United States Patent [19]

Roy

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[54] **DEMOLITION APPARATUS**

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[21] Appl. No.: **331,839**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 217,519, Jan. 13, 1972, abandoned.

[52] **U.S. Cl.** **241/235,** 241/73, 241/101.7, 241/260.1

[51] **Int. Cl.** **B02c 13/20**

[58] **Field of Search** ..... 241/101 M, 101.7, 73, 83, 241/84, 86, 88.1, 88.2, 227, 235, 278 R, 241, 246–248, 260, 260.1, 261; 280/438 R, 438 A

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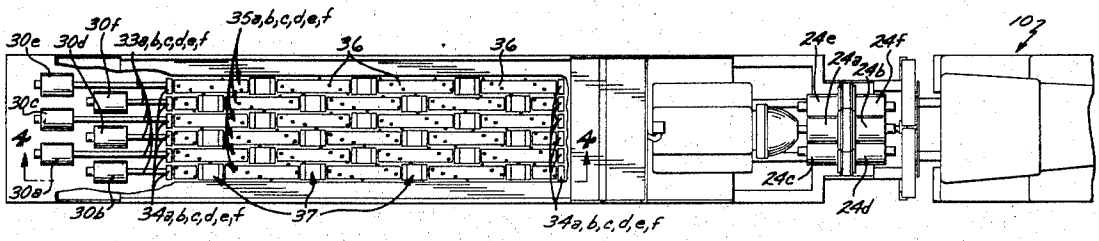
Primary Examiner—Roy Lake
Assistant Examiner—E. F. Desmond
Attorney, Agent, or Firm—Albert L. Gabriel

[57] **ABSTRACT**

The present invention relates to demolition apparatus for fragmenting to any desired fragment or chip size a wide variety of solid waste materials, as for example whole trees, stumps and logs, torn down houses, street collection trash, garbage and the like. Demolition apparatus according to the present invention has particular utility in clearing large tracts of land for buildings, shopping centers, housing developments, industrial plants, etc. The disclosed apparatus comprises a semi-trailer that is adapted to be towed by a tractor, and to perform its demolishing action either while stationary, or while being towed.

The disclosed demolition apparatus comprises a rubble chamber into which rubble such as entire trees is dumped, the apparatus having a masticating bed comprising multitoothed demolition rollers that cut the trees or other rubble into small fragments. The demolition apparatus then discharges the fragments to be collected and packaged or otherwise distributed as desired.

