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Ford

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[54] **MOBILE SHREDDER**

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[52] **U.S. Cl.** ..... **241/101.7,** 241/189 R, 241/190

[51] **Int. Cl.** **B02c 21/02**

[58] **Field of Search** ..... 241/101.7, 101 M, 189 R, 241/190, 186 R

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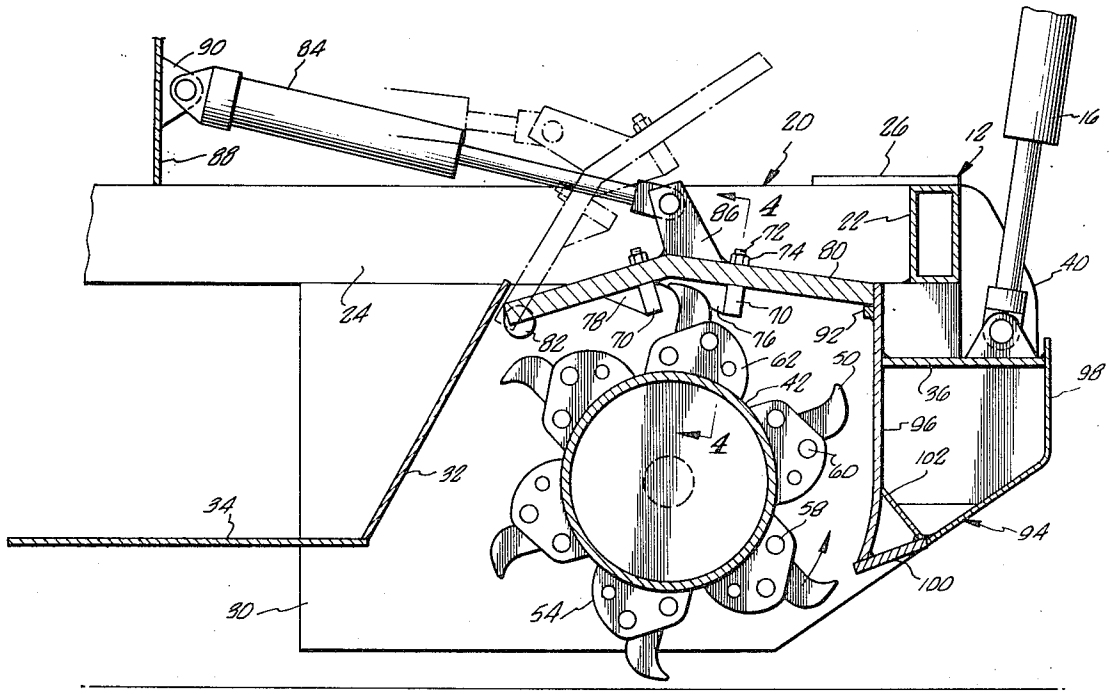
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Primary Examiner—Roy Lake
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Attorney, Agent, or Firm—Lyon and Lyon

[57] **ABSTRACT**

A shredder mounted on a heavy-duty carrier for shredding refuse spread on the ground such as in a land-fill dump. The shredder includes a frame structure mounted to the heavy-duty carrier, a rotating drum having a plurality of shredding elements mounted thereon, a fixed set of teeth cooperating with the rotating drum and a breaker bar assembly fixed to the shredder frame to partially cover the projected frontal area of the drum. The breaker bar assembly reduces the size of large refuse particles entering the shredder and prevents excessively large bundles of material from being pulled into the shredder all at once. Further, the breaker bar, in combination with the frame, creates a vacuum scoop tending to draw smaller refuse particles into the shredder.

