable lining therein. Spaced knocker arms with cutters at the free ends, forming the top of the rotor, progressively shear and rend the lead ends of the car body as it projects into the mill and the pieces are further broken up and rolled into balls and otherwise irregularly shredded and compacted as they then move down between the rotor and the shell lining, the rotor having ring hammers at intervals around its periphery from a level just below said arms to its bottom. The end product drops into an annular trough from which it is expelled by vanes at the bottom of the rotor. Four motors with drive pinions arranged around a central gear wheel on an extension drive shaft at the bottom of the rotor drive the rotor at high speed.

16 Claims, 13 Drawing Figures



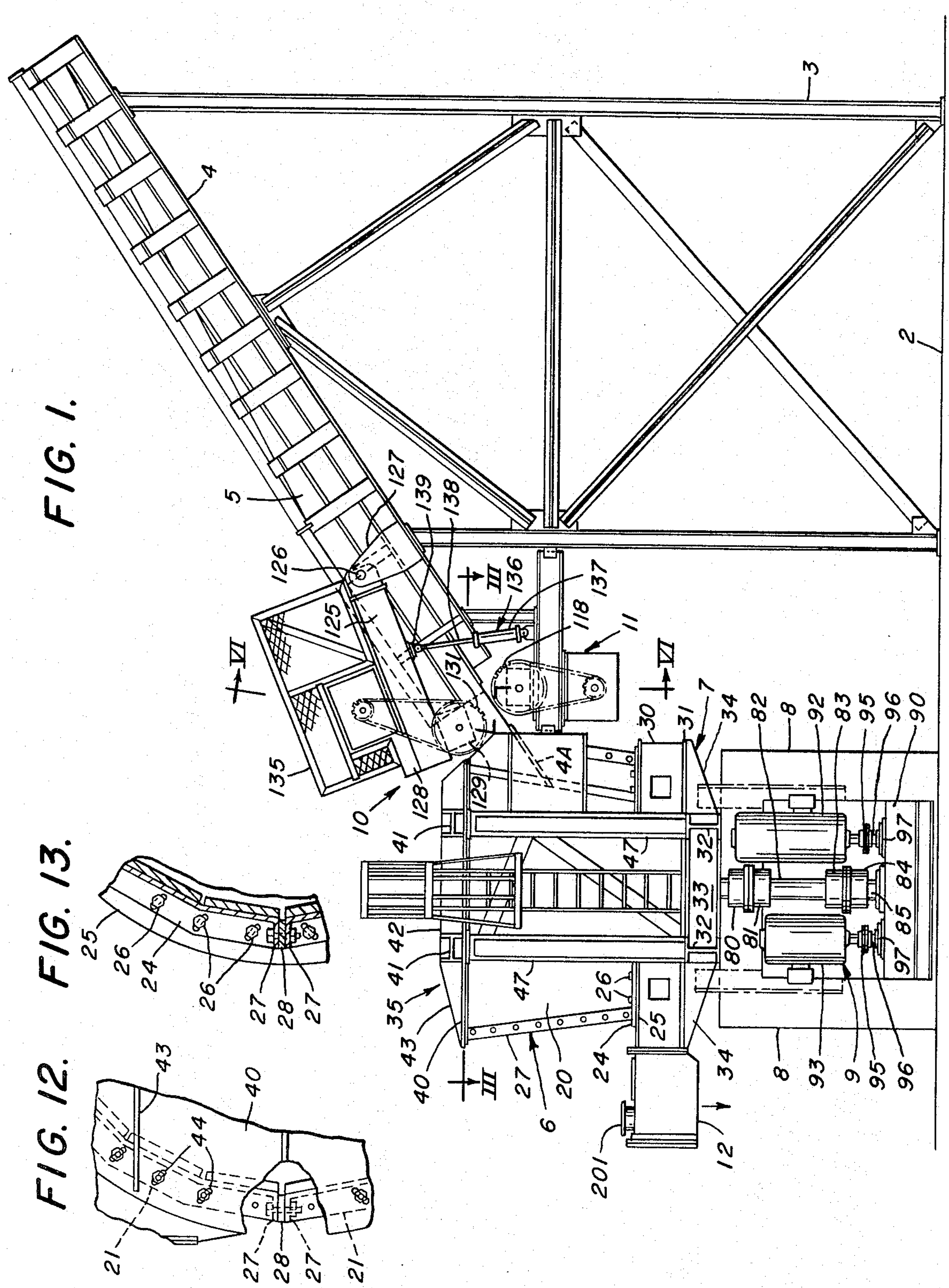


FIG. 1.

FIG. 13.

FIG. 12.

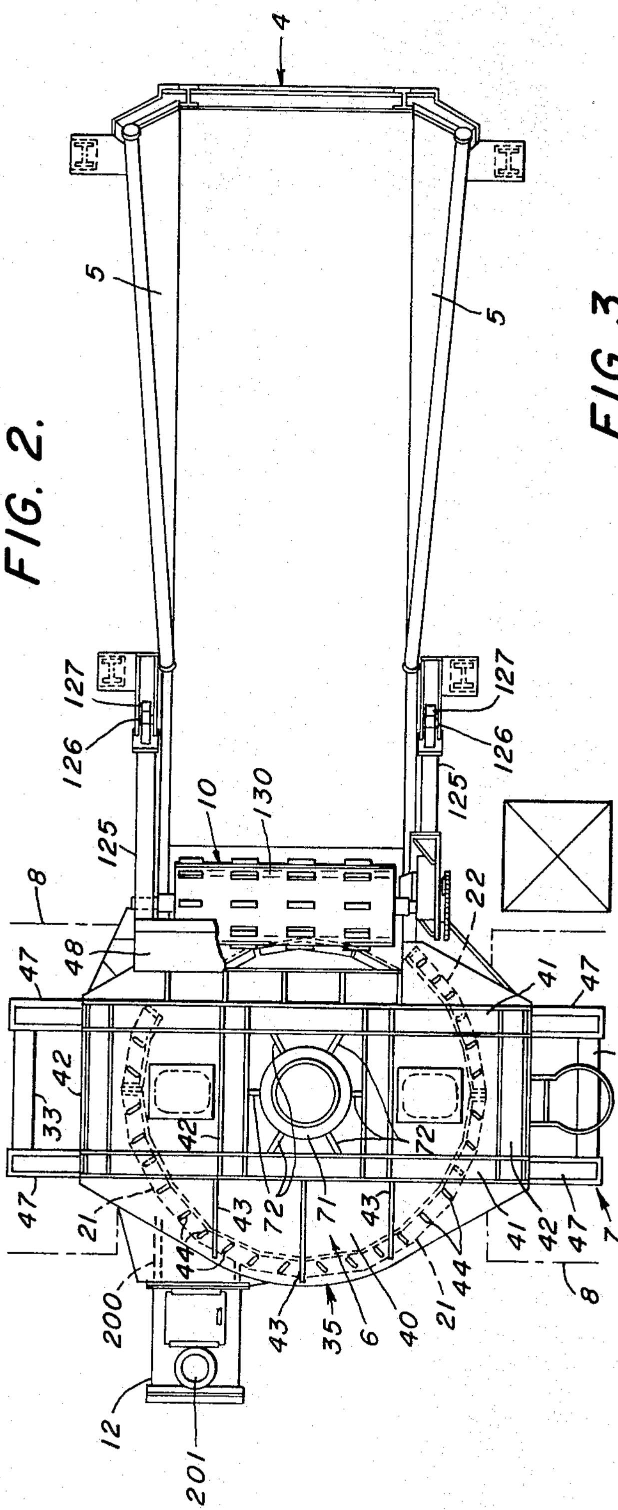


FIG. 2.