54 Claims, 27 Drawing Figures



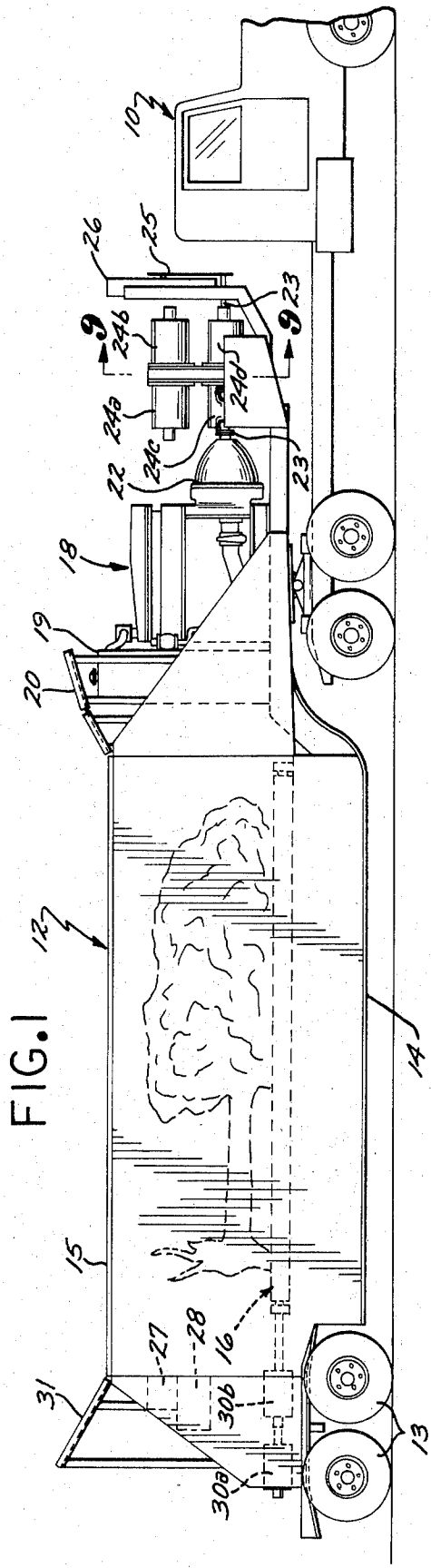


FIG. 1

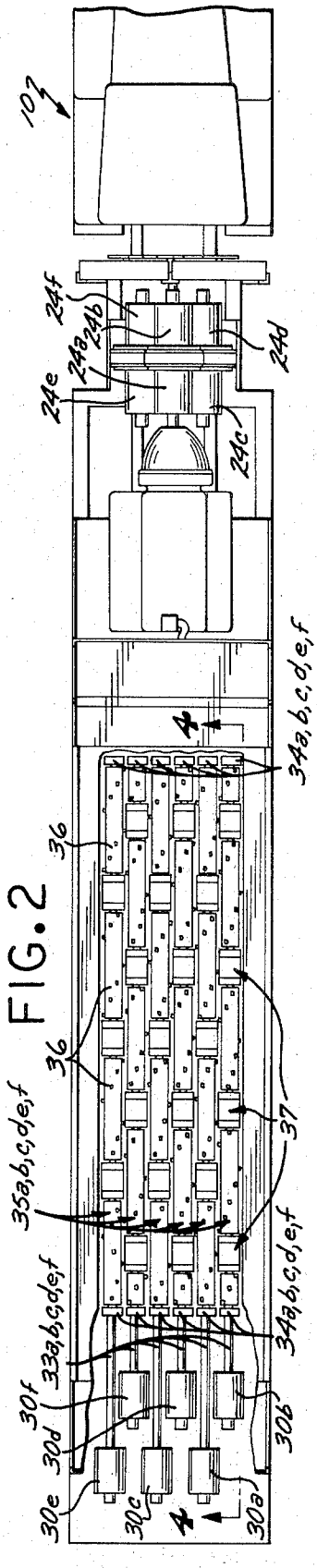


FIG. 2

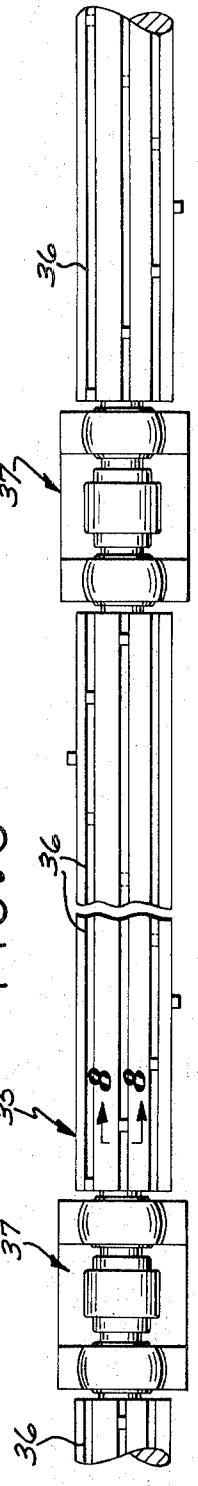


FIG. 3

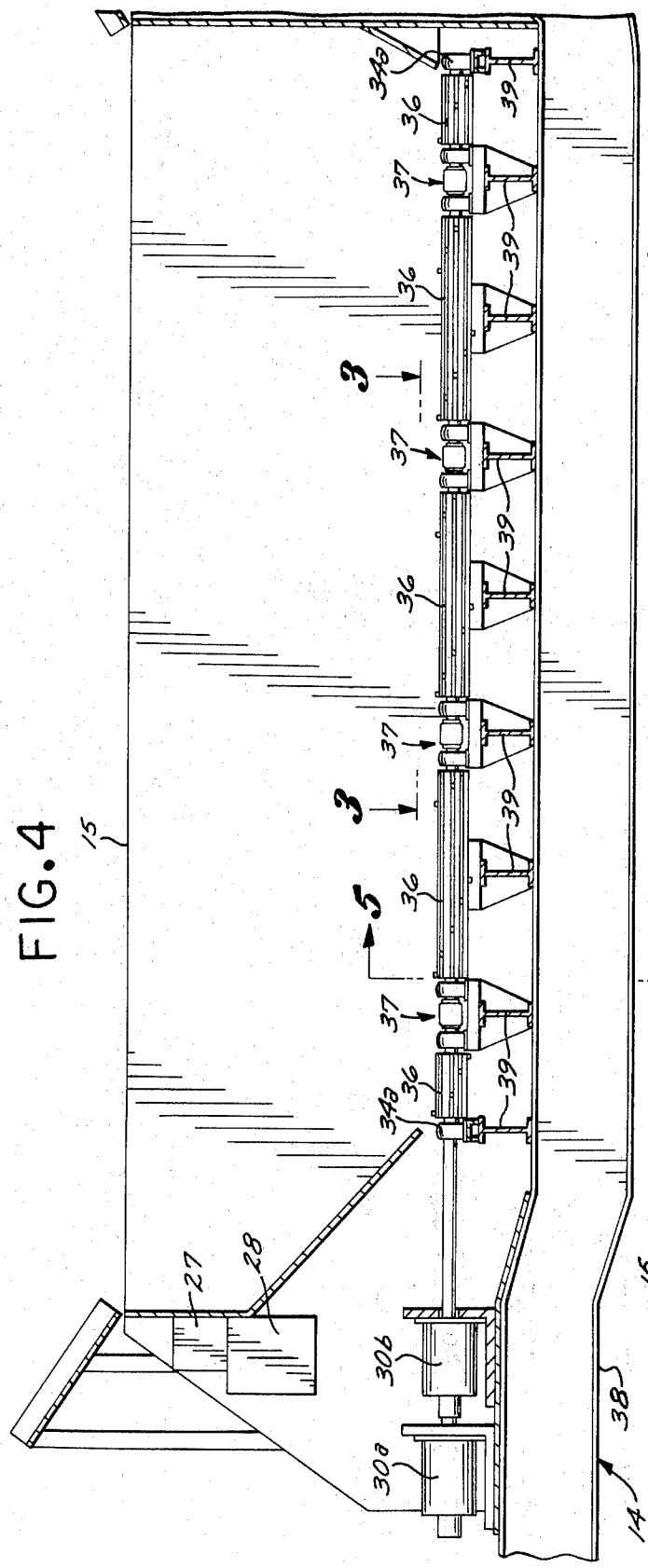


FIG. 4

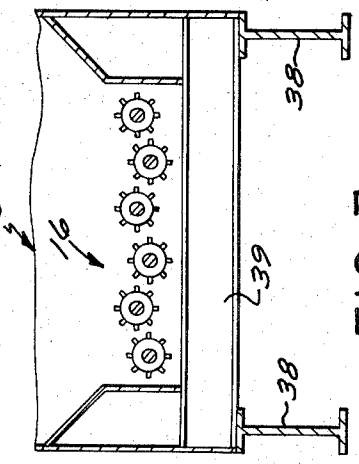


FIG. 7

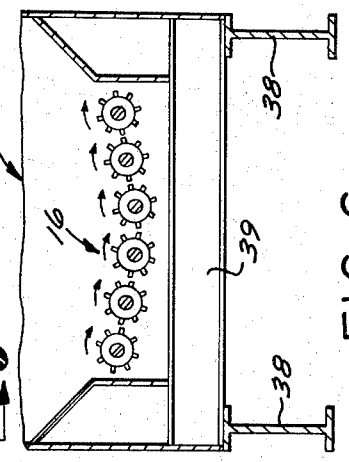


FIG. 6

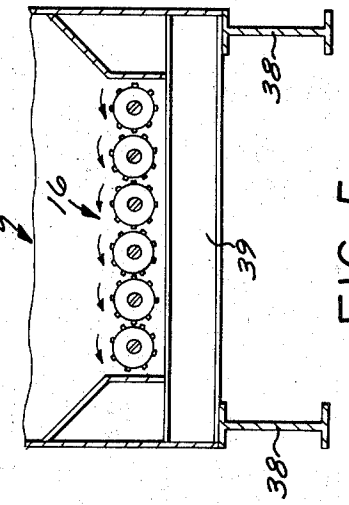


FIG. 5

FIG.8

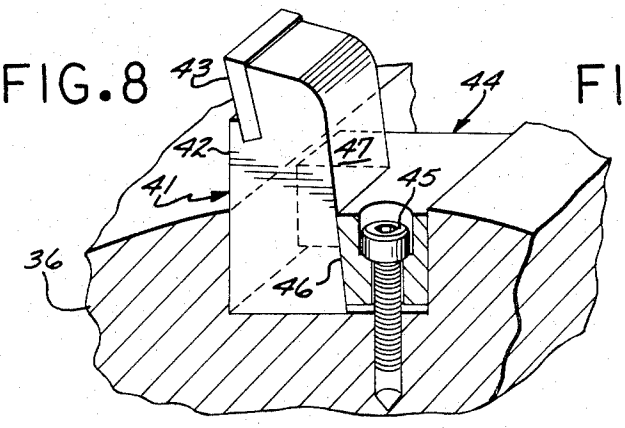
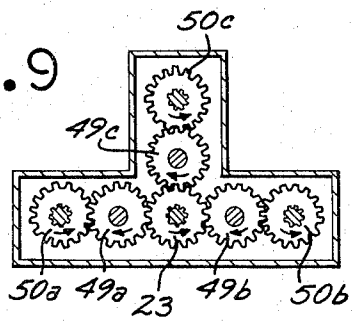


FIG.9



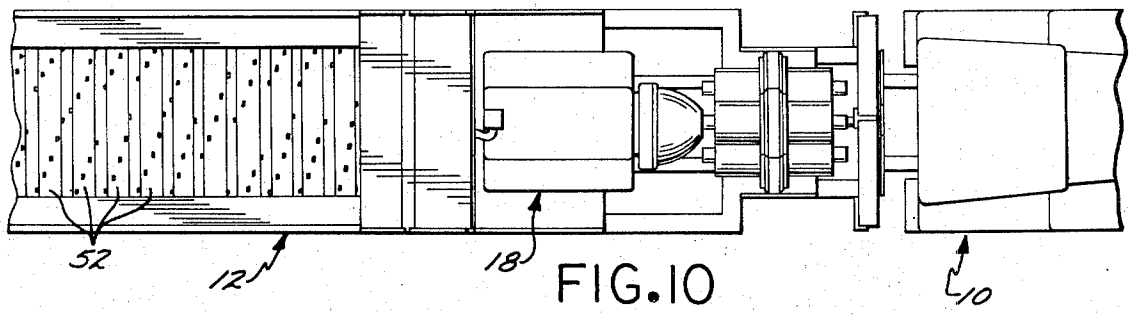


FIG.10

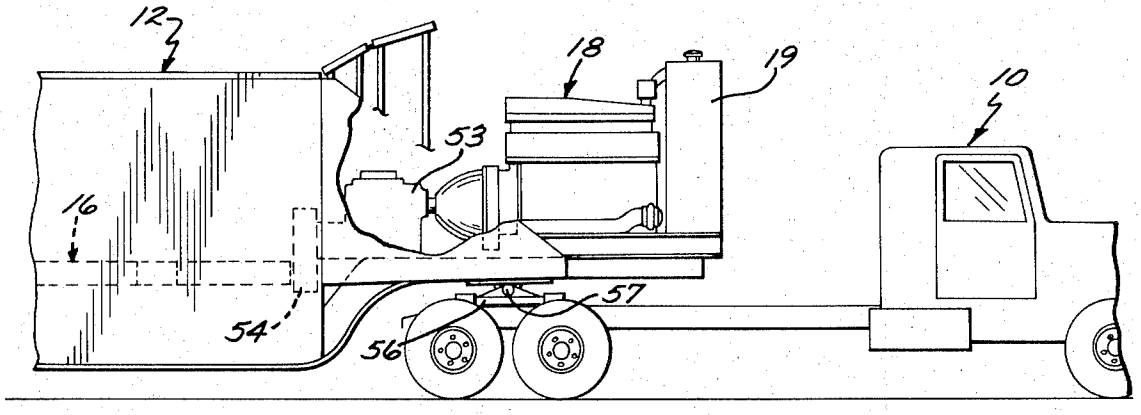


FIG.11

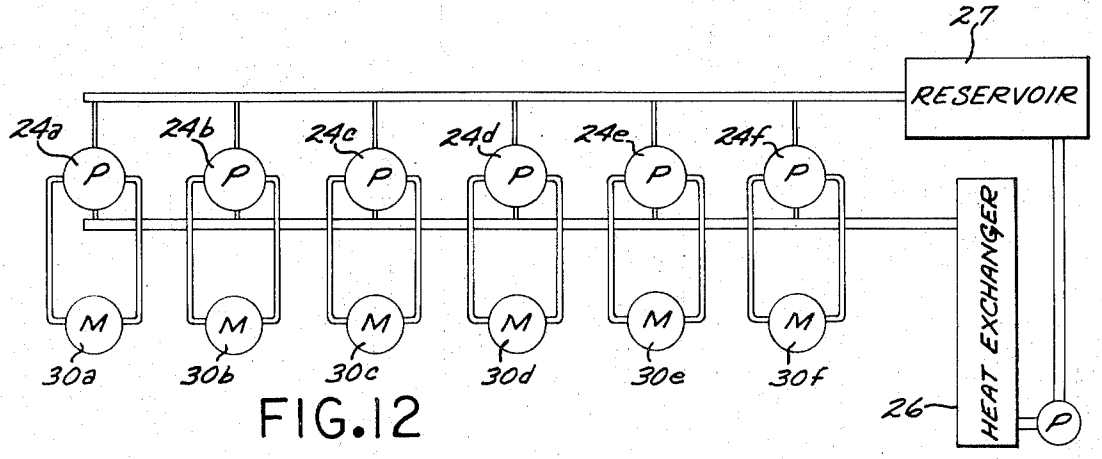


FIG.12

FIG.13

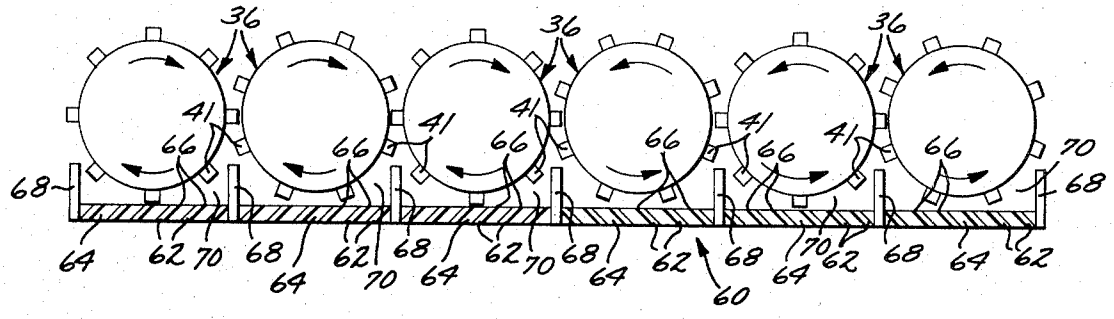
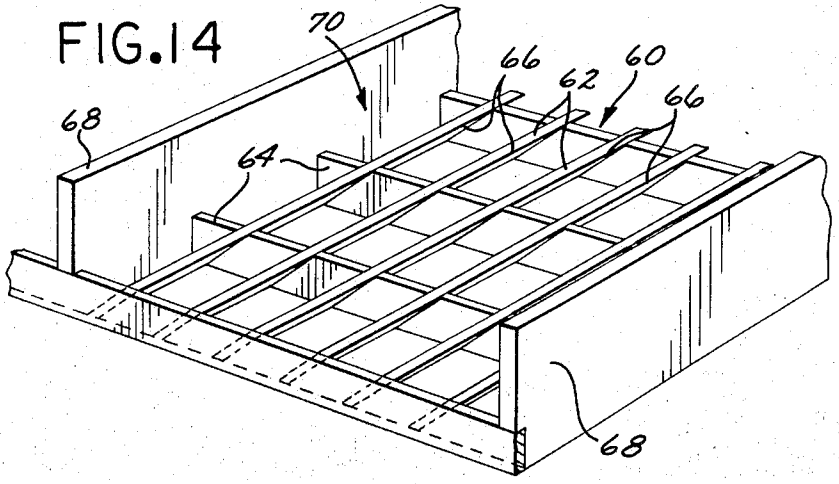


FIG.14



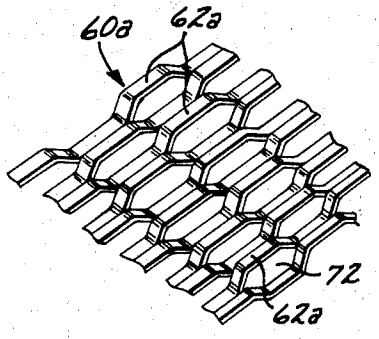
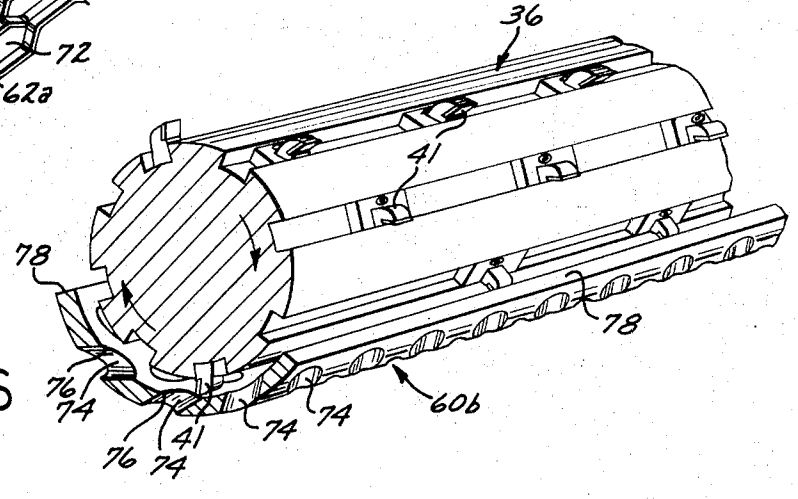