14 Claims, 5 Drawing Figures



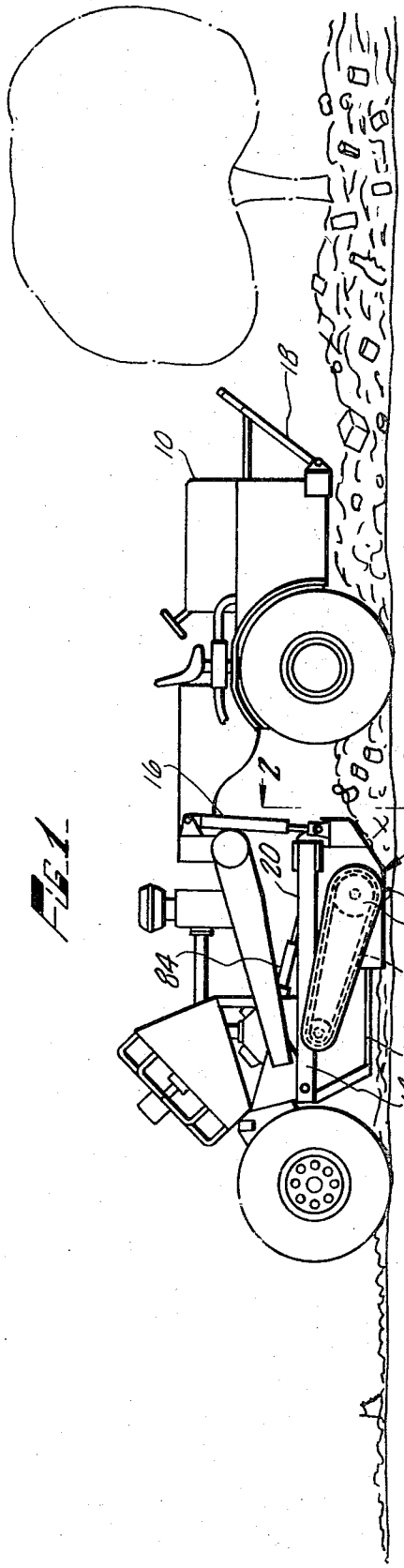


FIG. 1

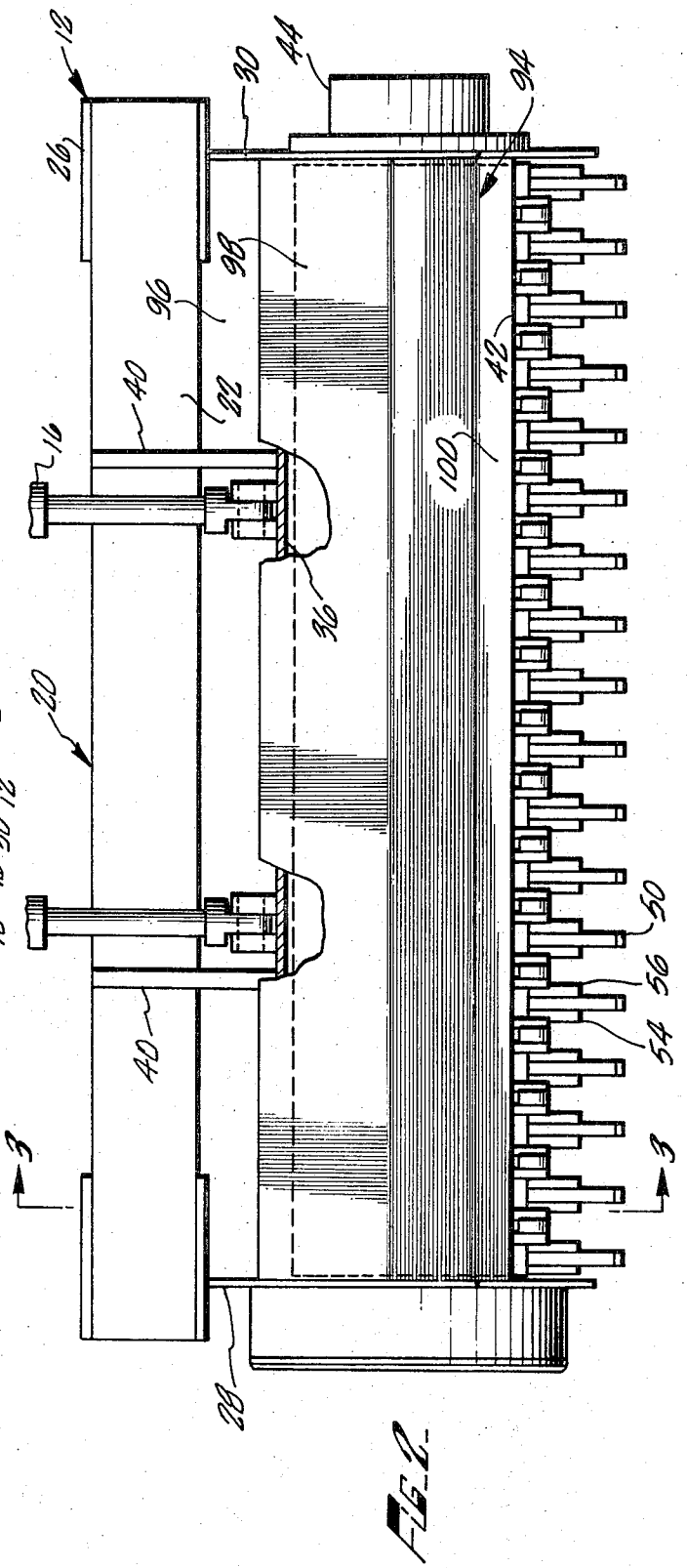