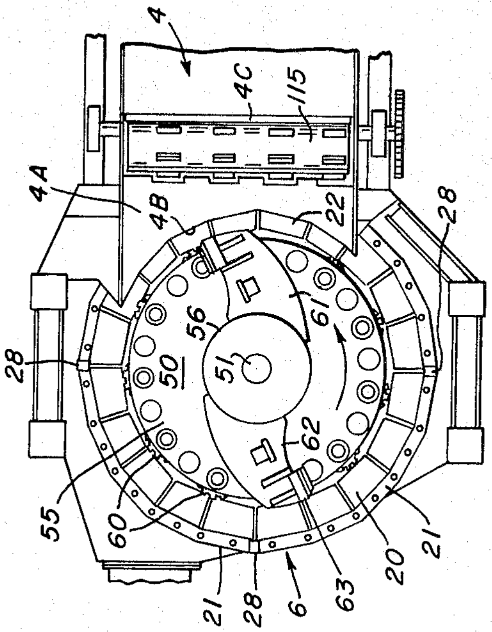


FIG. 3.

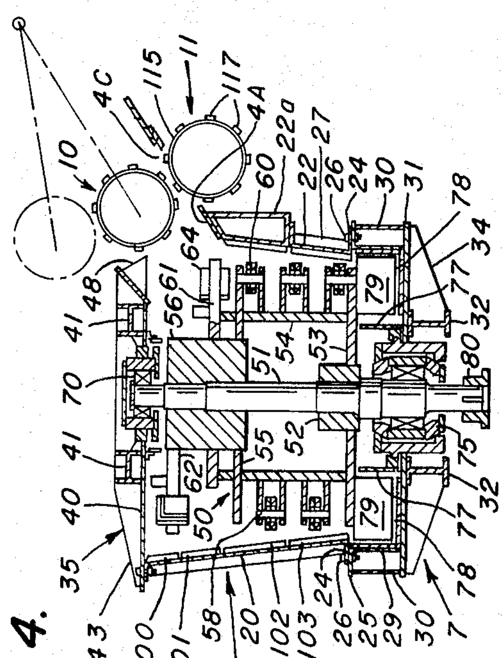


FIG. 4.

FIG. 6.

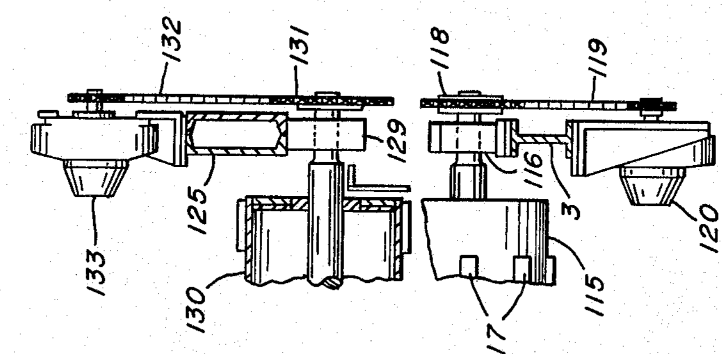

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FIG. 5.

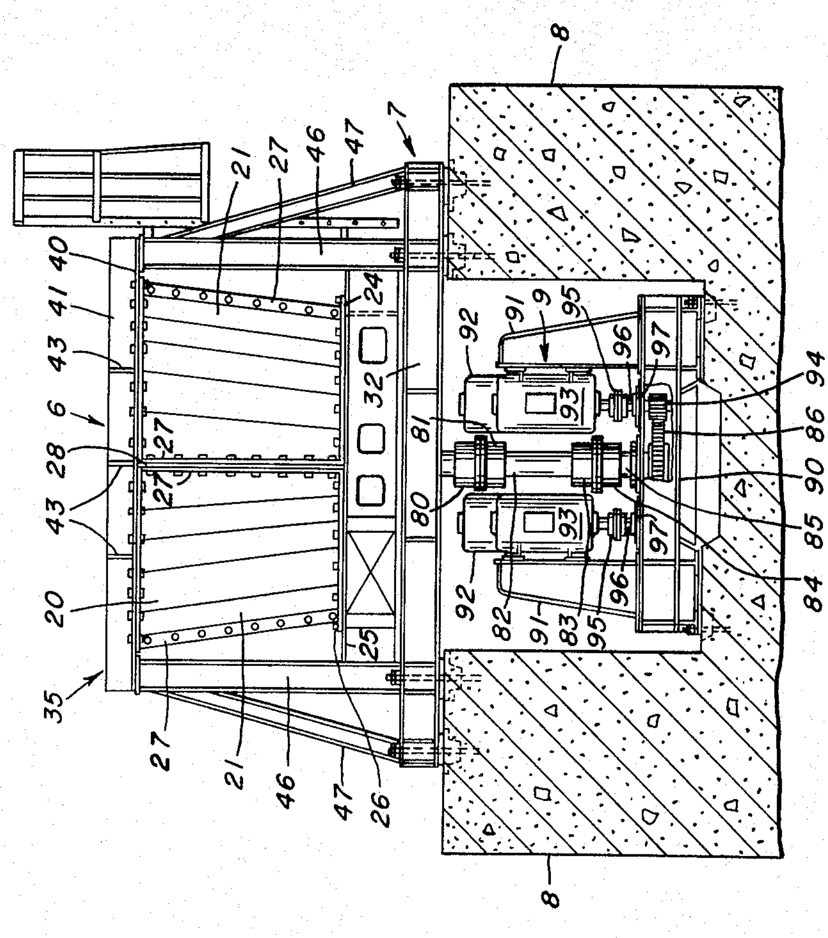
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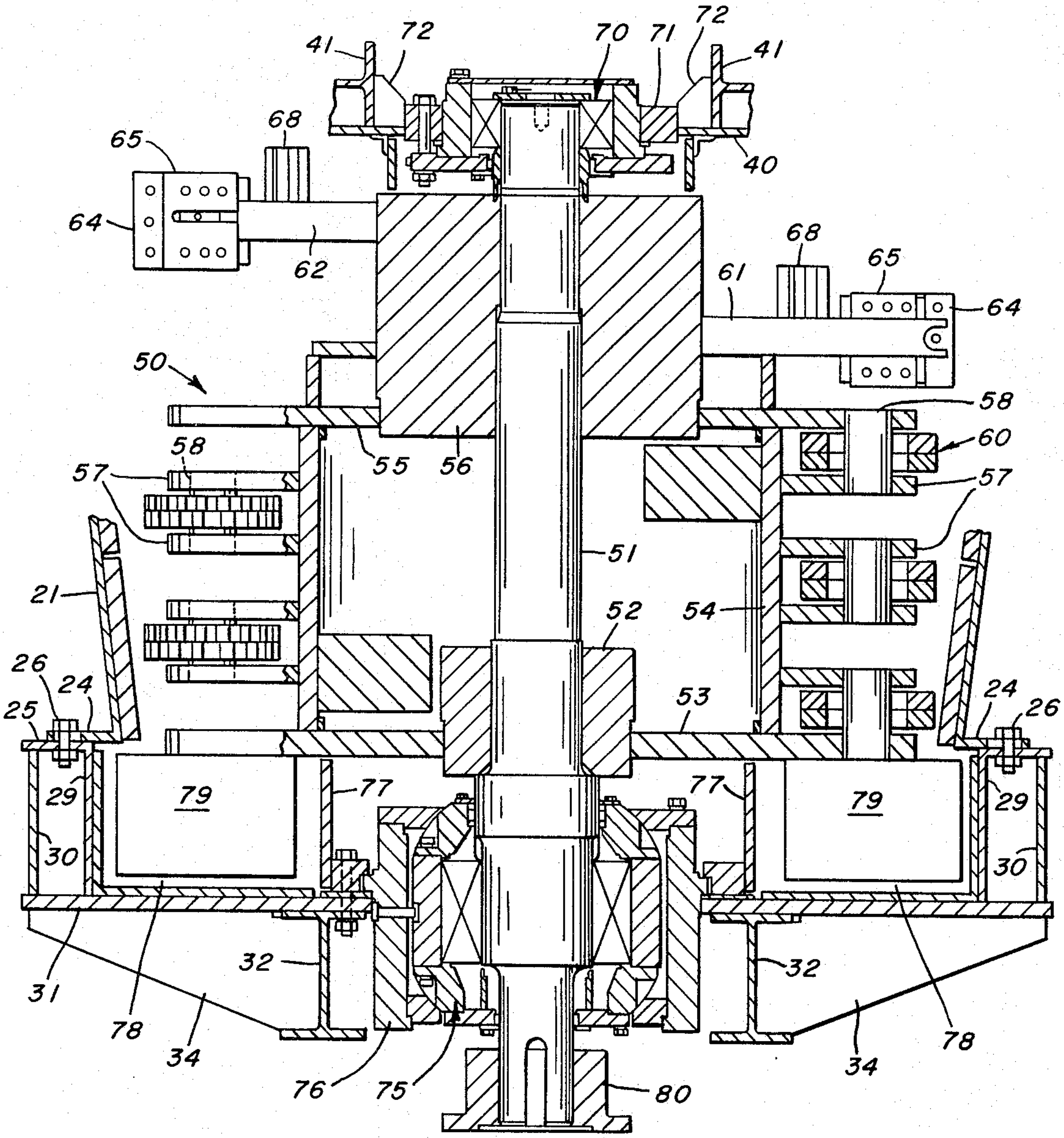
FIG. 7.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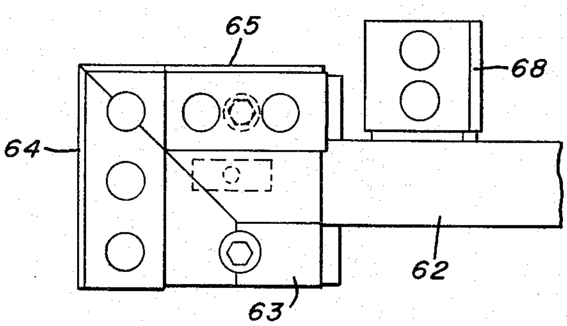
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FIG. 8.