FIG.15

FIG.16



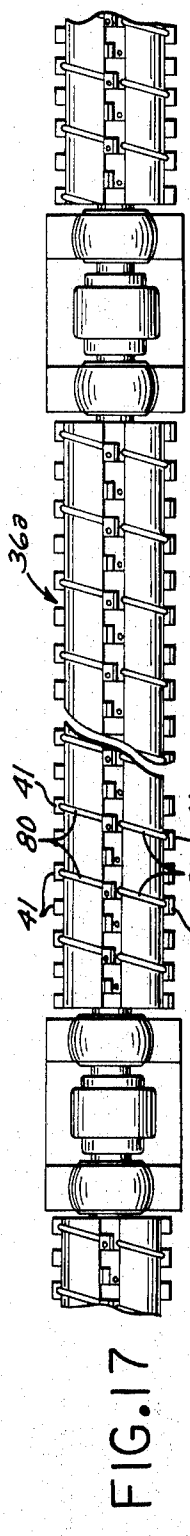


FIG.17

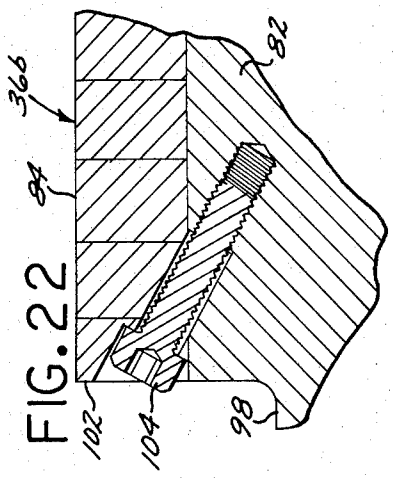


FIG.22

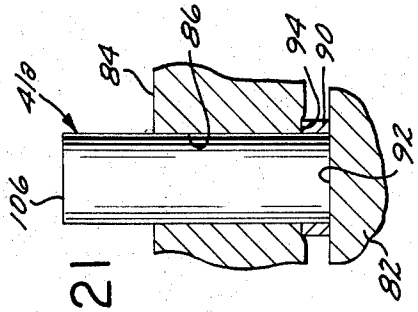


FIG.21

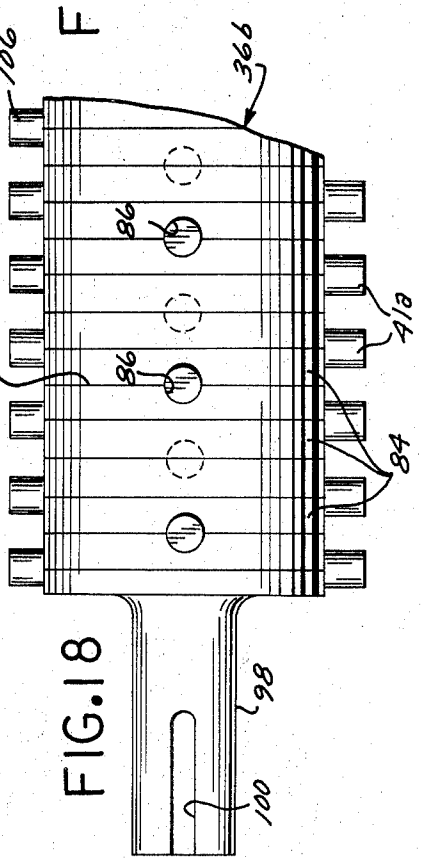


FIG.18

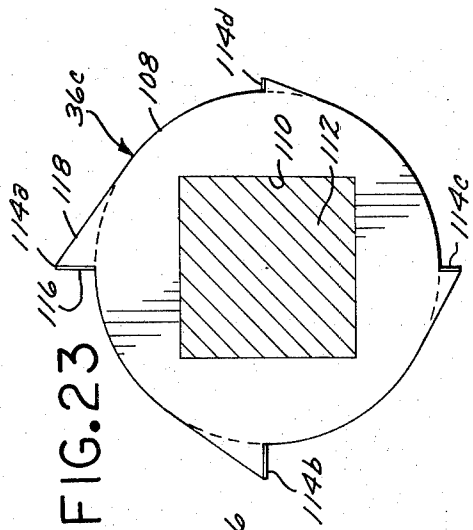


FIG.23

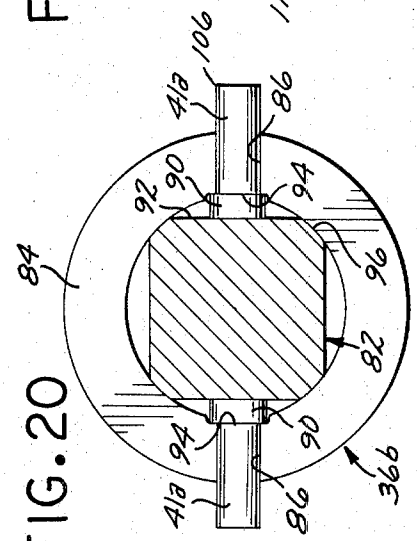


FIG.20

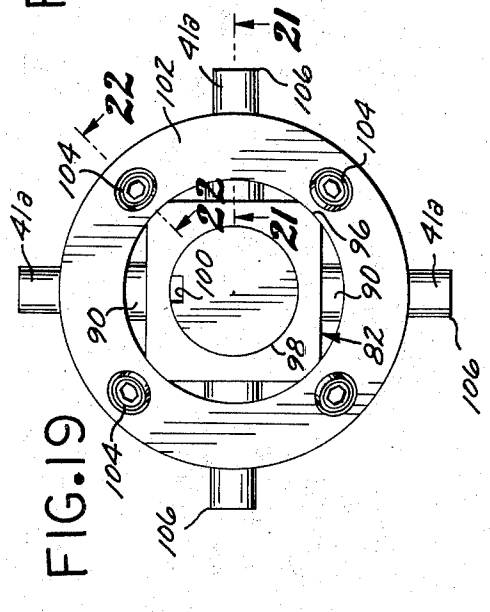


FIG.19

FIG. 24

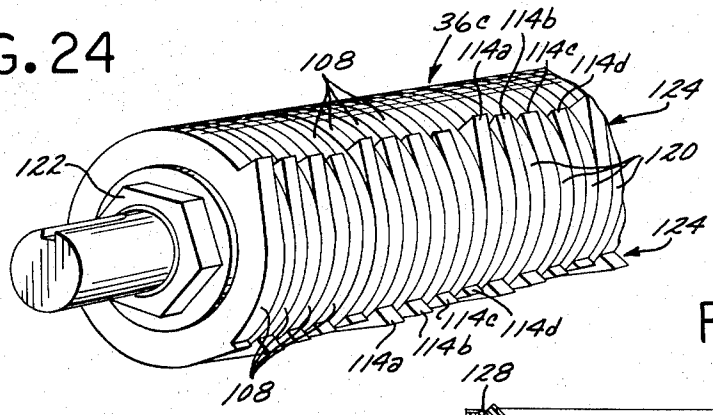


FIG. 25

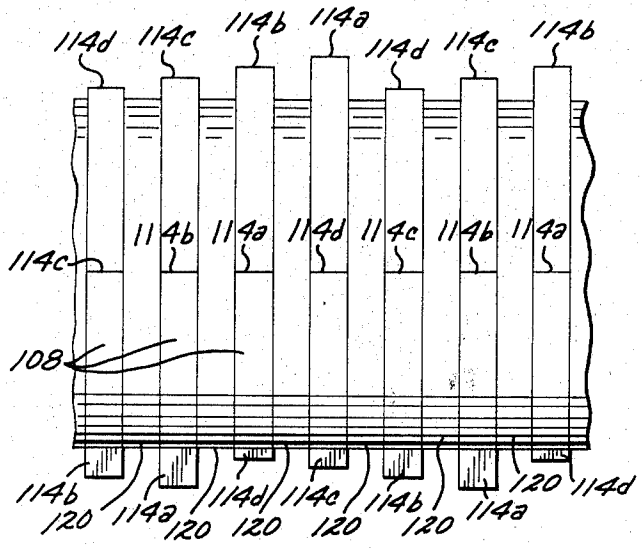


FIG. 26

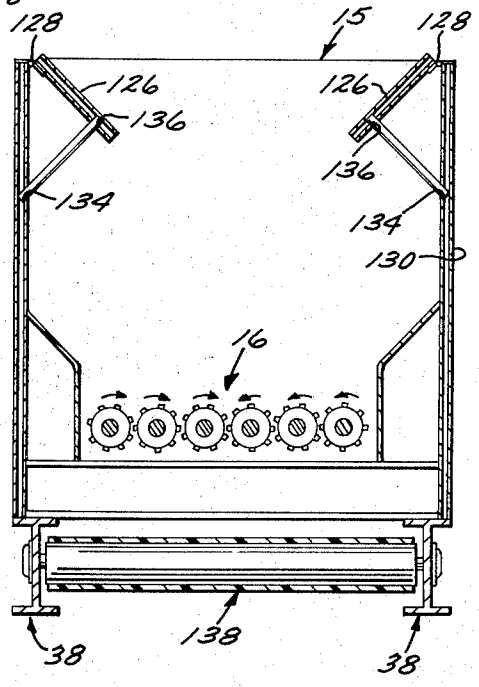
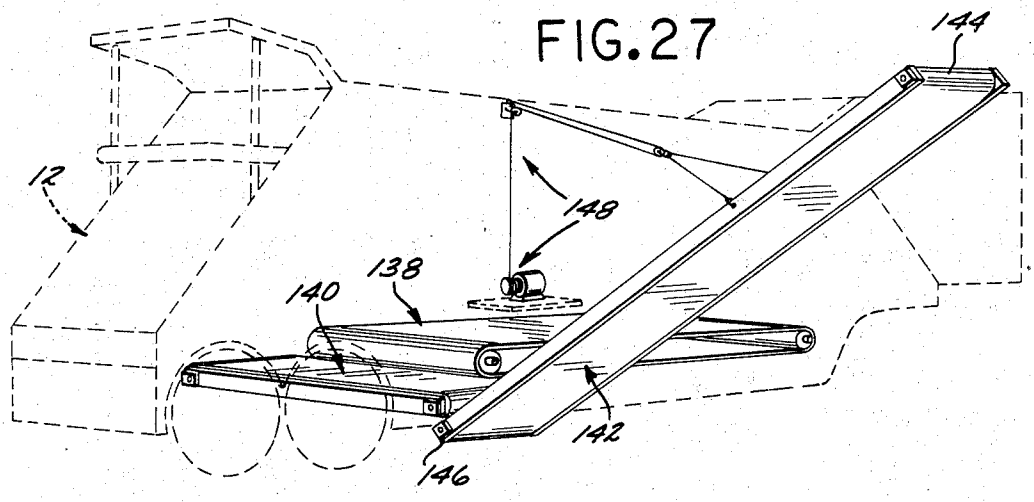


FIG. 27



DEMOLITION APPARATUS

RELATED APPLICATIONS

This application is a continuation-in-part of my copending application Ser. No. 217,519, filed Jan. 13, 1971, now abandoned for DEMOLITION APPARATUS.

BACKGROUND OF THE INVENTION

In the clearing of large land tracts for housing developments, shopping centers, industrial plants, freeways and the like, it often becomes necessary to remove orchards, concrete structures, asphalt pavements, whole houses including plaster, lumber, roofing materials, etc., and the removal of this rubble has always introduced problems, not only the problem of actual removal, but also the problem of how to dispose of the resultant debris.

The problem of actually removing the rubble from the ground has recently worsened, primarily because the low volume, prior art techniques have become too expensive and too inefficient. For example, some of these prior art removal techniques have involved defrocking and detrunking of trees, and then separately handling the limbs, trunks and stumps. Some prior art techniques have required that the resultant tree portions be preoriented and fed stump end first into chopping or crushing apparatus, whereas other prior art techniques have required that the various trunk portions be carefully placed on a rotor of chipping knives in order not to overload any of the knives.

As indicated above, these prior art removal techniques are no longer satisfactory.