FIG. 2

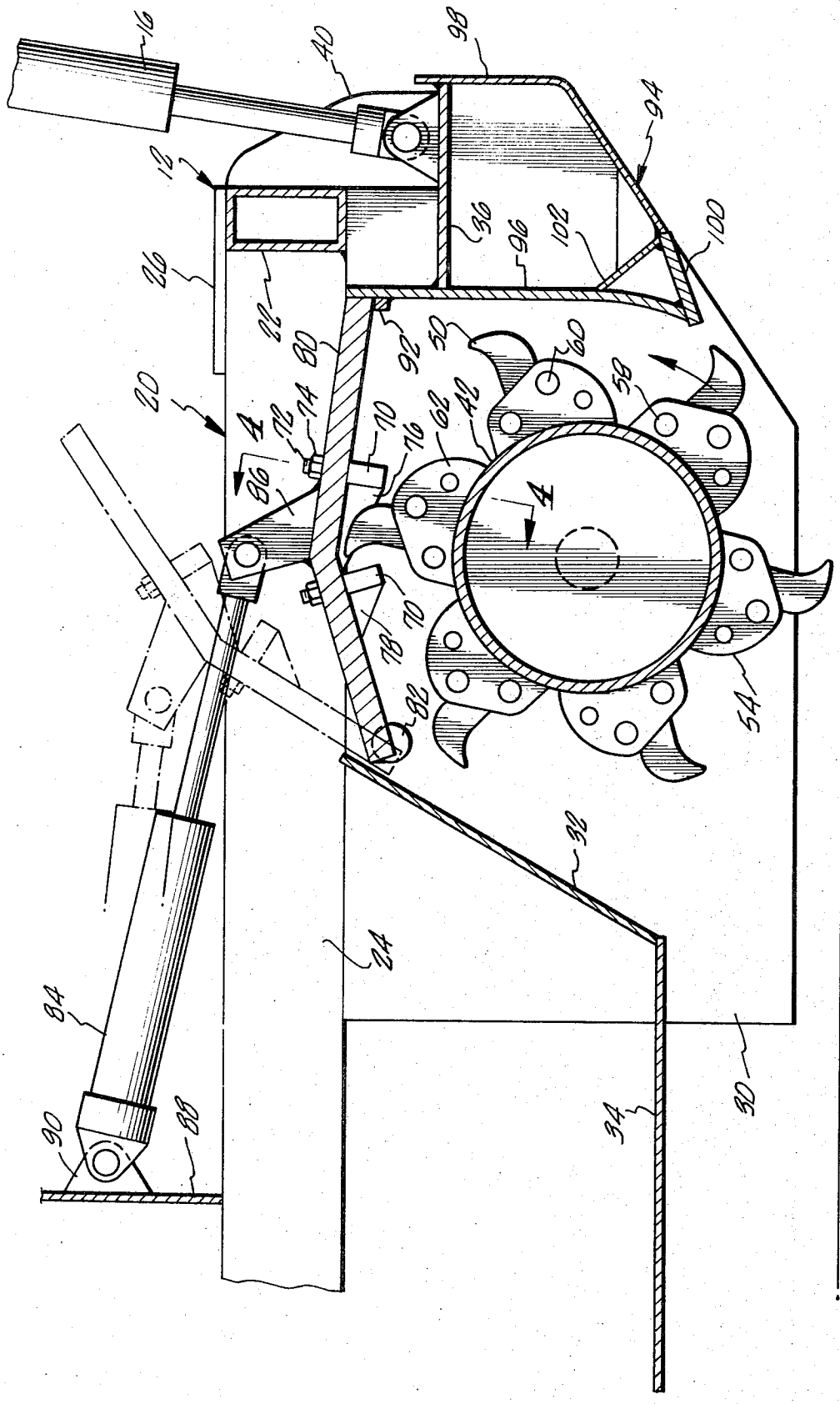
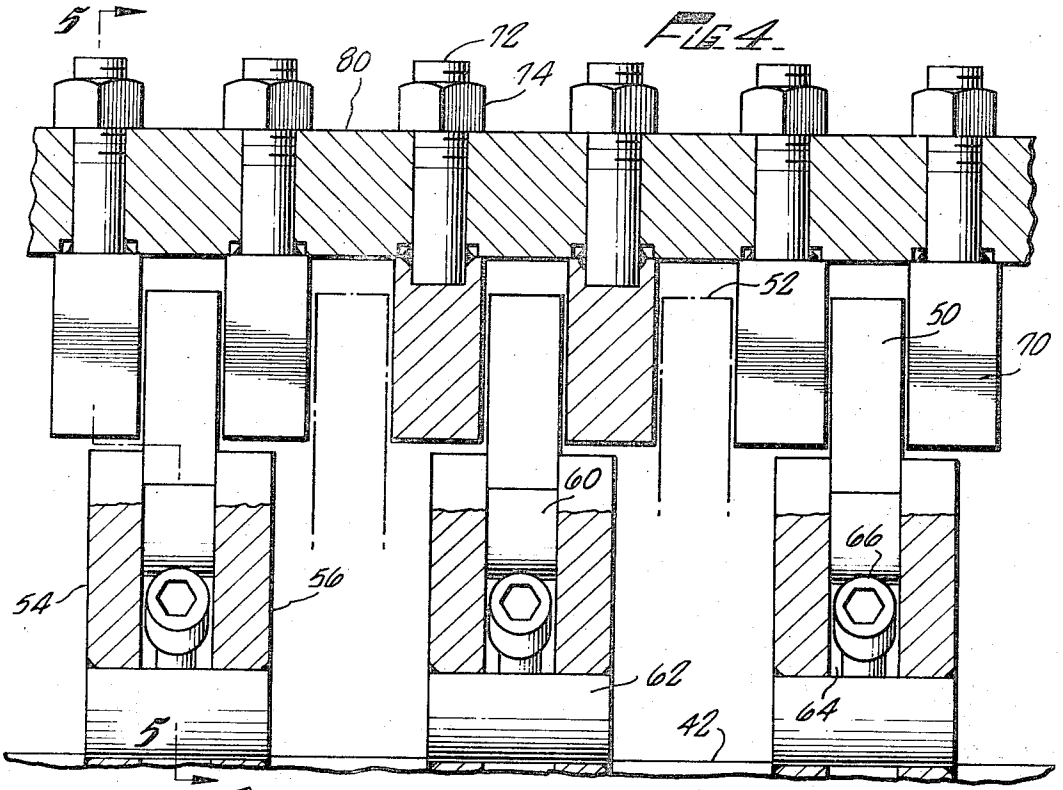