FIG. 9.

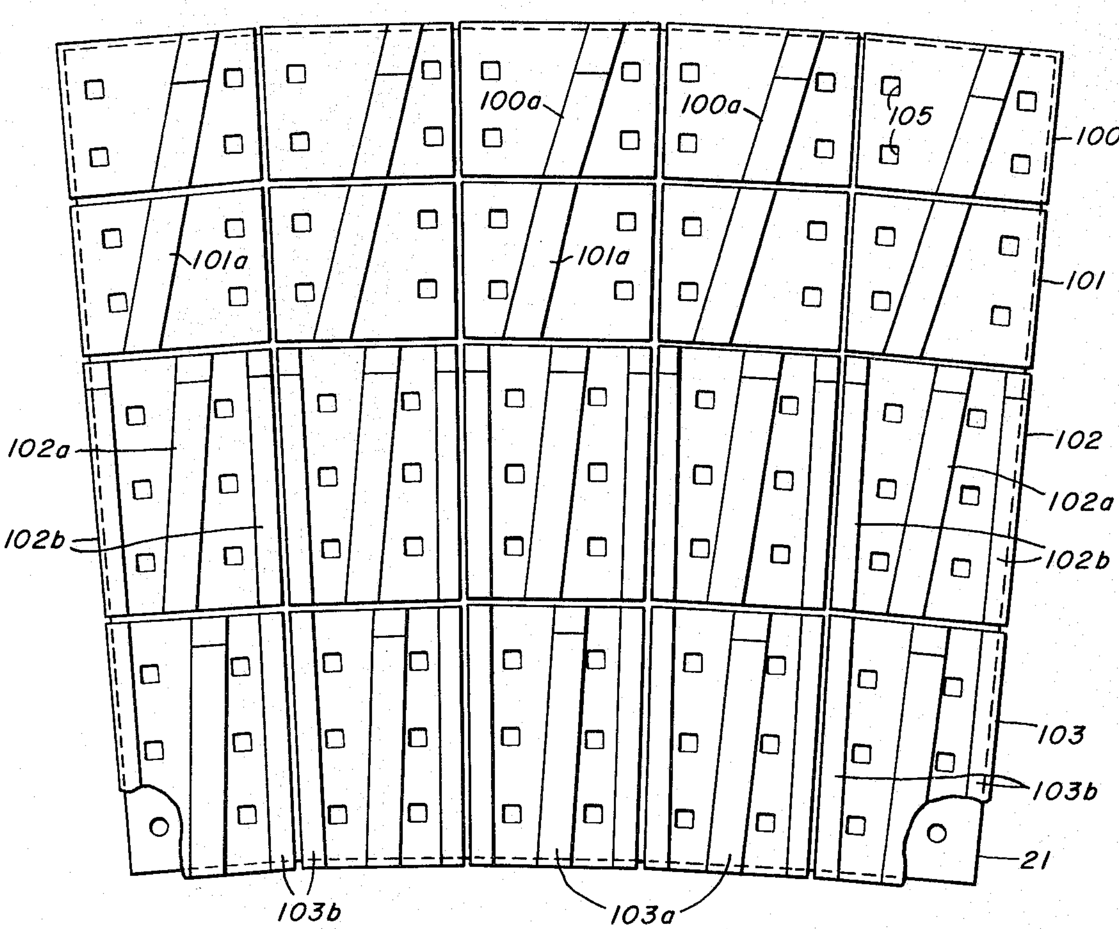


FIG. 11.