In the past, it has been possible to dispose of the debris by burning some of it, burying some of it, trucking some of it to other sites, etc. But of late, these disposal techniques have not been satisfactory because of the lack of disposal facilities, because of increasing cost of disposal, and because of the emphasis upon ecology.

On the other hand, the problem of disposing of properly fragmented wooden debris has decreased, primarily because the debris may take the form of wooden chips for which there seems to be an ever-increasing need. For example, wood chips are now used for the following purposes: barbecue chips, lemon chips, orange chips, briquettes, pressboard, paper, ground mulch, flower beds, weed deterrents, bedding for rose gardens, slip preventatives on ice, animal and restaurant flooring, sweeping compounds, etc.

Another and increasingly serious problem in the solid waste disposal field is in connection with the disposal of street collection trash, which includes such things as food garbage, paper products including cardboard boxes, plastics, metal cans, glass bottles, demolition lumber, plaster, roofing paper, automobile tires, and the like. Such trash is conventionally disposed of in whole form at city or county dumps by a cut and fill process, which requires the use of large areas of otherwise valuable land near cities.

Because such trash is dumped in "whole" form, much of it is not readily assimilated by the land, and such land may be ruined for many years, both ecologically and for developmental purposes. The high percentage of organic materials in such street collection trash, including food garbage, lawn trimmings and the like, generally creates a very bad smell, and attracts large populations of flies, rats, and other disease-carrying pests in the vicinities of the dumps, and this problem is compounded in or near large metropolitan areas where pest control is critical.

It has also been the practice in some major metropolitan areas adjacent to the ocean to take street collection trash a few miles offshore in garbage scows or barges and dump it into the ocean in whole form. This method of dumping is presently in disfavor because of the severe pollution damage it causes to coastal waters and coastlines, but prior to the present invention there has been no satisfactory solution to the problem.

OBJECTIVES AND DRAWINGS

It is therefore the principal object of the present invention to provide an improved demolition apparatus.

Another object of the present invention is to provide an improved demolition apparatus that is mobile, and may be taken to the location where it is needed.

Another object of the present invention is to provide an improved demolition apparatus that is adapted to demolish rubble while the apparatus is either stationary or moving.

Another object of the present invention is to provide an improved demolition apparatus that has a differential power arrangement for providing power where needed.

Another object of the present invention is to provide an improved demolition apparatus that has novel multitooth demolition rollers.

Another object of the present invention is to provide an improved demolition roller tht has novel replaceable teeth.

Another object of the present invention is to provide an improved demolition apparatus having a roughly flat masticating bed.

A further object of the invention is to provide fragment reprocessing means which improves masticating efficiency and enables the size of the fragments or chips from the demolition apparatus to be controlled, and to be reduced to as small a size as desired.

A further object is to provide demolition apparatus of the character described which embodies a novel cutter roller assembly comprising a series of apertured cutter discs removably stacked on an out-of-round driving shaft, which greatly reduces fabrication cost while nevertheless enabling cutter teeth to be readily replaced.

A further object of the invention is to provide demolition apparatus of the character described which has novel deflection wing means thereon which minimizes the projection of chips out of the open top of the rubble chamber.

A still further object of the invention is to provide demolition apparatus of the character described which thoroughly masticates street collection trash or the like into a finely-chopped and shredded, well mixed and thoroughly aerated product that has almost no smell and will not attract flies, rats, or similar pests in any substantial quantities. The end product from such trash is so well refined, mixed, and aerated by the present invention that it is readily assimilated in the soil almost anywhere, and can even be packaged and utilized as a soil enrichment product. Thus, large dump areas and associated cut and fill operations may be eliminated, together with associated hauling and dumping fees.

Disposal of this refined product on land or in the ocean will generally not impair the ecology.

The attainment of these objectives, and others, will be realized from a study of the following description, taken in conjunction with the drawings, of which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a side view of the overall demolition apparatus:

FIG. 2 shows a top view of the overall demolition apparatus;

FIG. 3 shows a partial elevational view of one form of demolition roller assembly, taken on the line 3—3 in FIG. 4.

FIG. 4 shows a partial longitudinal, vertical sectional view of the demolition apparatus;

FIGS. 5, 6, and 7 are fragmentary transverse, vertical sectional views taken on the line 5—5 in FIG. 4, of different configurations of the masticating bed and demolition roller arrangement;

FIG. 8 is taken on the line 8—8 in FIG. 3, and shows a partial pictorial view of a tooth attachment for the form of demolition roller assembly illustrated in FIG. 3.

FIG. 9 is a transverse, vertical section taken on the line 9—9 in FIG. 1, showing a gear arrangement for driving hydraulic pumps forming a portion of the power train from the engine to the demolition rollers;

FIG. 10 is a fragmentary top plan view showing a different masticating bed and demolition roller arrangement;

FIG. 11 is a fragmentary side elevational view, with portions broken away, showing an alternate prime mover engine arrangement;

FIG. 12 shows a schematic drawing of the hydraulic system;

FIG. 13 is a schematic view showing reprocessing grate and cutter bar means associated with a plurality of demolition rollers;

FIG. 14 is a fragmentary perspective view showing details of the reprocessing grate and cutter bar arrangement illustrated in FIG. 13;

FIG. 15 is a fragmentary perspective view of a second form of reprocessing grate, made of expanded metal plate;

FIG. 16 is a fragmentary perspective view of a third form of reprocessing grate, made of a perforated longitudinally cut pipe segment;

FIG. 17 is a partial elevational view similar to FIG. 3, showing a modified demolition roller assembly of the type depicted in FIG. 3, but with many more cutting teeth, and with helix rod segments aligned with some of the teeth for reducing their effective lengths;

FIG. 18 is an enlarged, fragmentary, elevational view of another form of demolition roller assembly comprising a series of tooth-supporting rings assembled on a square shaft;

FIG. 19 is an end elevational view of the roller assembly shown in FIG. 18;

FIG. 20 is a cross-sectional view, partly in elevation, showing details of the assembly of FIGS. 18 and 19;

FIG. 21 is a further enlarged, fragmentary section taken on the line 21—21 in FIG. 19, showing details of the tooth mounting;

FIG. 22 is fragmentary axial section taken on the line 22—22 in FIG. 19, showing how the assembled rings and teeth are held together on the shaft;

FIG. 23 is a transverse sectional view of a further form of demolition roller assembly wherein apertured cutter discs are stacked on a square shaft;

FIG. 24 is a fragmentary perspective view further illustrating the form of demolition roller assembly of FIG. 23;

FIG. 25 is a fragmentary elevational view of the form of roller assembly of FIGS. 23 and 24;

FIG. 26 is a transverse, vertical section taken through the body of the demolition apparatus, illustrating chip deflection wings hinged to the upper side edges of the rubble chamber, and also showing a primary conveyor extending longitudinally under the masticating bed; and

FIG. 27 is a schematic perspective view showing a complete conveyor arrangement.

SYNOPSIS

Broadly speaking, the present application discloses a demolition apparatus that is adapted to handle entire trees that may be dropped unoriented into a rubble chamber that has a masticating bed. The disclosed masticating bed is such that regardless of the tree's orientation, the cutting teeth of the masticating bed are provided with sufficient power to satisfy their instantaneous loads, whether the overall load happens to be a stump, hardwood tree, a plurality of trees, or the like. The disclosed demolition apparatus is also suitable for reducing almost any other type of solid waste to a more easily manageable and sanitary form, including but not limited to such things as torn down houses, street collection trash, garbage, and the like. Various power transmission systems are discussed, as well as the use of differently shaped masticating beds and several forms of toothed cutting rollers employed in the masticating bed. Reprocessing grate and cutter bar means are also disclosed for improving masticating efficiency and for controlling and reducing output particle size.

DETAILED DESCRIPTION

The Overall Demolition Apparatus

As was pointed out above, there is a pressing need for demolition apparatus that can handle extremely large volumes of various types of rubble while the demolition apparatus is either standing still or is moving. The disclosed invention accomplishes this result, as will be understood from FIG. 1.

FIG. 1 shows the overall demolition apparatus to have two parts, a tractor 10 that tows a semitrailer 12, the semitrailer 12 having a plurality of wheels 13 and a trailer base 14 onto which is built a hopper-shaped rubble chamber 15.

As will be explained later, the rubble chamber 15 contains at its lower portion a masticating bed 16 having a plurality of multitoothed demolition rollers, these rollers being powered by any one of a number of suitable power sources. The present explanation will be presented in terms of a hydraulic power system for powering the demolition rollers; although, as will be indicated later, other power systems may be used.

The prime mover engine for masticating bed 16 is shown to be an internal combustion engine 18, such as a 1200 hp Diesel engine of the Caterpillar D348 type, or its equivalent. Engine 18 may be conveniently mounted on the front end of the semitrailer 12, with its radiator 19 mounted under a guiding projection 20 that

protects the radiator **19** from being injured by the rubble that is dropped into the rubble chamber **15.**

Engine **18** of FIG. **1** is illustrated as having a bell housing **22** that encloses a transmission element such as a clutch or a torque converter that protects the engine **18** from overloads, and may, if this is deemed desirable, be adjustable for the loads that are expected. The output power shaft **23** from the bell housing **22** is applied to a gear train to be discussed later that drives a plurality — in the illustrated case, six — of hydraulic pumps **24***a*, **24***b*, **24***c*, **24***d*, etc., the hydraulic pumps **24** being, for example, of the 300 hp – 500 hp heavy duty pumps produced by Sundstrand Corporation. As will be discussed later, each of the hydraulic pumps **24** is adapted to power its own individual hydraulic motor.

For reasons that will become apparent later, the output power shaft **23** from the bell housing **22** is designed to also rotate a set of pulleys **25,** gears, or the like that pump some of the hydraulic fluid through one or more heat exchangers **26.** A reservoir **27** for hydraulic fluid and a tank **28** for Diesel fuel are mounted on the back portion of the semitrailer **12.**

A like polarity, six in this case, of hydraulic motors **30***a*, **30***b*, etc., are mounted on the base **14** of the semitrailer **12** just above the rear wheels, and suitable conduits, shown diagrammatically in FIG. **12,** interconnect each motor **30** with a respective one of the hydraulic pumps **24.** The advantage of this specific system will be discussed later.

A second guide projection **31** protects the hydraulic motors **30** from falling rubble.

The Demolition Rollers

In operation, the demolition apparatus of FIG. **1** is either parked, or is driven along. Suitable auxiliary apparatus (such as bulldozers, cranes, and the like) uproot and drop the rubble, including such rubble as one or more entire unoriented trees, into the rubble chamber **15.** The trees, due to their weight, drop to the bottom of the rubble chamber **15,** the lowermost portions of the trees, regardless of whether they are limbs, roots, stumps, etc., coming to rest on the masticating bed **16** at the bottom portion of the rubble chamber **15.**

Although the invention is not in any way limited as to dimensions, it has been found advisable to make the rubble chamber **15** about 10 feet high, about 25 feet long, and about 8 feet wide, as this size is capable of handling the largest tree that will be met in the ordinary usage of the disclosed demolition apparatus, while still being legally transportable on highways.

The masticating bed **16** uses a plurality of toothed demolition rollers that are best seen in FIG. **2** which is a plan view of the demolition apparatus discussed previously in connection with FIG. **1.** FIG. **2** shows the six hydraulic motors **30***a*, **30***b*, **30***c*, etc., to be positioned in a staggered relationship, so that their respective output shafts **33** are substantially equally spaced apart as indicated. Each motor shaft **33** is supported by an individual bearing **34,** and is then attached to an individual set **35***a*, **35***b*, **35***c*, etc., of demolition rollers.