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FIG 3

FIG 4


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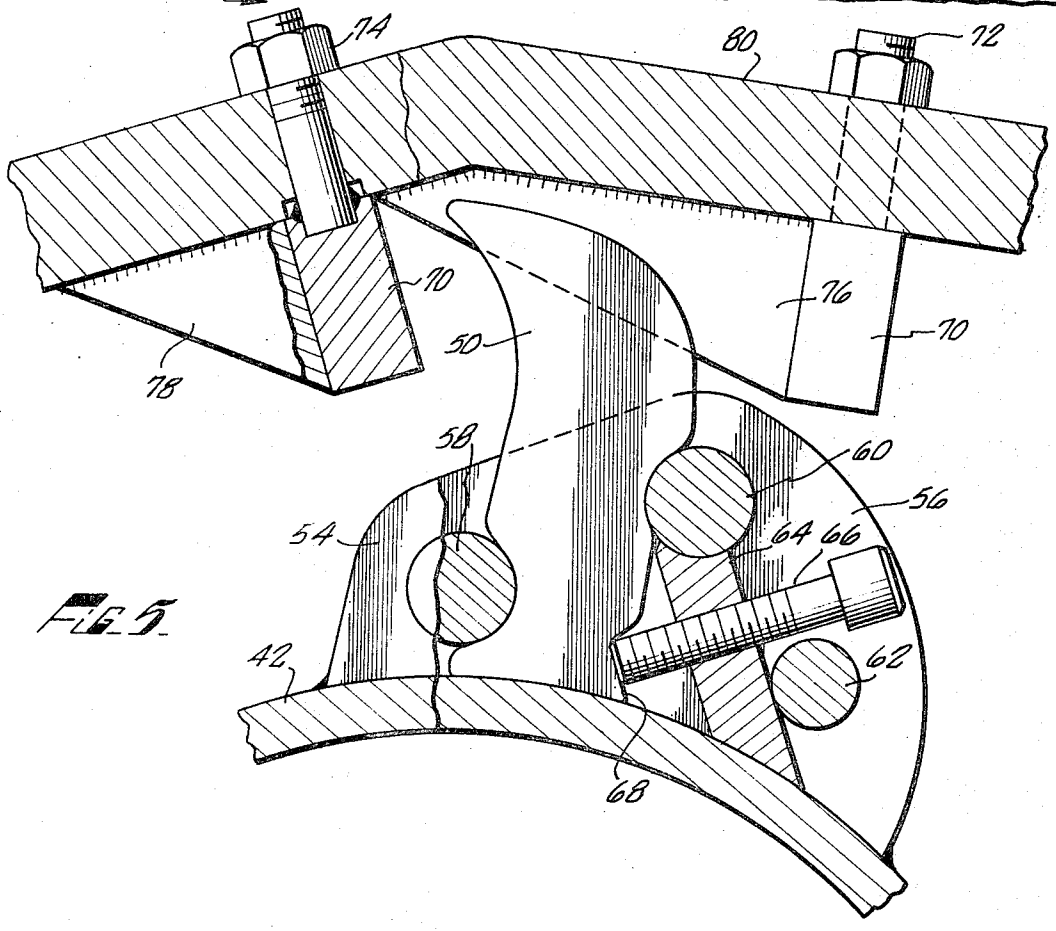

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FIG 5

MOBILE SHREDDER

The present invention is directed to a mobile shredder for shredding refuse and the like deposited on the ground.

The shredding of refuse has been found to be beneficial for the subsequent handling and stabilization of the refuse material. This is particularly true of landfill operations where refuse is deposited and later covered with soil. When refuse materal is properly shredded, the volume thereof may be reduced up to 50 percent. This volume reduction along with the resulting, more uniform particle size and overall homogeneity makes the refuse easier to handle and noticibly reduces the stabilization time of the resulting landfill. As a result, the costs associated with operating the landfill are reduced while the usefulness and consequently the economic value of the project is increased. In some instances, the shredded refuse tends to interlock thereby becoming less susceptible to being blown about. Consequently, the common and costly practice of spreading dirt each day over new refuse in a landfill operation may be eliminated.

In order that refuse may be shredded for landfill operations, it has been common practice to establish a refuse shredding station to which refuse is delivered, processed, and then removed to the landfill project. The stationary shredders located at such shredding stations generally employ a high speed rotating drum having either hammers or knives extending therefrom. When hammers are employed, a grate is normally associated with the hammers. The hammers impact the material, breaking it into particles small enough to pass through the grate and out of the system. When knives are employed, a stationary set of knives, or comb, may receive the rotating knives for shredding the refuse. Naturally, there are systems which combine the impact principle of the hammer mill and the cutting principle of the knife shredders. Such shredding stations require the additional steps in landfill operations of bringing the material to the station and subsequently taking it to the landfill project. This necessarily leads to added initial cost and operating expense.