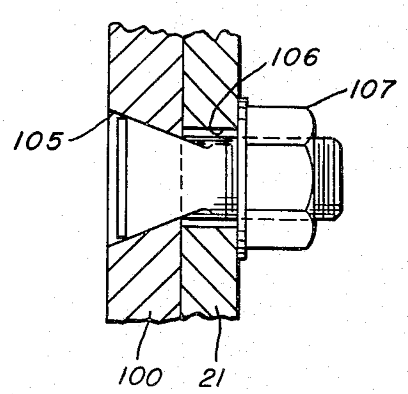
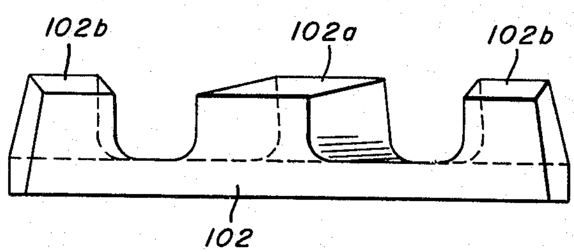


FIG. 10.



APPARATUS FOR REDUCING AUTOMOBILE BODIES AND OTHER WASTE TO USABLE SCRAP

This invention is for a heavy duty reducing and balling mill which is designed primarily for reducing whole automobile bodies or other large metallic objects which have become waste to metal fragments, at least most of which are rolled into balls for subsequent recycling of the usable metal.

It has heretofore been proposed to disintegrate automobile bodies in various ways as by crushing them, cutting the crushed bodies into chunks and reducing the chunks to fragments which are rolled into balls, as disclosed for example in Eidal U.S. Pat. No. 3,356,016. However, such machines for various reasons have not performed up to expectation and results have, for the most part, involved more expense and down time for maintenance than anticipated and more than can be economically justified.

In said Eidal patent the chunks of blocks of scrap produced by first mashing the cars and then cutting them up into sections were discharged into the top of the disintegrating mill where they were supported on a cone from which they moved toward the periphery of the cone to be eventually disintegrated. Recognizing the limitations of said U.S. Pat. No. 3,356,016, the patentee secured a second patent, U.S. Pat. No. 3,587,985, dated June 28, 1971, in which two rotors generally similar to the rotor of the earlier patent were positioned side-by-side, but instead of there being a cone at the top of each rotor there was an inclined chute down which an entire car body could feed by gravity against the upper part of the twin rotors. This introduced other problems.

The present invention, like the apparatus disclosed in the earlier Eidal patent, employs a single rotor on a vertical shaft within a surrounding shell of downwardly decreasing diameter, the rotor having radially movable rotatable hammer elements on its periphery that are yieldably urged outward by centrifugal force, which hammers are known as ring hammers. Each such hammer is free to move radially inward upon impacting a body or object which offers sufficient resistance to force it inward toward the center while centrifugal force urges them outwardly.

The present invention provides a chute arrangement with upper and lower extending feed rolls across the chute that not only crush car bodies from which the tries and engine are usually removed, and from which usable parts may have been removed, but control the rate at which the bodies move into the mill itself where its lead end projects toward the rotating vertical rotor. This single rotor has two radially extending knocker arms, one being 180° removed from the other around the rotor, and one is above the other, and each is provided with specially formed replaceable cutters at the ends. The car bodies to be disintegrated are fed into the enclosure around the rotor at an angle and at such elevation that the lead end of the body is first engaged by these cutters that cut and tear or break the metal into fragments while the feed rolls both feed the body forward at a controlled rate, but also restrain it from crowding or jamming against the rotor too rapidly. The fragments thus cut or torn or broken are strewn around the interior of the rotor and fall into the downwardly decreasing space between the rotor and the shell where they are further disintegrated and broken and the sheet metal fragments will ultimately, at least to a large extent, be rolled into balls or other compacts which are sometimes called "nuggets." These may also contain small solid metal fragments, upholstering which will burn out in a metallurgical furnace, and even glass which may aid in forming slag when the balls are melted down in a furnace. At the bottom of the machine these nuggets, fragments, and pieces, along with any free foreign material resulting from the rending of upholstery, carpets or roof coverings and glass, are delivered through a discharge duct perhaps to be separated by magnetic or other means.

In machines of the type here involved the rotating cone or rotor is of massive construction, weighing several thousand pounds, or many tons, and rotate at high peripheral speed. In a typical machine for reducing automobile bodies, the diameter of a rotor exceeds the width of the automobile bodies which it operates upon, that is, it may be of the order of 9.5 to 10 feet in diameter and rotate at a normal peripheral speed of the order of 70 m.p.h. The impact of such a massive body rotating at high speed against the automobile body or other waste metal object being reduced to usable waste imposes terrific shock and stresses both on the driving motors, bearing and supporting structures.

Our invention provides a machine for converting automobile bodies and like scrap wherein the destructive effects of these shocks and stresses is reduced. This is accomplished in part by providing bearings at the top and bottom of the rotor which are, in effect, integrated through a common rigid structural supporting frame exteriorly of and largely apart from the shell of the mill itself, and which is fixed to a foundation. Further than this, the rotor is operated through a driving gear connected with the rotor shaft by a flexible coupling, and this gear in turn is driven through a plurality of motors disposed around the gear and anchored to the foundation separately from said structural supporting frame. The motors and driving gear are thereby partially protected from the violent stresses and shock generated in the mill itself. An additional improvement in the mill is that the inverted conical shell in which the rotor is contained is formed in sections, some of which, at least, can be adjusted toward or away from the rotor as conditions may require. The interior of the shell is provided with replaceable shell plates of unique construction arranged to cooperate in disintegrating the metal pieces and the formation of the nuggets. Our invention may be more fully understood by reference to the accompanying drawings showing certain preferred modifications of our invention and in which:

FIG. 1 is a side elevation of the entire apparatus;

FIG. 2 is a top plan view of the mill of FIG. 1, part of the cover over the upper feed roll being broken away;

FIG. 3 is a horizontal section in approximately the plane of line III—III of FIG. 1;

FIG. 4 is a view partly in vertical section and partly in side elevation with certain parts somewhat schematically shown for clarity of illustration by reason of the small scale of the drawings, and with the drive for the rotor omitted;

FIG. 5 is a side elevation of the structure shown in FIG. 4 and in addition driving motors are shown, the view being at right angles to FIG. 1;

FIG. 6 is a somewhat schematic sectional view taken substantially along line VI—VI of FIG. 1 showing the drive arrangement for the feed rolls with portions only of the feed rolls but other parts of the structure are omitted for clarity of illustration;

FIG. 7 is a vertical section through the rotor and its bearings, the view being on a larger scale than FIGS. 1 to 5, most of the ring hammers being omitted;

FIG. 8 is an enlarged detail showing in elevation one end of the primary cutter arm;

FIG. 9 is a projection showing in elevation the various liner plates on one section of the inverted conical shell;

FIG. 10 is an end elevation of the lower end of one liner plate from one area of FIG. 9 to illusrate how the ribs stand out from the base of the liner plate;

FIG. 11 is a fragmentary transverse section showing one of several bolt and nut arrangements by the use of which the liner plates are removably attached to the shell;

FIG. 12 is a fragmentary top plan view of the cover of the mill with a portion broken away to illustrate the joint between two sections of the shell and showing the diagonal bolt slots in the cover; and

FIG. 13 is a fragmentary horizontal section through the shell near the base showing the lateral flanges at the base of the sections with slots similar to those shown in the cover.