Thus, each of the hydraulic pumps **24** drives a single hydraulic motor **30** which in turn rotates a single generally axially aligned set **35** of demolition rollers.

Due to the extreme length of the semitrailer **12,** it has been found desirable that with the rollers longitudinally oriented as in FIG. **2,** each set **35** of demolition rollers should be made up of a plurality of individual axially interconnected demolition rollers **36** that have their adjacent ends interconnected by means such as pillow blocks **37** to form the above mentioned set **35** of rollers. In this way, each individual roller **36** may be slightly out of alignment with the other rollers of its set, and may have its alignment vary from moment to moment as the semitrailer moves over relatively rough ground and under varying load and stress concentrations over the masticating bed **16,** but will still operate properly.

FIG. **3** shows a partial view of a set **35** of demolition rollers, three demolition rollers being indicated at **36,** and two pillow blocks being indicated at **37.** Due to the use of heavy duty ball bearing type pillow blocks **37,** alignment and the load encountered by the demolition rollers do not cause any difficulty.

Tooth Arrangement

It will be recalled from the above discussion that an entire tree may be dropped into the rubble chamber **15** and that the downwardly projecting portions of the tree come to rest on the masticating bed **16** that is formed by the toothed demolition rollers **36,** the sets **35** of demolition rollers being independently driven by their respective motors **30.** As indicated, each roller has a plurality of teeth that bite into the portion of the tree resting on, or adjacent to, that particular roller, and the teeth quickly masticate the tree to produce a stream of wood fragments or chips that may be spread on the ground as the demolition apparatus moves along. Alternatively, the wood fragments may drop onto one or more belts arranged underneath the demolition rollers for collection and bagging in suitable containers. For example, if desired, a pair of longitudinally moving conveyor belts respectively underlying the front and rear halves of the demolition bed may be employed to move the fragments onto a central, transverse conveyor belt which then moves the fragments out to one side of the apparatus for placing in bags or other suitable receptacles, or trucks or other transport means. Another conveyor arrangement is illustrated in FIGS. **26** and **27** and described hereinafter in connection therewith.

It is preferable from the point of view of power efficiency that too many teeth do not bite into the tree similtaneously as this would require excessive power. In order to prevent the power from becoming excessive, the teeth are preferably placed in a helix around the periphery of each roller. Moreover, the teeth of one roller are also preferably longitudinally offset from the teeth of the adjacent rollers as seen in FIG. **2,** so that there is no possibility of the teeth ever abutting each other. Also, the teeth of adjacent rollers may be circumferentially offset as seen in FIG. **5.** Due to the offset teeth relationship, the rollers may be closely spaced, even to the extent that the teeth of adjacent rollers overlap as seen in FIG. **5,** and the individual teeth may be made long enough so that each tooth takes a fairly deep bite out of the tree. When this tooth configuration is used, the teeth never abut each other; the teeth tend to bite into the tree at individually different times, and the teeth tend to produce smaller fragments.

Alternatively, the teeth may be positioned in peripheral circles around the rollers, being longitudinally either offset or aligned. If the teeth are thus longitudinally aligned, then if adjacent rollers are closely spaced, the teeth can be circumferentially offset or staggered as seen in FIG. **5.**

In an early experimental apparatus it was found that satisfactory operation, fragment size, and power demands were achieved in the demolition of whole trees, stumps, logs, and the like, by a roller diameter of about **8** inches, a tooth length of about **1** inch, and **40** teeth per roller. Thus, the masticating bed **16** as illustrated in FIG. **2,** based upon such early experimental apparatus, having the equivalent of **24** rollers, had a total of close to 1,000 teeth.

The Masticating Bed

It is desirable that the masticating bed **16** formed by the various sets of rollers be firm and rigid in order to provide the optimal cutting action. To achieve this desired sturdiness, the base **14** of the semitrailer is shown in FIG. **4** to be formed of longitudinal I beams **38** that carry suitable transverse I beams **39** which in turn support the bearings **34** and the pillow blocks **37** discussed above. In this way, the masticating bed of demolition rollers **36** is provided with the desired rigidity.

It will be realized that with the longitudinal sets **35** of rollers, if the individual demolition rollers **36** and their pillow blocks **37** were transversely aligned, this would tend to diminish demolition efficiency. In order to avoid this situation, the demolition rollers **36** are intentionally misaligned, as may be seen by referring to FIG. **2.** In this plan view, it will be noted that the pillow blocks **37** and thus the areas that are devoid of cutting teeth, are longitudinally and transversely staggered. This result is obtained by having selected sets of demolition rollers to start with, not complete demolition rollers, but with partial or half-rollers at each end of alternate roller sets.

However, rather than have a random location of the pillow blocks **37,** they are positioned in such a manner that they may be supported by selected transverse I beams **39** of FIG. **4.**

It has been found that a substantially flat masticating bed **16** is satisfactory for most purposes. Such a flat masticating bed **16** having closely spaced teeth is indicated by the transverse vertical section of FIG. **5.** At other times, an arcuate masticating bed **16** may be desired, and a concave arcuate arrangement of the demolition rollers is shown in FIG. **6.** Similarly, a vertically sinuous masticating bed **16** may be desirable for other situations, and such a bed is indicated in cross section in FIG. **7.**

For convenience, these various types of masticating bed configurations will be designated as "roughly flat."

The disclosed masticating beds comprise a plurality of sets of demolition rollers whose adjacent longitudinal edges and cutting teeth produce a multiple line cutting effect. The resultant plurality of cutting lines provide simultaneous cutting and positive fragmenting or chipping.

Since the disclosed demolition apparatus handles large amounts of rubble, this means that the weight of the rubble in the rubble chamber **15** helps hold the material relatively fixedly positioned for optimal cutting effect.

Tooth Attachment

It will be apparent that the teeth must be extremely strong and must be strongly affixed to the demolition rollers **36.** FIG. **8** indicates a tooth **41** and its attachment means. In this illustration, the tooth **41** has a body portion **42** and a hardened cutting portion **43.** In order to provide an easily replaceable tooth attachment, the demolition roller **36** has a recess that accepts a locking block **44** that is fastened in place onto the roller **36** by means such as a threaded bolt **45.** Thus, as the bolt **45** is tightened down, it pulls the locking block **44** into the recess, and a tapered portion **46** of the locking block **44** tightens itself against a complementary tapered portion **47** of the tooth body **42.** In this way, the tooth **44** is securely held, and yet is easily removable if such action is necessary.

It was previously indicated that the disclosed demolition apparatus may be used on various types of rubble, and this result is obtained by providing teeth whose cutting element is of a suitable material to demolish the particular type of rubble to be encountered. The density of the teeth in the masticating bed will also vary for optimum results on difference kinds of rubble, as well as to provide variations in the resulting chip size, as will be discussed in detail hereinafter.

Pump Drive

It was pointed out previously (in connection with FIG. **1**) that the prime mover engine **18** drives a set of six hydraulic pumps **24,** and one form of pump-driving mechanism is illustrated in FIG. **9.** Here, the power output shaft **23** from the bell housing **22** is adapted to also rotate three idler gears **49***a*, **49***b*, and **49***c*, the idler gears **49** in turn rotating respective pump shaft gears **50***a*, **50***b*, and **50***c* of pairs of tandem-mounted hydraulic pumps **24** of FIGS. **1** and **2.** In this way, each of the hydraulic pumps **24** is driven by prime mover engine **18,** and each hydraulic pump has an individual output that is applied by means of individual tubing, illustrated diagrammatically in FIG. **12,** to respective hydraulic motors **30.**

It should be noted that since each hydraulic pump and its associated hydraulic motor is independent of the others, each set of demolition rollers tends to rotate at its own speed, depending upon the load that the teeth of that particular roller are subjected to at a given instant.

The Differential Power Action

It was pointed out above that each set **35** of demolition rollers tends to have an individual speed of rotation that depends primarily upon its hydraulic pumps, on its hydraulic motor, and on the instantaneous load that its teeth encounter. It may so happen that one particular tree or other object in the rubble chamber **15** is of harder wood than other trees, or that a particular portion of the tree (say the stump) is harder than the other portions of the tree (say the leafy limbs). Also, such objects to be demolished are inherently irregular is configuration with projecting parts that tend to concentrate the load in a restricted zone. In cases such as these, the particular teeth that encounter the hardwood portions or projecting parts have a higher cutting load than the other teeth. A similar situation may arise when some teeth happen to be less sharp than other teeth.

In such a situation, the harder-working teeth require more power, and the added load on their rollers tend to slow down their rotation until the situation clears up. The disclosed differential power arrangement has a distinct advantage in situations such as these.

It will be recalled that each pump/motor/roller set is independent of the others, leading to the following differential power mode of operation. Assume, for instance, that two roller sets happen to have a projecting part of an object between them. The individual power transmission system causes each hydraulic pump to "see" the same load as its associated hydraulic motor,

so that the hydraulic pump reacts by assuming more of the power available to the pumps from the prime mover engine. Thus the harder working teeth and roller set receives additional power for the instantaneous situation, and as soon as this situation is cleared up the power is redistributed as required. Some of this additional power may be inertial energy feedback from freely rotating roller sets.

Under some conditions, it may be desirable to use sensing devices that actually sense the instantaneous rotational speed and/or loads of the individual roller set, and to have these sensing devices activate valves that control the flow of the hydraulic fluid to the various hydraulic motors in accordance with their instantaneous loads and power demands. For example, most hydraulic pumps have a "swash plate" that is controllable in this manner to increase pumping pressure with a reduced flow rate or vice versa.

Excessive Load Conditions

As indicated above, at various times the teeth of specific cutting lines may encounter hardwood or other hard rubble, and ordinarily the power transmission system will provide the necessary power for this situation. However, there may be times when the particular teeth may be exposed to an overload and at such times it may not be desirable to stress the apparatus or the teeth to too great an extent.

In situations such as these, the demolition rollers may be caused to momentarily rotate in their opposite directions in order to clear the excessive load situation. This result is easily achieved by use of the aforementioned clutch and suitable transmission means positioned in the bell housing **22.** If desired, the reversal may be controlled by a hand lever, or alternatively, may be controlled by automatic sensing devices that sense the extreme load condition.

Automatic accommodation for overall load changes in the rubble chamber may be provided by employing a conventional automatic transmission such as a combination torque converter and change-speed unit, at the output of prime mover **18** (i.e., in or in connection with bell housing **22**).

Alternative Masticating Bed

FIG. **10** illustrates an alternative type of masticating bed wherein individual sets of demolition rollers **52** are mounted in a transverse manner rather than being mounted in the longitudinal manner previously discussed. The transverse orientation roller mounting has the advantage that shorter demolition rollers may be used, thus obviating the need for the multiple pillow blocks, roller interconnections, and associated supporting structures.

Alternative Prime Mover Arrangement

FIG. **11** shows an alternative prime mover arrangement wherein the prime mover engine **18** has been reversed, this engine position providing additional exposure of the engine's radiator **19** to cooling air.

FIG. **11** also indicates the use of a mechanical rather than a hydraulic power transmission system, the illustration indicating the use of an automatic transmission **53** for transmitting power from the engine **18** to a gear box **54,** and thence to the masticating bed. The gear box **54** may be the mechanical equivalent of the gear system illustrated in FIG. **9,** wherein a single driving shaft from the transmission **53** drives a plurality of gears that are connected to the respective separate sets of demolition rollers, and in this way the power is apportioned to the roller sets according to their loadings.