Alternately, shredders have been mounted on heavy duty carriers. In this way, the shredder may be taken to the landfill project rather than the refuse to the shredder. The shredder may be driven over the deposited refuse and in this way bring about a reduction in the particle size of the landfill material. However, such systems have not been commercially pursued to any substantial extent because of substantial disadvantages inherent in such systems. Specifically, such systems have been unable to control the amount of material drawn into the shredder as the heavy-duty carrier drives over the piles of refuse. This is not true of shredding stations wherein refuse feed is easily controlled. This uncontrolled feed situation is aggravated by the tendency of the shredder to pull material into itself. As a result, the portable shredder quite often becomes jammed, overloaded or breaks down. Another problem is that the shredder must be designed to compromise between scooping up all of the refuse material and preventing the shredding elements from contacting the ground. Consequently, it is often necessary to set the rotating shredder at a position relative to the ground such that a substantial portion of the refuse is not processed.

The present invention is directed to a mobile shredder which may be used at a landfill site and which overcomes the feed problems heretofore experienced by

such mobile shredders. The shredder of the present invention is mounted on a heavy-duty carrier. A breaker bar assembly is provided on the front side of the shredder to partially cover the anterior side of the shredder mechanism. This breaker bar assembly helps to control the feed to the shredder mechanism by breaking the large refuse particles and allowing a preliminary shredding before the refuse enters the main portion of the shredder. Further, the breaker bar assembly, in combination with the shredder frame, define a vacuum scoop which enables the shredder to draw refuse material not intercepted by the rotating shredding elements into the shredder mechanism by means of a vacuum created by the rotating shredder mechanism.

Accordingly, it is an object of the present invention to provide an improved mobile shredder.

It is a further object of the present invention to provide a mobile shredder having a controlled refuse feed into the shredder mechanism.

It is another object of the present invention to provide a mobile shredder having a breaker bar assembly mounted to partially cover the anterior side of the shredding mechanism.

It is yet another object of the present invention to provide a mobile shredder having a vacuum scoop through which refuse is drawn.

Thus, a mobile shredder which may be employed at landfill projects is disclosed which controls the feed of refuse into the shredder mechanism. Other objects and advantages will become apparent from the description herein.

FIG. **1** is a side view of the mobile shredder shown operating over refuse.

FIG. **2** is a front view of the shredder taken along line **2—2** of FIG. **1.**

FIG. **3** is a cross-sectional side view of the shredder mechanism taken along line **3—3** of FIG. **2.**

FIG. **4** is a cross-sectional elevation of the shredder mechanism taken along line **4—4** of FIG. **3.**

FIG. **5** is a cross-sectional detail taken along line **5—5** of FIG. **4.**

Turning specifically to the drawings, a heavy-duty carrier **10** is illustrated in FIG. **1.** In the present embodiment, the heavy-duty carrier **10** includes a central portion designed for the suspension of equipment beneath the vehicle. The shredder mechanism, generally designated **12,** is suspended beneath the heavy-duty carrier **10** by means of a pivot **14** and hydraulic cylinders **16.** This mounting arrangement allows the shredder mechanism **12** to be raised or lowered relative to the heavyduty carrier **10** to prevent the shredder mechanism **12** from contacting the ground when going over rough terrain. A guard **18** is illustrated in the present embodiment as being provided on the front of the heavy-duty carrier **10.** The guard **18** may be employed to push over small trees when the shredder is used for thinning and shredding orchards and the like.

The shredder mechanism **12** incorporates a support frame **20** best illustrated in FIGS. **2** and **3.** The support frame **20** includes a box member **22** extending laterally across the upper anterior portion of the support frame **20.** Side box members **24** extend substantially the length of the shredder mechanism **12** on either side thereof from the outer ends of the box member **22** to the pivot **14.** Gussetts **26** strengthen the joints between the box member **22** and the side box members **24.**

The support frame **20** further includes side panels **28** and **30.** The side panels **28** and **30** depend from the side box members **24** to positions near the ground. The extension of the side panels **28** and **30** to positions near the ground helps to keep refuse picked up by the shredding mechanism from being thrown laterally from the shredder. A back panel **32** as seen in FIG. **3** extends between the side panels **28** and **30** to help direct shredded material toward the ground. A horizontal panel **34** extends rearwardly from the lower end of the back panel **32** to help contain shredded material on the ground and protect the aft portion of the heavy-duty carrier. A horizontal plate **36** also extends between the side panels **28** and **30** at the forward end of the shredding mechanism **12.** The hydraulic cylinders **16** are attached to the shredder mechanism **12** at the horizontal plate **36** by lugs **38.** Vertical support plates **40** help support the horizontal plate **36** about the hydraulic cylinder **16.** The vertical support plates **40** extend upwardly to the box member **22.**

A drum **42** is positioned on a substantially horizontal axis extending between the two side panels **28** and **30** below the main portion of the support structure **12.** The drum **42** is exposed to the ground directly beneath the carrier **10** for receiving refuse lying on the ground as the carrier **10** moves across the landfill site. The drum **42** is rotatively mounted to each of the side panels **28** and **30** by means of heavy-duty bearings **44.** At one end, a pulley **46** is fixed relative to the drum **42** exterior to the side panel **28.** Means are provided for forcibly rotating the drum through the pulley **46.** A **400** horsepower engine (not shown in detail) powers a drive belt **48** which is tightly drawn over the drum pulley **46.** The size of the engine employed to rotate the drum **42** is dependent upon the power requirements of the shredder. Specifically, the width of the shredder, the number and type of shredding elements, the material being shredded, and the speed at which the carrier is driven will all operate to establish the power requirements. A 400 horsepower engine has been found to be very suitable for the present embodiment as herein described. A clutch is employed with the engine to start the drum **42.**