GENERAL DESCRIPTION

Referring to the drawings, and particularly to FIG. 1, 2 designates the top level of a supporting foundation. On this foundation there is a structural frame 3 entirely separate from the remainder of the mill that provides the principal support for an inclined feed chute 4. The chute is preferably of a length to accommodate at least two passenger car bodies of average length in tandem. It is wide enough to easily receive an average passenger car body, the width typically being of the order of 100 inches between the side walls 5.

The inner end of the chute extends into the mill, designater generally as 6, the chute terminating inside the upper portion of the mill. The mill includes a structural metal base 7 that is bolted to spaced supporting piers 8 extending above the level 2 (see FIGS. 2 and 5).

The space between the foundation piers 8 provides room to receive the drive mechanism for the mill, this mechanism being designated generally as 9.

Other important parts of the mill comprise an upper feed roll and mounting with its drive, the roll extending across the chute near where the chute enters the mill, this assembly being designated generally as 10. There is a complementary lower feed roll and driving assembly located below the upper one, this assembly being designated generally as 11. The scrap, largely in the form of rolled-up metal fragments called "nuggets" and small chunks of solid metal, also comprehended by that term, are discharged from the mill at 12 along with fragments of upholstery, glass, etc.

THE MILL

The mill, designated generally as 6, comprises an inverted conical outer shelf 20 made of four complementary sections, two of which, designated 21, are the full height of the shell and are of about 90° in arcuate extent, and the other two of which, designated 22, extend only part-way up the height of the shell and are also about 90° of arc in extent. All of these sections have outwardly extending laterally-extending base flange portions 24 (see FIG. 13) which set on a supporting ring 25. The flanges are slotted with diagonal slots so that bolts with nuts, indicated at 26, secure the sections to the ring, the position of the bolts in the rings being fixed. All of the sections have confronting vertical flanges 27 that are bolted together with removable shims 28 between the flanges. By removing the shims entirely or replacing them with thinner ones and loosening the fasteners 26, the sections may be moved closer together, thereby reducing the internal diameter. After such an adjustment is made, all fastenings are again tightened.

The supporting ring 25 is at the top of a circularly extending inner wall 29 and an outer annular wall member 30 (see FIGS. 4 and 7), the walls 29 and 30 being welded to a heavy base plate 31, the ring 25 thus comprising part of a rigid box section capable of sustaining a heavy load.

The base plate 31 rests on and is welded to two spaced parallel I-beams 32 which, as shown in FIG. 2, are connected at the ends by cross beams 33. In addition there are gussets or braces 34 extending from the outer faces of these structural sections 32 under the plate 31 to the edge of said plate, this arrangement comprising the base 7. As best seen in FIG. 5, the ends of the parallel beams 32 rest on and are bolted to anchor bolts on the tops of the concrete piers 8.

There is a cover assembly on the top of the shell which comprises a metal plate 40 secured to the under side of two spaced parallel main cover-supporting sections 41, these sections being directly over the lower main sections 32, these sections being connected by transverse structural sections 42. The cover is somewhat eliptical in shape (see FIG. 2), having its major axis parallel with the roof beams 41 and the lower beams 32. There are gussets or braces 43 extending transversely from the outer surfaces of the sections 41 to the edges of the cover at the left side as viewed in FIGS. 2 and 4. The tops of the shell sections 21 have laterally extending flanges with holes therein for the reception of bolts (see FIG. 12), and these pass upwardly through diagonal slots 44 in the cover similarly arranged to those in the base flanges of the sections, as above described, to accommodate the adjustment of the tops of the shell sections toward and away from the center of the cone when shims 28 are inserted, removed or changed.

The main cover supporting structural sections are supported at each end by rigid structural columns 46 buttressed by diagonal structural braces 47. At the right side of the cover as viewed in FIG. 2, the cover has an elevated hood portion 48 over the chute 4 where it enters the shell, the hood being slightly greater in length, from one side to the other, than the width of the chute.

Substantially centered within the inverted conical shell is a rotor, designated generally as 50, comprising a central shaft 51 on which is fixed a lower hub member 52 to which is welded a lower circular plate 53. Mounted on and secured to this plate is a heavy vertical cylinder 54. A circular plate 55 of the same diameter as plate 53 is welded to the top of the cylinder 54, and the peripheral margins of the plates 53 and 55 both extend the same distance beyond the periphery of the cylinder. The inner periphery of the plate 55 is secured to a massive central hub member 56 fixed on the shaft 51.

The cylinder 54 has a plurality of equally-spaced supporting annuli 57 spaced equally from the plates 53 and

55 and from each other. There are registering holes in the peripheral margin areas of the plates **53** and **55** and in the annuli **57** to receive straight shafts **58,** only some of which are shown, others being omitted for clarity of illustration. The shafts are arranged in a stacked relationship to each other, with the shafts in one stack laterally offset or staggered with the shafts of the adjacent stacks. Positioned on each shaft **58** is a hammer unit **60.** Each such unit, as here shown, comprises two elements, one above the other, each being a large gearlike annulus with a central bore larger than the shaft **58** so that each hammer element may move radially outwardly under centrifugal force to a position shown in FIG. **3** where a portion of the periphery projects beyond the peripheral edge of the over and underlying annulus **57** or move radially inward under pressure or impact to a retracted position where the teeth of the hammers do not protrude beyond such annuli. These hammers, known as "ring hammers" are well known and understood in the art. The diameter of the rotor from the bottom plate **53** to the top plate **55,** assuming all hammers to be retracted, is about uniform, so that there is a downwardly converging clearance space around the rotor between the interior of the shell and the rotor.

Above the upper plate **55** of the rotor the hub member **56** has two diametrically opposed radially extending curved arms **61** and **62** sometimes referred to as "cutter arms" or "knocker arms," the arm **61** being below the arm **62.** As indicated in FIG. **3** of the drawings, the rotor is designed to turn in a counterclockwise direction. The leading faces of these arms at the outer ends thereof each has a removable support block **63** bolted thereto which, as seen in FIGS. **4** and **8** is of a vertical height exceeding the vertical thickness of the arm on which it is carried. Each block has a replaceable cutter thereon with a vertical portion **64** at the outer edge of the block and a horizontal portion **65** along the top edge of the block. These block and cutter assemblies are removably bolted to the respective arms on which they are carried so as to be readily replaceable. Since the arms are at different levels the cutters sweep in complementary and not overlapping swaths, or swaths which only slightly overlap.

The roof has an opening therein through which the upper end of the shaft **57** projects and there is a heavy-duty roller bearing unit **70** for the upper end of this shaft in this opening. The bearing assembly is fixed in a roof-ring **71** welded to the roof and from which radiate a plurality of vertical webs **72** abutting against and welded to the roof beams **41** and **42** so that the bearing unit is effectively integrated into the roof frame. As seen in FIG. **2** of the drawing there are six of these webs which hold the shaft bearing immovably fixed in the roof structure.

The bottom plate **31** has an opening therethrough. The lower end of shaft **51** extend through this opening and there is a combined heavy-duty radial and thrust bearing unit **75** for the rotor shaft **51** in this opening in the bottom plate. This unit is confined by a collar **76** secured to the plate **31** so that the bottom bearing is effectively integrated for structural purposes in the bottom plate. There is an annular trough **78** between wall **77** and the wall **29.** This is a scrap discharge channel and blades **79** on the underside of the plate **31** move the scrap around this channel to a discharge opening as hereinfater described.