The foregoing discussion has indicated that the power transmission system may be either hydraulic or mechanical, but electrical power transmissions may alternatively be used. In this case, the prime mover engine may be replaced by a motor/generator set such as Model D348 produced by Caterpillar Tractor Company. This unit produces electric power that may be applied over suitable wiring to a group of electric motors that drive the demolition rollers. Such an electrical system has the advantage that there is no danger of fluid leakage, no need for a heat exchanger, no requirement for a reservoir, etc., and moreover, has an automatic differential power action since the electric motors inherently take more or less power depending upon their instantaneous loads.

Fifth Wheel

As discussed above, it has been found extremely desirable for the masticating bed **16** to be quite rigid, and this leads to the need for having the base **14** of the semitrailer quite rigid despite the fact that there is a tendency for it to be racked and twisted as it is towed across rough terrain where the invention is likely to be used. It has therefore been found desirable to modify the "fifth wheel" arrangement that is ordinarily used for towing a semitrailer, since the usual fifth wheel arrangement is designed for relatively smooth roads. The subject fifth wheel is designed to function in the manner of a gimbal, as by the use of pivot rods **56** and **57** of FIG. **11** that are respectively parallel and transverse relative to the longitudinal axis of the tractor-trailer combination.

The Heat Exchanger

It is well known that in a hydraulic system transmitting appreciable amounts of power, the hydraulic fluid becomes hot, and must be continuously cooled in order to perform the desired power transmission function. Most hydraulic power transmission systems are designed to include cooling facilities for such purpose.

FIG. **12** schematically illustrates such a fluid cooling system. This illustration shows the pumps **24***a*, **24***b*, etc., supplying hydraulic fluid to hydraulic motors **30***a*, **30***b*, etc., using respective closed circuit fluid paths for power transmission. A hydraulic fluid reservoir **27** contains additional hydraulic fluid to compensate for leaks, expansion and contraction, momentary volumetric changes due to varying loads, etc.

As indicated in FIG. **12,** each pump/motor/hydraulic system permits a small volume of the hydraulic fluid to be pumped therefrom to the heat exchanger **26** wherein the hydraulic fluid may be cooled by any suitable means such as circulating air, or the like. In this way, a suitable amount of fluid cooling is provided, the amount and extent of cooling being controlled by well known means.

Fragment Size Control

Positive control of the output particle size from the demolishing apparatus is desirable. For example, various wood chip products are preferred to be in different chip grades or sizes. As another example, it is desirable to reduce street collection trash, garbage and the like to a refined state composed of small particles, chips, shreds and the like.

Fragment size control is achieved in the present invention by several means which are preferably combined for optimum particle size control. One means for

controlling fragment size is the reprocessing grate means illustrated in FIGS. **13** to **16,** which performs both re-chipping and sizing functions. This reprocessing grate means is preferably coupled with a series of upstanding cutter blades as shown in FIGS. **13** and **14** so as to provide reprocessing chambers for the respective rollers as best shown in FIG. **13.** This reprocessing means will be described in detail hereinafter with reference to FIGS. **13** to **16.**

Fragment size control is also provided according to the present invention by the provision of cutter teeth of different effective sizes; i.e., teeth with different extents of radial exposure relative to the axes of their respective demolition rollers. In general, the finer the teeth (shorter in the radial direction), the finer the fragments or chips resulting therefrom. It is preferred to provide a combination of teeth of different sizes generally regularly interspersed over the entire masticating bed **16.** With such arrangement, the larger teeth take the first "bite," but at the same time the smaller teeth tend to form a "stop" which limits the extent of the bite of the larger teeth; then after the first bite by the larger teeth, the smaller teeth are enabled to bite into the rubble, and in this manner all of the teeth will tend to take smaller and more equal bites of the rubble. In contrast, if all small teeth were employed, then too many teeth are all trying to cut at once at the same diameter, which tends to bounce the rubble off of the teeth, or cause the rubble to ride on the teeth. However, should the rubble be such that the small teeth could all tend to catch on it at once, the apparatus could be overloaded. On the other hand, if all large teeth were employed, the rubble might ride on top of those also, but more likely the teeth would tend to take too large a cut for some purposes, and the apparatus could easily become overloaded.

Accordingly, with the preferred combination of some small and some large teeth, the result is that the teeth tend to take successive bites from the largest teeth successively on down to the smallest teeth, such bites generally being of the same size if the teeth have similar successive size differences (e.g., tooth exposure from roller from largest to smallest teeth 1 inch, ¾ inch, ½ inch, ¼ inch). Since the teeth then operate in succession, not so many will dig in at the same time, so that overloading is avoided, the rubble does not tend to ride over the teeth, and there is less tendency for the rubble to bounce off of the teeth.

The presently preferred size range for radial tooth extension from the rollers is from about ¼ inch to about 1½ inches. For chips from logs, teeth up to 1½ inches are satisfactory. At the other extreme, for demolishing trash, garbage, and the like, teeth as small as ¼ inch provide satisfactory results. A combination of teeth from about ¼ inch to about 1 inch provides a good "all purpose" masticating bed which will provide good results with both trees, logs, stumps and the like on the one hand and street collection trash, garbage, and the like on the other hand.

Teeth can be made of different sizes in several different ways. For example, in demolition roller assemblies having teeth that are removable and replaceable such as those detailed in FIG. **8** and in FIGS. **18** to **22,** individual teeth of varying lengths can be employed. In the demolition roller assembly form illustrated in FIGS. **23** to **25,** a series of tooth-bearing discs are removably engaged in a stacked array on a shaft, and in this form each disc can have a plurality of teeth of different sizes regularly spaced about its periphery. FIG. **17** illustrates another means for effecting variable tooth lengths, wherein helix rod segments are aligned with some of the helically arranged teeth so that only portions of the lengths of these teeth are exposed, while other teeth that are unobstructed remain effectively longer.

Fragment size control may also be accomplished by variations in the number or density of the teeth that are present in the masticating bed. In general, the larger the number or density of the teeth, the smaller the chips or fragments. Thus, for trash, garbage and the like, a very large number of teeth will be desirable. The early experimental apparatus referred to hereinabove had a masticating bed roughly 25 feet long and 6 feet wide, with approximately 1,000 teeth, and that apparatus provided excellent results for demolishing whole trees, logs, stumps, and the like. However, for all purpose demolishing apparatus according to the invention which is not only suitable for trees, logs, stumps and the like, but is also suitable for such things as street collection trash, garbage and the like, it is presently preferred to have a higher tooth density, as for example on the order of about 2,500 or more teeth for the same size masticating bed.

Demolition Roller Arrangement and Direction of Rotation

The demolition rollers may be arranged relative to the longitudinal axis of the semitrailer **12** either in a generally longitudinal array as shown in FIGS. **1** to **7,** or in a generally transverse or lateral array as shown in FIG. **10.**

With regard to the direction of rotation of the demolition rollers, they may be driven so as to all rotate in the same direction of rotation as indicated in FIGS. **5** and **6;** or the demolition rollers in one-half of the masticating bed **16** may all rotate in one direction of rotation, while the rollers in the other half of the masticating bed all rotate in the opposite direction of rotation, as illustrated in FIGS. **13** and **26.** As a further alternative, successive adjacent pairs of the demolition rollers may be driven in opposition to each other; i.e., each roller then would be driven in a direction of rotation opposite to its adjacent parallel roller, as are the center two rollers of FIGS. **13** and **26.**

For elongated rubble, such as logs and the like, it is preferable to have the demolition rollers generally longitudinally oriented as in FIGS. **1** to **7.** For this type of rubble it is also preferable to have the demolition rollers on one side of the masticating bed moving in one direction of rotation and the rollers on the other side of the masticating bed moving in the opposite direction of rotation, and it is also desirable to have these directions of rotation such that the upwardly exposed roller teeth in the masticating bed all move generally toward the center of the bed, which is the case for the illustrated directions of rotation in FIGS. **13** and **26,** as this tends to continually bias the constantly shifting elongated rubble toward the center of the masticating bed so as to keep the log or other elongated rubble in a generally central operating zone and prevent it from becoming lodged against a side wall of the rubble chamber.

However, for street collection trash, garbage, and other smaller type rubble, it is presently preferred to provide a masticating bed comprising transversely oriented rollers as shown in FIG. **10.** For this type of rub-

ble, and with such transversely oriented rollers, it is also presently preferred to have all of the demolition rollers rotating in the same direction of rotation, as illustrated in FIGS. **5** and **6,** which provides each cutting line with one set of downwardly moving teeth and one set of upwardly moving teeth, thereby providing a scissors-like cutting action between the teeth of adjacent rollers. This cutting action is highly effective for chopping paper and other fibrous material which may otherwise tend to be pulled around the rollers.

Fragment Reprocessing

The primary means for effecting fragment or chip reprocessing comprises reprocessing grate means generally designated **60** in FIG. **13,** and preferably extending completely under the entire masticating bed **16** so as to require all fragments or chips to pass downwardly therethrough in order to leave the rubble chamber **15.** While the toothed demolition rollers produce fragments or chips that tend to vary in size, these multisized fragments or chips are reduced to a more uniform size by the action of the demolition rollers in combination with the reprocessing grate means **60,** the grate means **60** serving to both further chop and size the fragments. Thus, the chips as originally fragmented in the masticating bed will remain above the grate means **60** and be continuously reprocessed by the chopping action of the moving demolition roller teeth relative to the fixed grate means **60.** It will be appreciated that the finer the grate means **60,** the smaller the ultimate chips or fragments that are produced by the machine, whereby positive control of the particle output size is effected.

The grate means **60** is preferably in the form of a grill, having a series of parallel, generally regularly spaced reprocessing blades **62** which are oriented substantially parallel to the axes of the demolition rollers **36;** and having a series of generally regularly spaced blade supporting bars **64** set at right angles to the blades, and hence generally at right angles to the axes of the demolition rollers **36.** This grill-like arrangement of the reprocessing blades **62** and blade supporting bars **64** is illustrated in detail in FIG. **14.**

The reprocessing blades **62** of the grate means **60** are preferably inclined from the vertical in a direction so that the upper, leading, cutting edges of the reprocessing blades **62** face toward the oncoming moving teeth of the respective demolition roller. With this arrangement, the demolition roller teeth push the fragments directly into the cutting edges of the reprocessing blades **62** for maximum cutting effectiveness. Also, this tilt or incline of the reprocessing blades **62** causes the principal forces applied to the blades **62** to be in an edgewise direction for best utilization of the structural strength of the reprocessing blades **62.** The angle of inclination of the blades **62** from the vertical is preferably from about 30° to about 60°, with a preferred incline of about 45° from the vertical. Nevertheless, it is to be understood that even with the reprocessing blades **62** set generally vertically, they will still be effective in reprocessing the chips or fragments.

It will be noted that the reprocessing blades **62** as illustrated in FIGS. **13** and **14** have upper cutting edges **66** that are generally coplanar along a horizontal plane, whereby the actual leading cutting edges have an acute angle in cross section for maximum cutting effectiveness.

Since tee three demolition rollers **36** at the lefthand side of FIG. **13** are all rotating clockwise, the teeth thereof proximate the grate means **60** move to the left, so that the reprocessing blades **62** under these left-hand three rollers are arranged to incline upwardly and to the right. On the other hand, the right-hand three demolition rollers **36** are shown to rotate anticlockwise in FIG. **13,** whereby the teeth thereof proximate the grate means **60** move to the right, so that the reprocessing blades **62** under these right-hand three demolition rollers are arranged to angle upwardly and to the left to face the oncoming teeth.