Shredding elements **50** are mounted about the drum **42** for performing the shredding operation. The shredding elements **50** are shown in the present invention to be fixed teeth. However, a plurality of shredding element configurations are compatible with the present system. A hammer mill arrangement may be employed wherein pivoted hammers replace the fixed teeth of the present embodiment. The pivoted hammers are held outwardly by centrifugal acceleration and tend to employ impact rather than shearing loads to shred the material. In the present embodiment, there are approximately **105** teeth located on an 8 foot drum in 6 rows. It is believed that the more teeth which can be employed, the better the shredding action. However, there is a limit to the number of teeth which may be placed on a given drum because of space considerations. The shredding elements **50** are also staggered in succeeding rows such that each succeeding row of elements **50** follows a path between the paths of the elements **50** of the preceeding row. This effect is shown in FIG. **4** wherein phantom shredding elements **52** are illustrated between the shredding elements **50.** This staggered arrangement is employed in the present embodiment for ease of fabrication rather than for improved shredding. In the present embodiment, each shredding element **50** is formed into a fixed tooth **50** having a hooked tip pointing in the direction of rotation. The hook is believed to help concentrate the initial force exerted by each tooth **50** against the refuse being shredded.

Each tooth **50** is mounted to the drum **42** between mounting plates **54** and **56.** The mounting plates **54** and **56** are welded to the drum **42** in pairs for receiving each of the teeth **50.** The mounting plates **54** and **56** are spaced approximately **1** inch apart which is the width of each of the teeth **50.** Extending through each set of mounting plates **54** and **56** are dowels **58, 60** and **62.** The teeth **50** are profiled to receive the dowels **58** and **60** as best seen in FIG. **5.** Each shredding element **50** may be threaded between the dowels **58** and **60** and then rotated into the position as shown in FIG. **5.** A locking plate **64** is positioned behind each tooth **50** and ahead of the locking dowel **62.** The locking plate **64** is prevented from moving away from the tooth **50** because of interference with the dowels **60** and **62.** A locking bolt **66** extends through the locking plate **64** to engage a profiled notch **68** in the tooth **50.** The locking bolt **66** is compressed against the tooth **50** thereby forcing the retention of the tooth **50** between the mounting plates **54** and **56.** The locking bolt **66** also holds the locking plate **64** against the dowels **60** and **62.** In this manner, each of the plurality of teeth **50** may be rigidly retained on the drum **42** and yet may be easily replaced when worn or damaged.

The overall diameter from tip to tip of the drum and teeth **50** is approximately 32 inches in the present embodiment. Including the drum **42,** the shredding elements **50,** the mounting plates **54** and **56** and the remainder of the teeth locking mechanisms, it is estimated that the overall drum weight is approximately 4 tons. The angular speed of the drum is maintained at approximately 1,000 rpm on the present device. A standard rule of thumb on tip speeds used in such devices is to maintain the tip speed between 5,000 and 10,000 feet per minute. It is believed that in the present invention, a tip speed in the neighborhood of 8,000 or 9,000 feet per minute is preferred. However, the system will operate at lower tip speeds.

The position of the drum and shredding elements relative to the ground is controlled by the hydraulic cylinders **16** as discussed above. It is preferred that the teeth **50** do not hit the ground during the operation of the unit. The operator of the carrier is able to keep the support frame **12** high enough above the ground by manipulation of the hydraulic cylinders **16** so that teeth **50** will be in the desired position relative thereto. The relative positioning of the drum **42** and the support frame **12** is such that in the present embodiment, the lower most travel of the teeth **50** is below the bottom edges of the side panels **28** and **30.** This relationship is not critical and it is believed that the side panels **28** and **30** may extend to a position at or below the lower most travel of the teeth **50.** It has been found beneficial to have the side panels **28** and **30** extend to prevent refuse from being thrown laterally from the shredding mechanism. At the same time, the side panels **28** and **30** should not extend so low that they will drag on the ground and prevent the teeth **50** from being properly positioned relative to the ground.

For cooperating with the teeth **50** to shred refuse, means are provided which are fixed to the support frame **12.** In the present embodiment, stationary teeth

70 are arranged in two rows extending across the support frame 20 to form two combs. To support the stationary teeth 70, each tooth 70 is welded to a stud 72 which is bolted to the support frame by means of bolts 74. This relationship is best seen in FIG. 4. The stationary teeth 70 are also supported from behind by means of triangular support blocks 76 and 78 which are welded to the support frame. The stationary teeth 70 are spaced approximately 1 inch apart are aligned with the teeth 50 such that the teeth 50 will pass between the stationary teeth 70. In this way, refuse brought to the stationary teeth 70 by the teeth 50 is torn and impacted into chunks which will fit between the stationary teeth 70. The clearance between the stationary teeth 70 and the several mounting plates 54 and 56 is kept to a practical minimum in order that the great majority of refuse will pass through the stationary teeth 70 rather than underneath. The centrifugal acceleration of the refuse as it is forced around the drum 42 by the rotating shredding elements 50 also operates to force the debris into a path which intersects the stationary teeth 70.