The projecting lower end of the shaft **51** carries one element **80** of a well-known type of flexible coupling. There is a mating section **81** bolted thereto, this being at the upper end of coupling shaft **82.** There is a similar element **83** at the lower end of **82** which is bolted to member **84** on a stub shaft **85** at the center of a drive gear wheel **86.**

DRIVING GEAR

This driving gear is centered in a square structural steel frame **90** set in the recess between the piers **8.** On this frame, which is anchored to the foundation independently of the mill supporting beams **32** and **33,** is the drive assembly for the rotor. The frame has opposed rigid stanchions or supports **91** for a plurality of motors, preferably four of them, with vertical shafts, the motors having their respective shafts spaced equally from one another. Two motors **92** are preferably wound rotor motors and two shorter ones **93** are preferably squirrel cage motors, but all are of equal horse power, each being in the machine here specifically described 500 horsepower motors. Motors **92** are particularly useful for starting rotation of the rotor, but all function together as operating speed of the rotor is reached. Each motor drives a pinion **94** that meshes with the drive gear wheel **86,** preferably through couplings **95** and short shafts **96** in bearings **97.** With this arrangement there are several advantages, one of which is that tremendous power can be delivered to the rotor for rotating it at high speed but any shock is distributed to four driving pinions instead of all of the shock being transmitted through one or two gear teeth on the gear wheel **86.**

As best seen in FIGS. **3** and **4,** and as previously explained, the shell sections **22** are of less height than the full height of the shell, providing a recess below the remainder of the top of the shell so that the lower end portion **4A** of the chute **4** enters the shell below the top of the shell and just below the level at which the cutter on the lower cutter arm **61** rotates. The inner edge of the chute terminates at **4B** in an arc concentric about but spaced outwardly from the circle of rotation of said cutter. As seen in FIG. **3,** the shell sections **22** have a support structure **22***a* at the tops thereof for the lower end of the chute.

THE SHELL LINING

The interior of the shell from the top to about the level of the lower rotor plate **53** has a lining constructed for cooperation with the cutters and hammers. Preferably this liner is comprised of several courses of liner plates, one course above another, removably bolted to the interior of the shell. Preferably also there is a difference between the liner plates of the several courses. In the drawings, **100** designates the liner plates of the uppermost course, **101** the next lower course, **102** the third course down form the top, and **103** the lowermost course.

The liner plates are flat from side to side and top to bottom, and the walls of the outer shell section **21** and **22** are similarly flattened so that the shape is not truly circular in transverse section but is a many-sided polygon. In FIG. **9** there is shown in porjection the arrangement of liner plates on one shell section **21.** This is duplicated on the other section **21** and because of the recess in the top of the large section **22** to receive the trough, the arrangement in sections **21** is substantially duplicated where possible; that is the same pattern is followed with twice the number of blocks in the two lowermost courses, or some special blocks to give much the same pattern may be provided.

Referring to FIG. 9, each liner block **100** in the top course has a diagonal rib **100***a* starting near the right upper corner of the block and terminating at the bottom at about the middle. The blocks **101** of the second course have a similar rib **101***a* that forms in effect a continuation of the diagonal ribs of the block of the top course. The blocks of both courses taper in width downwardly, the tops of blocks **101** being of subtantially the same width as the bottoms of the blocks in the upper course. This taper continues downwardly in each course, so that while the number of blocks in each row is the same as in any other row, the width diminishes according to the downwardly diminishing diameter of the outer shell. The abutting side edges of the blocks are beveled at the required angle to fit closely together. The blocks **102** of the third course from the top are of greater length than the blocks of the upper two courses. They have a somewhat diagonally extending rib **102***a* in the central area which is inclined in the same direction but more steeply than the ribs **100***a* and **101***a* and in addition have a substantially vertically extending but slightly narrower rib **100***b* down each vertical edge. Although these ribs **102** are narrower than the inclined ribs **120***a*, the ribs **102***b* of two abutting blocks form in effect a single wide, nearly vertical rib around the interior of the shell alternated with an inclined rib.

The blocks **103** of the lower row are of course much narrower than the blocks of the upper row. They are much like blocks **102** in length and they, too, have a diagonal rib **103***a* in the central area extending from top to bottom but much more nearly vertical than the corresponding rib of the blocks **102.** They also have substantially vertical side ribs **103***b* that are in alignment with the ribs **102***b* of the blocks above, and in effect form continuations thereof.

In order to better illustrate the nature of the ribs, FIG. **10** shows the bottom end view of one of the blocks **102,** in which view of course dimensions in the direction of the length of the block appear greatly foreshortened.

The liner plates or blocks are cast of a hard, tough steel alloy with non-circular, preferably square, non-circular tapering bolt holes therein as indicated. FIG. **11** shows in detail the manner of attaching the liner plate to the shell. In this view **21** indicates in section a typical fragmental portion of the outer shell, and **100** a typical portion of one of the liner plates other than a rib portion. One of the non-circular or square bolt holes of the outwardly diminishing area is indicated at **105** and **106** is a round hole in the shell **100** that registers with square hole or socket **105.** There is a countersunk bolt having a conical square head received in the socket while its shank **106** passes through the hole in the shell and is threaded to receive a nut **107.** The fastenings as thus arranged can be tightened from the exterior of the shell, and no part of the bolt projects beyond the surface of the liner plate and each bolt continues to be effective to hold the plate even though the plate wears away until it is no longer usable.

The liner in the shell of course confronts the ring hammers on the rotor and at the bottom of the rotor the clearance between the rotor and the liner plate ribs is quite small. Typically with the hammers in the extended position shown in FIG. **4** where the rotor is approximately 10 feet in diameter with the ring hammers in the position shown, this clearance is of the order of 1 ½ inches.

FEED ROLLS

In the bottom of the chute **4** just outside the shell there is an opening **4C** across substantially the full width of the chute through which the upper portion of the periphery of the lower feed roll in the assembly **11** is exposed. This feed roll, designated **115** (FIG. **6**), has shaft extensions which are received in bearings **116** at each end and which are fixed on the structural supporting frame **3.** It has projecting axially elongated teeth or projections **117** arranged in rows both around its periphery and across its length so that they are axially and peripherally spaced from one another. These teeth, along with a portion of the periphery, project through the opening **4C** in the trough a slight distance above the trough bottom. As best seen in FIG. **6** the roll has a sprocket wheel **118** at one end which is driven by chain **119** and a motor **120,** preferably a hydraulic motor, fixed to the supporting structure below the bearing **116.**

For cooperation with the lower feed roll there is the upper feed roll assembly designated generally as **10.** This assembly comprises two rigid lever arms **125** extending along the outside of the chute, one at each side. Each arm is pivoted at **126** to support **127,** the supports **127** being secured to the chute-supporting structural frame **3.** The free ends of these arms are connected by a cross beam **128.** There is a bearing **129** on the underside of each arm near its outer end to receive shaft extensions of the upper feed roller **130.** The roller **130** extends across the full width of the interior of the chute and it has a sprocket **131** on a shaft extension at one end driven through a sprocket chain **132** from a motor, also preferably a hydraulic motor **133,** which is supported on one of the lever arms **125.** Like the lower roll **115,** the upper roll has projecting teeth thereon arranged similarly to those on the lower roll. There is a cage **135** carried on the vertically pivoting structure comprising arms **125,** the cross beam **128** and the parts carried thereby, this cage being covered with expanded metal or other covering to prevent the escape of metal fragments that may be projected from the shell where it is open to receive the chute, or fragments of glass or metal generated by the action of the feed rolls.