There does not appear to be any tendency for the grate means **60** to become clogged because of the large amount of driving force behind the roller teeth when the teeth force the chips down into the grate means **60.**

Reprocessing is made even more effective by utilizing a series of parallel, regularly spaced, upstanding cutter blades **68** in conjunction with the grate means **60,** the cutter blades **68** being generally parallel to the reprocessing blades **62** and the axes of the demolition rollers **36,** and extending upwardly from the grate means **60** proximate the cutting lines intermediate adjacent rollers, and also to the outside of the outermost rollers. These upstanding cutter blades **68** in combination with the grate means **60** provide a series of reprocessing chambers **70** located directly underneath respective demolition rollers **36.** With this arrangement, chips or fragments which do not pass through the grate means **60** will be driven laterally and upwardly by the teeth and chopped against the upper corners of the upstanding cutter blades **68** as part of the reprocessing, the chips then tending to fall back down into the reprocessing chambers **70** and to be then worked downwardly through the grate means **60.** Generally, each demolition roller **36,** or each coaxial set **35** of demolition rollers **36,** will extend down into a respective reprocessing chamber **70.**

The reprocessing blades **62** and upstanding cutter blades **68** are strong, rigid members suitable for enduring the chopping forces imposed against them by the demolition roller teeth. By way of illustration only, and not of limitation, suitable blades **62** may be made of ⅜ inch to ⅝ inch steel plate, while upstanding cutter blades **68** may be made from ¾ inch to 1 inch steel plate.

FIG. **15** illustrates alternative grate means **60a** formed of so-called "expanded metal" made by partially severing or slitting portions of a metal plate, and then forming or "expanding" the plate. The resulting grate means **60*a*** includes rows of inclined reprocessing blades **62*a*** each of which has an aperture **72** thereunder. The reprocessing blades **62*a*** are arranged generally parallel to the axes of the demolition rollers **36,** with the blades **62*a*** inclined generally similarly as the blades **62** shown in FIGS. **13** and **14.** The expanded metal grate means **60a** is preferably but not necessarily employed in connection with a series of upstanding cutter blades **68** in an arrangement similar to that best illustrated in FIG. **13.**

Another form of grate means **60b** is illustrated in FIG. **16,** and comprises an arcuate segment of a pipe, such as a sewer pipe, which is slightly larger in diameter than the tooth diameter of the demolition roller **36.** The pipe segment grate means **60*b*** is provided with a multiplicity of grate holes **74** of suitable size to provide

chips of the desired size, and these grate holes **74** are preferably inclined from the radial direction toward the oncoming cutter teeth so as to provide chip cutting edges **76** having acute included angles. The pipe segment grate means **60***b* is preferably arranged generally coaxially of the respective demolition roller **36.** The longitudinal edges **78** of the pipe segment will function similarly as the upstanding cutter blades **68** shown in FIGS. **13** and **14.**

Alternative Demolition Roller Form

FIG. **17** shows a modification **36**a of the demolition roller form **36** previously described and shown in some detail in FIGS. **3, 4, 8,** and **16.** The modification in the demolition roller **36***a* of FIG. **17** consists of the addition of helix rod segments **80** which are welded to the roller in alignment with helically arranged sets of the cutting teeth **41** so as to reduce the exposed, and hence effective, radial length of the aligned cutter teeth **41.** For example, with one-inch teeth **41,** ½ inch diameter helix rod segments **80** will reduce the cutting depth of the aligned teeth **41** to approximately ½ inch. By this means, with teeth **41** all of the same length, the demolition roller **36***a* may quickly and easily be set up with teeth of different lengths. In the illustration of FIG. **17,** in each longitudinal row of teeth **41,** alternate teeth have the helix rod segments **80** aligned therewith, and in this manner one-half the teeth on the demolition roller **36***a* will be long, fully exposed teeth, and the other one-half will be short, only partially exposed teeth.

FIGS. **18** to **22** illustrate another form of demolition roller assembly generally designated **36***b* which comprises a generally square shaft **82** along which a series of cutter tooth support discs **84,** in the form of rings, are stacked. Adjacent pairs of the tooth support discs **84** have radial bores **86** centered at their interface **88.** Each radial bore **86** is adapted to receive therethrough a respective tooth **41***a* in the general configuration of a metal dowel rod. Each tooth **41***a* has an enlarged head **90** welded or otherwise formed onto the inner end of the tooth, the head **90** being engaged between one of the flat sides **92** of square shaft **82** and the inner circumference of the adjacent pair of support discs **84** which may be recessed to receive the head **90** as at **94** by a back counterbore to the bore **86.** The corners **96** of the square shaft **82** are preferably ground down to receive the ring-shaped tooth support discs **84.**

The ends **98** of the shaft **82** are machined round for journaling, and at least one end of each shaft is provided with a keyway **100** for driving the shaft. An end disc **102** is provided on each end of the square shaft **82** for securing the stack of tooth support discs **84** on the shaft, each end disc **102** being held axially in position by a series of bolts **104** which extend therethrough and threadedly engage in the square shaft **82** as best seen in FIGS. **19** and **22.**

Assembly of the demolition roller **36***b* is easily accomplished by simply sliding the tooth support discs **84** onto the square shaft **82** from either or both ends of the shaft, and before the discs **84** are closed against each other inserting the cutter teeth **41**a between their respective adjacent pairs of the discs **84;** and finally after all of the discs **84** are stacked with the teeth **41***a* in place, securing the end discs **102** in place by means of the bolts **104.**

It will be apparent, particularly from FIG. **18,** that a large number of the cutter teeth **41***a* may be embodied conveniently in the demolition roller form **36***b.* It will be noted from FIG. **18** that the cutter teeth **41***a* are arranged in a generally helical pattern. Each tooth **41***a* has a flat outer end which provides a sharp annular cutting edge **106;** and with the heads **90** of the teeth being annular, the teeth may rotate about their own axes in their operative position so as to utilize the entire annular cutting edge **106** of each tooth to get the maximum utility out of the cutting edges. Abutment of the tooth heads **90** against the flat sides **92** of the square shaft will cause the rotational driving force to be imparted from the square shaft to the tooth support discs **84** and the teeth **41***a.*

FIGS. **23** to **25** illustrate a further form of demolition roller **36***c* which also employs a square shaft upon which a series of tooth support discs is stacked. In this embodiment the tooth support discs have square apertures **110** therethrough enabling the discs **108** to be slidably engaged over the square shaft **112** in rotatable driving engagement. The teeth are welded or hardfaced directly on the perimeters of the discs **108.** Preferably each disc **108** has a series of the teeth regularly spaced about its perimeter, and preferably these teeth are of successively different sizes. Thus, for example, the disc **108** illustrated in FIG. **23** has four teeth **114***a, b, c,* and d regularly spaced at 90° intervals about its perimeter and ranging in succession from the largest tooth **114**a down to the smallest tooth **114***d.* For a typical disc diameter of about **8** inches, a satisfactory spread of tooth size in the radial direction is about 1 inch for the tooth **114***a,* ¾ inch for the tooth **114***b,* ½ inch for the tooth **114***c,* and ¼ inch for the tooth **114***d.* Thus, as this series of teeth **114***a, b, c,* and *d,* successively engage the rubble, they will tend to bite off chunks of the rubble in ¼ inch increments.

These teeth **114***a, b, c,* and *d,* are preferably of generally triangular shape, with a generally radially oriented front cutting face **116** and generally straight back surface **118** as designated in connection with the large tooth **114***a* in FIG. **23.** The back faces **118** of all of the teeth come into the disc **108** generally tangentially so as to provide a tooth depth in the peripheral direction that is substantially greater than the tooth height in the radial direction, such peripheral depth preferably being at least about twice the tooth height in the radial direction, and for the smaller teeth even more. For example, a ¼ inch tooth (in the radial direction) will be approximately 1 inch deep in the peripheral direction, and a ½ inch tooth (radially) will be about 1 ½ inches deep in the peripheral direction. In this manner the teeth per se and their joinder with the disc are made extremely durable.

Adjacent tooth support discs **108** may be spaced apart any desired distance along the shaft **112** by any number of washers **120** which preferably have the same diameter as the tooth support disc **108.** In the illustrations of FIGS. **24** and **25,** one such washer **120** is disposed intermediate each adjacent pair of the tooth support discs **108.**

The ends of the shaft **112** are round and arranged for driving in generally the same manner as on the shaft of FIGS. **18** to **22,** and if desired the discs **108** and washers **120** may be secured on the shaft in the same manner as in FIGS. **18** to **22.** However, as shown in FIG. **24** the discs **108** and washers **120** may alternatively be secured upon the shaft by a nut **122** threadedly engaged on each end of the shaft.

The preferred array of tooth support discs **108** on the shaft **112** is illustrated in FIGS. **24** and **25.** According to this array, successive discs **108** are rotationally offset 90° so that each of the four lines **124** of teeth will have repeated successions of teeth of different heights. In this manner the different sized teeth will be generally uniformly spread out over the entire masticating bed.

Chip Deflection Wings

Because of the great amount of power supplied to the demolition rollers, chips from some types of rubble tend to bounce off of the walls and fly out through the top of the rubble chamber with considerable force. This may be satisfactorily controlled as shown in FIG. **26** by providing a pair of chip delfection wings **126** which are hinged at **128** to the respective upper edges of the side walls **130** of the rubble chamber **15.** These wings **126** extend along substantially the entire length of the rubble chamber **15,** and in their operative positions they are propped out to an angle preferably at least about 45° from the vertical by means of respective support posts **132,** which may be lengths of pipe. Both the side walls **130** and the deflection wings **126** are preferably of double-walled construction, and with such construction the support post ends can be lodged through holes **134** through the inner wall portions of the side walls **130** and holes **136** through the lower wall portions of the deflection wings **126.**

The downward incline of the deflection wings **126** in their operative positions as shown in FIG. **26** allows rubble to be dropped down therebetween into the rubble chamber **15,** and the inclined wings **126** will guide the rubble into the chamber. Nevertheless, most chips which are bounced upwardly against the side walls **130** will be captured by the deflection wings **126** and deflected thereby back down onto the masticating bed **16.**

The Conveyor

A satisfactory conveyor arrangement for transporting the demolished rubble from underneath the masticating bed **16** out to a pile to one side of the apparatus is illustrated in FIGS. **26** and **27.** A longitudinal conveyor unit **138** is mounted between the longitudinal I beams **38** and extends substantially the length of the rubble chamber, with the upper surface thereof moving rearwardly. To the rear and below the longitudinal conveyor unit **138** is a transverse conveyor unit **140** which receives the demolished rubble from the longitudinal unit **138** and transports it laterally to the right in FIG. **27** to a third, inclined conveyor unit **142.** The inclined conveyor unit **142** receives the demolished rubble from the transverse unit **140** and transports it upwardly and laterally outwardly from the semitrailer, dropping the demolished rubble off of the free end **144** of the inclined conveyor **142.** In this manner, the demolished rubble can be dropped into piles, can be fed into trucks, railroad cars or the like, or can be fed directly to packaging apparatus.