The stationary teeth 70 are fixed relative to a top plate 80 forming a part of the overall support frame 20. The top plate 80 is pivotally mounted to the side panels 28 and 30 at pivots 82 as best seen in FIG. 3. The top plate 80 may be pivoted away from the shredding elements 50 as seen in phantom in FIG. 3. A hydraulic ram 84 is pivotally mounted to the top plate 80 through mounting bracket 86 and is supported at its other end relative to the side box members 24 by a mounting plate 88 and lugs 90. A rod 92 accurately locates the top plate 80 when it is in the closed position. During operation of the shredding mechanism, the top plate 80 is forcefully held in position by the hydraulic ram 84. The top plate 80 is retractable from the drum for easy access to the drum 42, the teeth 50, and the stationary teeth 70.

A breaker bar assembly, generally designated 94, is positioned to partially cover the anterior projection of the drum 42 and teeth 50, as best seen in FIG. 3. A vertical plate 96 extends between the side panels 28 and 30 downwardly from the side box members 24. The horizontal plate 36 abuts the vertical plate 96 and is rigidly fixed thereto. The breaker bar assembly 94 further includes a guide plate 98 forming the furthermost portion of the shredder mechanism 12. The guide plate 98 is rigidly fixed to the horizontal plate 36 and extends downwardly to prevent refuse from building up on the vertical plate 96 and other members. The guide plate also extends at an angle downwardly and rearwardly to force refuse toward the lower side of the drum 42.

A heavy breaker bar 100 extends across the lower side of the shredder 12 substantially parallel to the axis of the drum 42. The breaker bar 100 forms an extension of the guide plate 98 and further forces refuse downwardly toward the lower portion of the drum 42 and teeth 50. The breaker bar 100 is of 1 inch steel plate to help break up large pieces of refuse before they can be entangled with the rotating drum 42 and to cooperate with the rotating teeth 50 to provide a preliminary shredding of the refuse. Support for the breaker bar 100 is provided by the vertical plate 96 and a support brace 102. The rearward edge of the breaker bar 100 is met by the vertical plate 96 which is slightly arcuate to provide clearance for the shredding elements 50. The junction between the vertical plate 96 and the breaker bar 100 is established, in the present embodiment, at approximately one inch from the path of the shredding elements 50.

The positioning of the breaker bar 100 results in a reduced entrance area leading to the rotating drum 42 and teeth 50 and provides a stationary structure near the rotating teeth 50 for effecting a preliminary coarse shredding mechanism for large refuse pieces. This reduced entrance area is capable of controlling the refuse particle size approaching the shredding mechanism. The positioning of the breaker bar 100 relative to the ground operates to provide a first sizing of the incoming refuse particles by crushing the refuse as the carrier passes. The reduced entrance area also tends to prevent large entangled masses of refuse from being drawn into the shredding mechanism all at once by providing efficient resistance to the flow of refuse to the drum and teeth that the masses will become disentangled.

The reduced entrance area determined by the lower edge of the breaker bar 100 and the ground is primarily established by the vertical setting of the entire shredder mechanism 12 relative to the ground. However, the position of the shredder mechanism is dependent upon the desired positioning of the teeth 50 relative to the ground. As the teeth are positioned as close as practical to the ground, the breaker bar will also be properly positioned. Further, as the shredder mechanism 12 is raised, the drum 42 is also raised. Thus, when the breaker bar 100 is up, the shredding elements 50 will contact only the upper portion of large refuse particles. It has been found that the vertical relationship between the drum and teeth and the breaker bar is acceptable for most operations when the breaker bar 100 covers the anterior projection of the drum 42 and teeth 50 to approximately the bottom of the drum 42 as best seen in FIG. 3.

The relative positioning of the breaker bar 100 and the teeth 50 further reduces the refuse particle size drawn upward to the stationary teeth 70. When refuse is encountered by the shredder mechanism 12 which is larger than the spacing between the drum 42 and the breaker bar 100, the teeth 50 tend to initiate a primary shredding at the location of the breaker bar 100. The entire mass of material will be forced upward by the rotating teeth 50. However, the breaker bar 100 will prevent such upward movement except by the portion of material which has passed the inner edge of the breaker bar 100. This action creates a preliminary shredding and disentangling of the refuse before it reaches the stationary teeth 70. The refuse which then reaches the stationary teeth 70 will be of acceptable size and easily processed. It should be noted that the spacing between the breaker bar 100 and the drum 42 is not affected by the position of the entire shredder mechanism relative to the ground. Consequently, the preliminary shredding action of the breaker bar 100 does not depend on the positioning of the support frame.

The breaker bar 100 is spaced from the tips of the rotating teeth 50 approximately one inch in the present embodiment. It is not essential that a one inch space be maintained. However, the closer the breaker bar is to the rotating teeth, the more preliminary shredding will occur. Therefore, the lower edge of the breaker bar 100 should terminate in a line near the tips of the teeth 50, less than around four inches in the present embodiment and preferably around one inch.