It will be noted in FIG. **1** that there is a hydraulic or other fluid pressure jack or dash pot at **136,** and there is a duplicate (not shown) at the other side of the machine. Each jack has a cylinder **137** pivoted to a beam comprising part of the structure **3** and it has a piston with a piston rod **138,** the upper end of which is pivotally connected at **139** to the underside of the lever arm **125.** The jack as here shown with its duplicate on the opposite side together support the pivoted upper roll-carrying structure in its lowermost position where its axis of rotation is "downstream" or to the left of the axis of the lower roll at a position where it just clears the shell and its roof. The rolls **115** and **130** are both driven so that their confronting peripheral areas work together to advance the car down the chute as indicated by the arrows in FIGS. **1** and **4.**

OPERATION

In operation an automobile from which the engine and tires have been removed is hoisted by a crane (not shown) to the top of the chute and headed down toward the feed rolls, and when it has moved down to where it is about to be, or has been engaged by the feed rolls, a second auto body will be placed in the chute behind it so that gravity will assist in pushing each car in turn between the two rollers. The upper roll is pulled against the roof by the hydraulic jacks **136** in such a manner as to effectively grip the roof and control the feed of the automobile, and to some extent mash the roof so that the automobile can enter the shell. At the same time the lower roll may be tearing at underchassis parts of the assembly while th two rolls together urge the body down over extension **4A** of the chute where the lead end of the car is projected into the path of rotation of the cutters on the arms **61** and **62.** Since these cutters are moving at a peripheral speed generally of the order of 70 miles per hour in a typical operation, the lead end of the car will be progressively torn, cut and rent into chunks and pieces of varying sizes.

The pieces and fragments which are thus produced fall into the spaces between the rotor and liner where the hammers knock them against the liner plates, breaking and shearing them, and sheet metal and other malleable thin metal fragments will be rolled and compacted into variously shaped nuggets, which can be introduced into metallurgical furnaces and leave space between them, as contrasted to flat or sheared sheets that may pack together to an objectionable extent. The greater inclination of the ribs on the upper plates away from vertical encourages the dropping of pieces straight down and tends to induce the bending of sheet metal fragments toward a condition where the fragments will "ball up," while lower down the effect of the ribs is to still further induce a rolling and compacting of the fragments.

Finally, at the bottom of the rotor smaller pieces can fall through into the discharge trough **78** all around the periphery of the rotor and larger pieces and compacts can drop down into the discharge trough between the ribs of the liner plates and the periphery of the rotor.

PRODUCT DISCHARGE

On the side of the shell at the bottom there is a tangentially-extending passage from the discharge channel or trough into a duct **200** (see FIGS. **1** and **2**). The blades **79** on the rotor moving around the trough force the fragments or nuggets out this duct from which they may drop into a receptacle or onto a receiving conveyor, neither of which is shown. Considerable heat is generated that may result in oil vapors and fumes being generated and possible ignition of upholstery. The rotating scraper blades **79** act as a centrifugal fan to draw these fumes down and expel them into the duct **200.** This duct has a flue outlet **201** at its top to take care of such gaseous products.

As previously mentioned, the inclined chute of a length to receive two vehicles provides for the effective use of gravity to assist the feed rolls, which, however, are rotated at a controlled speed that may prevent jamming of the autos against the rotor. At the same time these rolls serve to mash the cars down to a size where they can enter the mill.

The feed chute terminates at a level where the cutters on arms **61** and **62** can effectively engage the lead end of the vehicles as they feed forward. Since the rotor is completely surrounded, except where the chute ends, by the shell liners, all fragments are discharged into the downwardly narrowing space around the rotor.

By using the four driving motors to drive the rotor the impact forces on the driving gear are distributed to four driving pinions, avoiding excessive stress at any one location. The driving gear is further relieved of shock by reason of the flexible connections between the pinion and rotor and by the drive being secured to the foundation entirely apart from the mill itself. Having the motors inverted reduces the overall height of the mill, and there is no need for a pit below ground level to receive the driving gear.

The rotor itself is constantly subjected to stresses which are especially severe at that side of the rotor where the cutters first contact the car bodies to be disintegrated. For this reason the top bearing set into the cover is provided. This bearing in turn is immovably set in the cover and braced against the cover beams. The bottom bearing for the rotor shaft is also immovably supported in the bottom plate and braced against the bottom structural beams. Lateral forces or pressure against the rotor is divided between these two bearings and the upper and lower bearings are structurally integrated through the rigid frame comprising the top and bottom parallel beams and the upright connecting posts and braces. The shell is likewise integrated into the frame structure through the cover and the ring **25** on the boxlike ring structure on the bottom plate, so that relative movement between the shell and rotor due to impact of the rotor with the car being demolished cannot vary the relation between the rotor and the shell or the shell and the structure in which it is mounted.

If adjustment of the shell relative to the rotor is required, it may be accomplished by changing the shims **28** and then adjusting the bolts at the base and roof of the shell radially, as permitted by the diagonal slots, as shown in FIGS. **12** and **13.**

The rotor, at least at the top, has a diameter greater than the width of the chute **4** and consequently greater than the width of any car body that is fed down the chute **4** with its lead end projecting into the path of the cutters on the arms **61** and **62.** As previously indicated, the chute is typically 100 inches wide while the rotor and the arms at the top are typically about 120 inches in effective diameter. This assures that no part of the lead end of the car body will be clear of the swath through which the cutters move. Reduction of the car bodies to smaller sections is therefore unnecessary and problems encountered with twin rotors are avoided.

We claim:

1. Apparatus for reducing automobile bodies to fragments for metallurgical use with a mill comprising:

a. a shell of downwardly decreasing diameter with an internal liner,

b. a single rotor substantially centered in the shell having a pair of diametrically opposed knocker arms thereon, one below the other, and means below the arms providing a plurality of ring hammer units arranged around the rotor below the arms in a descending succession of levels, there being a downwardly decreasing clearance between the exterior of the rotor and the liner in the shell and at the bottom of the rotor there is a minimum clearance space for the discharge of fragments to a receiving means below the rotor,

c. the rotor having a depending shaft extending below the shell and having drive means for rotating the rotor at the lower end of the shaft,

d. an inclined chute of a width to receive an automobile endwise extending upwardly and outwardly from the shell and having a lower terminal portion passing through the shell and terminating therein in such position that the forward end of an automobile body upon reaching the lower end of the chute will be in the plane of rotation of said knocker arms, and

e. feed means comprising cooperating upper and lower power-driven rollers extending crosswise of the chute, said upper roller being movable vertically and being weighted to yieldably bias it downwardly toward the lower one.

2. Apparatus for reducing automobile bodies to fragments as defined in claim **1** in which both of said rolls have a plurality of projections thereon spaced from each other lengthwise and peripherally of the rolls on which they are carried.