The inclined conveyor unit **142** is preferably pivotally connected at its base end **146** to the side of the semitrailer **12** and supported for adjustment of its angle of incline by winch and cable means generally designated **148** in FIG. **27.**

SUMMARY

The present invention has numerous advantages over prior art devices, some of which are as follows: First, it will handle entire trees without requiring such prepreparation as defrocking, destumping, or the like, and if the trees are not too large it can handle a plurality thereof simultaneously; and it can accommodate a variety of other types of rubble. Second, it is particularly suitable for use in connection with the disposal of street collection trash, garbage, and the like, demolishing such rubble to a refined, aerated condition which does not tend to attract pests, and which can be disposed of by means other than the usual cut and fill type dump operation. Third, it will handle trees that are simply dropped, unoriented, into the rubble chamber. Fourth, the power transmission for the demolition rollers is such that each roller is provided with enough power for its instantaneous load. Fifth, various types of power transmission systems may be used. Sixth, the disclosed apparatus may utilize masticating beds of different configurations. Seventh, the disclosed apparatus may utilize masticating beds having different orientation of its demolition rollers. Eighth, the disclosed apparatus may utilize different demolition roller assemblies and cutter tooth constructions and sizes. Ninth, the disclosed apparatus may include reprocessing grate means associated with the demolition rollers for improved demolishing efficiency and fragment size control. Tenth, the disclosed apparatus produces wood fragments or chips that are useful for a wide variety of purposes. Eleventh, the disclosed invention is adapted to produce chips of practically any desired size. Finally, the disclosed apparatus can handle volumes of rubble at many times the rate of consumption of prior art apparatus used for such purpose.

While the instant invention has been shown and described herein in what are conceived to be the most practical and preferred embodiments, it is recognized that departures may be made therefrom within the scope of the invention, which is therefore not be limited to the details disclosed herein.

I claim:

1. Demolishing apparatus comprising:

a roughly flat, upwardly facing masticating bed adapted for gravity feeding of material to be processed;

said masticating bed having a plurality of spaced parallel toothed demolition roller units;

each of said roller units comprising a plurality of discrete cutting teeth projecting outward from spaced points along the surface of said roller unit and disposed collectively to cooperate in closely spaced relation with the corresponding plurality of teeth on adjacent roller units in the masticating of said material, and wherein the material is floatingly supported by the action of the rollers as portions thereof are chipped from the material and pass downwardly between the rollers;

wall means extending upwardly from positions adjacent the opposed side edges of said bed for confining material thereon; and

power means operatively connected to said demolition roller unit so as to rotatively drive said demolition roller units, whereby material exposed to said bed by gravity force is subject to the action of said demolition rollers.

2. The apparatus of claim **1,** wherein said demolition roller units rotate substantially independently of each other.

3. The apparatus of claim 1, wherein said power means comprises prime mover means, and an independent drive connection from said prime mover means to each of said demolition roller units for providing each of said demolition roller units with sufficient power for its instantaneous load.

4. The apparatus of claim 1, wherein said power means comprises differential power means for providing each of said demolition roller units with sufficient power for its instantaneous load.

5. The apparatus of claim 4, wherein said differential power means comprises individual motor means for each of said demolition roller units.

6. The apparatus of claim 1, wherein said masticating bed comprises a plurality of said demolition roller units having a substantially flat relationship to each other.

7. The apparatus of claim 1, wherein said masticating bed comprises a plurality of said demolition roller units having a substantially arcuate relationship to each other.

8. The apparatus of claim 1, wherein said masticating bed comprises a plurality of said demolition roller units having a substantially sinuous relationship to each other.

9. The apparatus of claim 1, wherein said masticating bed is elongated and comprises a plurality of longitudinally oriented said demolition roller units.

10. The apparatus of claim 1, wherein said masticating bed is elongated and comprises a plurality of transversely oriented said demolition roller units.

11. The apparatus of claim 1, wherein said demolition roller units have replaceable teeth mounted thereon.

12. The apparatus of claim 1, wherein said power means comprises a hydraulic power transmission system.

13. The apparatus of claim 12, including heat exchanger means for cooling the hydraulic fluid of said hydraulic power transmission system.

14. The apparatus of claim 12, wherein said power means comprises prime mover means, a plurality of hydraulic pumps driven by said prime mover means, and a like plurality of hydraulic motors driven by respective ones of said hydraulic pumps.

15. The apparatus of claim 1, wherein said power means comprises a mechanical power transmission system.

16. The apparatus of claim 1, wherein said power means comprises an electric power transmission system.

17. The apparatus of claim 1, wherein each of said demolition roller units comprises a single demolition roller.

18. The apparatus of claim 1, wherein each of said demolition roller units comprises a plurality of axially interconnected demolition rollers.

19. The apparatus of claim 1, including reprocessing grate means disposed under said masticating bed adjacent to the periphery of at least one of said demolition roller units.

20. The apparatus of claim 19, wherein said reprocessing grate means comprises a plurality of generally parallel reprocessing blades.

21. The apparatus of claim 20, wherein said reprocessing blades are arranged generally parallel to the rotational axis of said one demolition roller unit.

22. The apparatus of claim 21, wherein said reprocessing blades are angled opposite to the direction of movement of the adjacent demolition roller teeth.

23. The apparatus of claim 20, wherein said grate means comprises a grill-like structure including said reprocessing blades and a plurality of generally parallel blade supporting bars interconnecting said blades and arranged generally at right angles to said blades.

24. The apparatus of claim 19, wherein said grate means extends under at least a portion of said masticating bed including a plurality of substantially parallel said demolition roller units.

25. The apparatus of claim 19, which further includes elongated barrier means projecting upwardly from said grate means and arranged generally parallel to and laterally offset from the rotational axis of said one demolition roller unit to the side that is generally downstream as to adjacent tooth movement, said barrier means tending to retain rubble fragments in the region of said grate means for reprocessing thereof.

26. The apparatus of claim 25, wherein said barrier means comprises an upstanding cutter blade having an upper edge arranged adjacent to the periphery of said one demolition roller unit for further reprocessing action in cooperation with the roller teeth.

27. The apparatus of claim 25, which includes a second said barrier means similar to said first-mentioned barrier means but laterally offset to the other side of said one demolition roller unit;

said grate means and said first and second barrier means defining reprocessing chamber means associated with said one demolition roller unit.

28. The apparatus of claim 19, wherein said grate means extends under at least a portion of said masticating bed including a plurality of substantially parallel said demolition roller units; and

elongated barrier means projecting upwardly from said grate means and arranged generally parallel to the rotational axes of said demolition roller units;

said barrier means comprising a plurality of elongated barriers arranged with a pair of said barriers located on opposite sides of each said demolition roller unit so as to define reprocessing chamber means associated with each of said demolition roller units.

29. The apparatus of claim 19, wherein said grate means comprises expanded metal structure.

30. The apparatus of claim 19, wherein said grate means comprises perforated pipe segment means.

31. Demolishing apparatus as defined in claim 1, wherein at least one of said demolition roller units has a first set of cutting teeth thereon having a first cutting length; and

a second set of cutting teeth on said one demolition roller unit having a second cutting length that is substantially shorter than said first cutting length;

said first and second sets of cutting teeth being substantially uniformly distributed about said one demolition roller unit.

32. Demolishing apparatus as defined in claim 31, wherein each of said first and second sets of cutting teeth are generally helically arranged about the body of said demolition roller unit;

each of said first and second sets of cutting teeth projecting substantially the same radial extent from the body of the demolition roller unit;

said second set of cutting teeth being made effectively shorter than said first set of cutting teeth by helix rod means affixed to the body of the demolition roller unit generally in line with said second set of cutting teeth.

33. Demolishing apparatus as defined in claim **31,** which also includes a third set of cutting teeth on said one demolition roller unit;

said third set of cutting teeth having a third cutting length that is substantially shorter than said second cutting length;

said first, second, and third sets of cutting teeth being substantially uniformly distributed about said one demolition roller unit.

34. Demolishing apparatus as defined in claim **33,** which also includes a fourth set of cutting teeth on said one demolition roller unit;

said fourth set of cutting teeth having a fourth cutting length that is substantially shorter than said third cutting length;

said first, second, third, and fourth sets of cutting teeth being substantially uniformly distributed about said one demolition roller unit.

35. Demolishing apparatus as defined in claim **1,** wherein at least one of said demolition roller units comprises a roller assembly including a shaft of irregular cross section;

a series of apertured tooth support discs stacked along said shaft so as to define generally cylindrical roller surface means; and

a multiplicity of cutter teeth supported by said tooth support discs and having cutting end portions projecting radially outwardly from said generally cylindrical roller surface means.

36. Demolishing apparatus as defined in claim **35,** wherein said irregular shaft cross section is generally square.

37. Demolishing apparatus as defined in claim **35,** wherein said tooth support discs are generally ring-shaped;

adjacent pairs of said discs having tooth-receiving bores directed generally radially at their interfaces;

said teeth each having head means engaged between the shaft and discs and shank means extending generally radially outwardly through respective said bores and terminating radially outwardly beyond said surface means.

38. Demolishing apparatus as defined in claim **37,** wherein said shaft cross section is generally square;

said head means of said teeth being engaged against flat sides of said square shaft to provide rotational driving engagement between the shaft on the one hand and the teeth and discs on the other hand.

39. Demolishing apparatus as defined in claim **35,** wherein said teeth are directly secured to the respective support discs so as to project radially outwardly from the perimeters thereof.

40. Demolishing apparatus as defined in claim **39,** wherein the apertures in said discs are generally complementary to the cross-sectional configuration of said shaft for rotational driving engagement between the shaft and said discs.

41. Demolishing apparatus as defined in claim **40,** wherein said irregular shaft cross section is generally square.

42. Demolishing apparatus as defined in claim **39,** which includes washer disc means disposed between adjacent said tooth support discs for spacing said tooth support discs apart from each other along said shaft.

43. Demolishing apparatus as defined in claim **39,** wherein at least some of said tooth support discs have a plurality of teeth supported thereon and generally regularly space about the perimeter thereof.

44. Demolishing apparatus as defined in claim **43,** wherein said plurality of teeth have different cutting lengths.

45. Demolishing apparatus as defined in claim **44,** wherein said plurality of teeth are four in number ranging in succession about the disc periphery from a longest tooth to a shortest tooth.

46. Demolishing apparatus as defined in claim **44,** wherein adjacent stacked discs with teeth of different cutting lengths are rotationally displaced on said shaft to provide adjacent teeth of different cutting lengths in the longitudinal direction of said roller assembly.

47. Demolishing apparatus as defined in claim **1** wherein said wall means defines a rubble chamber including a pair of elongated side walls; and

a pair of elongated chip deflection wings connected to and extending longitudinally along said side walls adjacent the upper edges of said side walls;

said chip deflection wings projecting generally laterally inwardly toward each other from their respective said side walls so as to overlie respective side portions of the rubble chamber.

48. Demolishing apparatus as defined in claim **47,** wherein said chip deflection wings are inclined downwardly and inwardly generally toward the center of the rubble chamber.

49. Demolishing apparatus as defined in claim **47,** wherein said chip deflection wings are hingedly connected to said side walls of the rubble chamber;

said chip deflection wings being movable from an inoperative collapsed position wherein they hang downwardly against their respective said side walls and an operative extended position overlying respective side portions of the rubble chamber; and

support means releasably engageable between said chip deflection wings and their respective said side walls for supporting said chip deflection wings in said operative extended position.

50. Demolishing apparatus as defined in claim **1,** which includes conveyor means disposed beneath said masticating bed and extending outwardly therefrom so as to collect and transport demolished rubble which has passed downwardly through the masticating bed.

51. Demolishing apparatus as defined in claim **50,** wherein said conveyor means includes a laterally moving conveyor portion.

52. The apparatus of claim **1,** including secondary cutting and restraining means disposed adjacent to the periphery of at least one of said demolition roller units so as to cooperate with said teeth of said one demolition roller unit in the demolition action.

53. The apparatus of claim **52,** wherein said secondary cutting and restraining means comprises reprocessing grate means disposed under said masticating

bed adjacent to the periphery of said one demolition roller unit.

54. The apparatus of claim **52,** wherein said secondary cutting and restraining means comprises an upstanding cutter blade having an upper edge arranged adjacent to the periphery of said one demolition roller unit.

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