The breaker bar assembly **94,** in combination with the side panels **28** and **30,** further enchance this shredding operation through the creation of a vacuum scoop. The rotation of the drum **42** in the neighborhood of 1,000 rpm creates a vacuum at the leading side of the drum **42.** The side panels **28** and **30** and the breaker bar assembly **94** in forming a closed structure about the drum **42** operate to enhance this vacuum. The vacuum created near the leading side of the drum **42** is of sufficient magnitude to draw refuse particles toward the rotating teeth **50.** In this way, the shredder mechanism **12** may be set sufficiently above the ground to insure that the teeth **50** will not come in contact therewith and yet substantially all of the refuse lying on the ground will be drawn toward the stationary teeth **70** by the combined operation of the vacuum and the physical action of the teeth **50.**

In summary, the overall system is operated by rotating the drum **42** at approximately 1,000 rpm. At the same time, the shredding mechanism **12** is positioned such that the shredding elements **50** will approach but will not contact the ground. The heavy-duty carrier is then moved forward to allow the shredder mechanism **12** to encounter and process the refuse laying on the ground. It has been found that on smooth ground the heavy-duty carrier may travel at speeds up to 20 mph. Naturally, with material which is extremely resistant to shredding, the carrier speed may be reduced to insure that the shredder mechanism **12** will not be overloaded.

Thus, a mobile shredder is provided which is capable of controlling the refuse input to the shredder mechanism. Further, a vacuum scoop is provided to help draw particles not positively contacted the rotating teeth **50** into the shredder. While embodiments and applications of this invention have been shown and described, it would be apparent to those skilled in the art that many more modifications are possible without departing from the inventive concepts herein described. The invention, therefore, is not to be restricted except by the spirit of the appended claims.

What is claimed is:

1. A mobile shredder mounted to a heavy-duty carrier and comprising
- a support frame adjustably mounted to the heavy-duty carrier;
- a drum rotatably mounted to said support frame, the axis of said drum being substantially horizontal and said drum being exposed to the ground over which the carrier is directed;
- means for forcibly rotating said drum;
- a plurality of shredding elements mounted to said drum and extending outwardly therefrom;
- means fixed to said support frame cooperating with said shredding elements for shredding material introduced to said shredder; and
- a breaker bar assembly rigidly mounted to said support frame substantially parallel to the axis of said drum, said breaker bar assembly terminating at a line near the outermost path of said shredding elements.

2. The shredder of claim **1,** wherein said breaker bar assembly terminates at a point approximately 1 inch from the extreme path of travel of said shredding elements.

3. The shredder of claim **1** wherein said breaker bar assembly partially covers the anterior projection of said drum.

4. The shredder of claim **3** wherein said support frame further includes side panels extending at either end of said drum to below said drum, said side panels and breaker bar assembly cooperating to form a vacuum scoop.

5. The shredder of claim **1** wherein said plurality of shredding elements are teeth fixed to said drum

6. The shredder of claim **1** wherein said breaker bar assembly includes a heavy steel plate forming the terminating line near the outermost path of said shredding elements.

7. A mobile shredder mounted on a heavy-duty carrier comprising
- a support frame adjustably mounted to the heavy-duty carrier and including side panels extending downwardly from said support frame;
- a drum rotatably mounted to said support frame, the axis of said drum being substantially horizontal and said drum being exposed to the ground over which the carrier is directed, said drum being positioned between said side panels;
- means for forcibly rotating said drum;
- a plurality of shredding elements mounted to said drum and extending outwardly therefrom;
- means fixed to said support frame cooperating with said shredding elements for shredding material introduced to said shredder; and
- a breaker bar assembly rigidly mounted to said support frame substantially parallel to the axis of said drum, said breaker bar assembly partially covering the anterior projection of said drum to provide in cooperation with said side panels a vacuum scoop for the attraction of light refuse into said shredder.

8. The shredder of claim **7,** wherein said breaker bar assembly terminates at a point approximately 1 inch from the extreme path of travel of said shredding elements.

9. The shredder of claim **7** wherein said plurality of shredding elements are teeth fixed to said drum.

10. The shredder of claim **7** wherein said breaker bar assembly includes a heavy-duty steel plate forming the terminating line near the outermost path of said shredding elements.

11. A mobile shredder comprising
- a heavy-duty carrier;
- a support frame adjustably mounted to said heavy-duty carrier;
- a drum rotatably mounted to said support frame, the axis of said drum being substantially horizontal and said drum being exposed to the ground over which said carrier is directed;
- means for focibly rotating said drum;
- a plurality of shredding elements mounted to said drum and extending outwardly therefrom;
- means fixed to said support frame cooperating with said shredding elements for shredding material introduced to said shredder; and
- a breaker bar assembly rigidly mounted to said support frame substantially parallel to the axis of said drum, said breaker bar assembly partially covering the anterior projection of said drum to reduce the entrance area to said drum.

12. The shredder of claim 11 wherein said breaker bar assembly terminates near the outermost path of said shredding elements.

13. The shredder of claim 12 wherein said breaker bar assembly terminates at a point approximately one inch from the extreme path of travel of said shredding elements.

14. The shredder of claim 11 wherein said support frame further includes side panels extending at either end of said drum to below said drum, said side panels and breaker bar assembly cooperating to form a vacuum scoop.

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