3. Apparatus for reducing automobile bodies to fragments for metallurgical use with a mill comprising:

a. a shell of downwardly decreasing diameter with an internal liner,

b. a single rotor subtantially centered in the shell having a pair of diametrially opposed knocker arms thereon, one below the other, and means below the arms providing a plurality of ring hammer units arranged around the rotor below the arms in a descending succession of levels, there being a downwardly decreasing clearance between the exterior of the rotor and the liner in the shell and at the bottom of the rotor there is a minimum clearance space for the discharge of fragments to a receiving means below the rotor,

c. the rotor having a depending shaft extending below the shell and having drive means for rotating the rotor at the lower end of the shaft,

d. an inclined chute of a width to receive an automobile endwise extending upwardly and outwardly from the shell and having a lower terminal portion passing through the shell and terminating therein in such position that the forward end of an automobile body, upon reaching the lower end of the chute, will be in the plane of rotation of said knocker arms,

e. means extending across the chute for moving an automobile body down the chute toward said knocker arms at a controlled constant rate, and

f. each of said knocker arms having a cutter at its outer end, the cutters being of a vertical dimension greater than the thickness of the respective arms on which they are carried and which sweep complementary swaths with the rotation of the rotor.

4. Apparatus for reducing automobile bodies to fragments as defined in claim **3** wherein said cutters are removably mounted on the arms.

5. Apparatus for reducing automobile bodies to fragments as defined in claim **4** in which the cutters have a vertical edge portion and a horizontal edge portion.

6. Apparatus for reducing automobile bodies to fragments as defined in claim **3** wherein said shell is comprised of a plurality of segments removably joined together and radially adjustable, those segments under the chute being of less height than the others to provide a recess in the shell through which the chute extends.

7. Apparatus for reducing automobile bodies to fragments as defined in claim **6** in which the shell sections have ribbed liner plates removably attached thereto over substantially the entire surface thereof.

8. Apparatus for reducing automobile bodies to fragments as defined in claim **7** in which the liner plates have a plurality of conical holes therethrough of noncircular contour and of diminishing area outwardly toward the shell, said holes registering with bolt holes in the shell section on which the plates are mounted, and bolts having non-circular heads that fit into said noncircular holes in the plates to restrain the bolts from turning, the bolts having shanks which pass through the holes in the shell and onto which nuts are screwed at the exterior of the shell for securing the plates immovably on the shell.

9. Apparatus for reducing automobile bodies to fragments as defined in claim **7** in which the uppermost liner plates have ribs that are inclined from top to bottom in the direction of rotation of the rotor and the lower plates have ribs which increasingly approach the vertical.

10. Apparatus for reducing automobile bodies to fragments as defined in claim **7** in which the uppermost liner plates have ribs that are inclined from top to bottom in the direction of rotation of the rotor and the lower plates have ribs which increasingly approach the vertical, the lower liner plates also having vertically extending ribs located along their edges and which are in addition to the inclined ribs.

11. Apparatus for reducing automobile bodies to fragments as defined in claim **3** wherein said shell is comprised of a plurality of segments which are joined to one another by a vertical joint between each two segments, said joints being adjusted to receive spacing shims which may be placed and removed therefrom for adjusting the sections relatively to each other and radially with respect to the rotor, the sections under the chute being of less height than the other sections to provide a recess through which the chute enters the shell.

12. Apparatus for reducing automobile bodies to fragments as defined in claim **3** wherein said shell is comprised of at least three segments, the first one of which has a recess in which said chute is received, said shell resting on a fixed base ring at the bottom with lateral flanges on the said two shell segments bolted to the base ring, the tops of said other two segments having outwardly turned lateral flanges thereon and a cover over the shell rested on and bolted to said last-named flanges, the flanges on the bottom segments and the cover over the top flanges being diagonally slotted to receive the respective bolts and secure the bottoms of the shell segments to the ring and the cover having correspondingly arranged diagonal slots for the bolts that pass through the top flanges of the segments and the cover, the slots on one segment being on an oppositely directed diagonal with respect to those on the other.

13. Apparatus for reducing automobile bodies to fragments for metallurgical use with a mill comprising:

a. a shell of downwardly decreasing diameter with an internal liner,

b. a single rotor substantially centered in the shell having a pair of diametrically opposed knocker arms thereon one below the other and means below the arms providing a plurality of ring hammer units arranged around the rotor below the arms in a descending succession of levels, there being a downwardly decreasing clearance between the exterior of the rotor and the liner in the shell and at the bottom of the rotor there is a minimum clearance space for the discharge of fragments to a receiving means below the rotor,

c. the rotor having a depending shaft extending below the shell and having drive means for rotating the rotor at the lower end of the shaft,

d. an inclined chute of a width to receive an automobile endwise extending upwardly and outwardly from the shell and having a lower terminal portion passing through the shell and terminating therein in such position that the forward end of an automobile body upon reaching the lower end of the chute will be in the plane of rotation of said knocker arms,

e. means extending across the chute for moving an automobile body down the chute toward said knocker arms at a controlled constant rate,

f. said shell being mounted on a circular box beam section which defines the outer wall of a trough below the shell and rotor into which fragments discharged from the space between the shell and rotor fall, there being another vertical wall spaced inwardly from said box section forming the inner wall of the trough, the rotor having vanes attached to the under surface thereof extending into the trough for moving the fragments around said trough, the trough having an outlet located at one point thereabout into which the vanes discharge the fragments, and

g. said circular box section hving a supporting plate at the bottom, a rigid structural frame under said supporting plate and attached thereto the structural frame having opposed end portions, spaced foundation piers on which said end portions of the supporting frame set and to which they are secured, the drive means for the rotor being below the tops of said piers.

14. Apparatus for reducing automobile bodies to fragments as defined in claim **13** in which there is a cover over the top of the shell, a structural frame extending over the cover in vertical alignment with said first-named structural frame and to which the cover is attached, diametrically opposite structural members rigidly connecting the structural frame on the top with the one on the bottom to integrate them into a common rigid supporting frame, a foundation to which said rigid supporting frame is fixed, the rotor having a shaft portion at the top and a bearing unit for said shaft portion centered in the cover and integrated with structural frame to which the cover is attached, the rotor having a lower shaft portion extending below the supporting plate at the bottom, and a bearing for the shaft at the lower end of the rotor integrated with said bottom plate and the structural frame under said plate whereby there are top and bottom shaft bearings for the rotor rigidly connected and through said common rigid supporting frame.

15. Apparatus for reducing automobile bodies to fragments as defined in claim **14** in which an extension is flexibly coupled to the lower rotor shaft portion, said extension having a gear wheel thereon, a second structural frame having a bearing for said extension surrounding the gear wheel and bolted to the foundation independently of the first-named supporting frame, a plurality of motors with vertical shafts on said second frame, each of which drives a pinion that meshes with said gear wheel, said motors and pinions being spaced from each other around the gear wheel.

16. Apparatus for reducing automobile bodies to fragments as defined in claim **15** in which said foundation has spaced piers on which the first-named structural frame is set and to which it is secured, the second structural frame being positioned on the foundation between said piers, the motors having their respective pinions at their lower ends with the bodies of the motors extending upward but positioned below said first-named structural frame.

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