Sept. 13, 1966 L. E. HAYNES 3,272,559

PAVEMENT CUTTING AND EARTH EXCAVATING DEVICE

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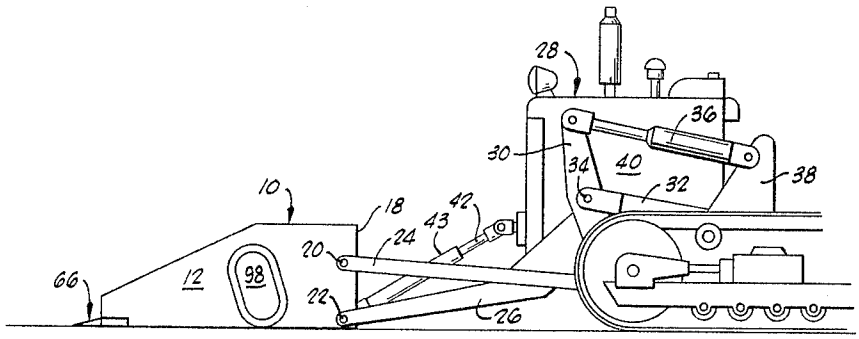


Fig. 1

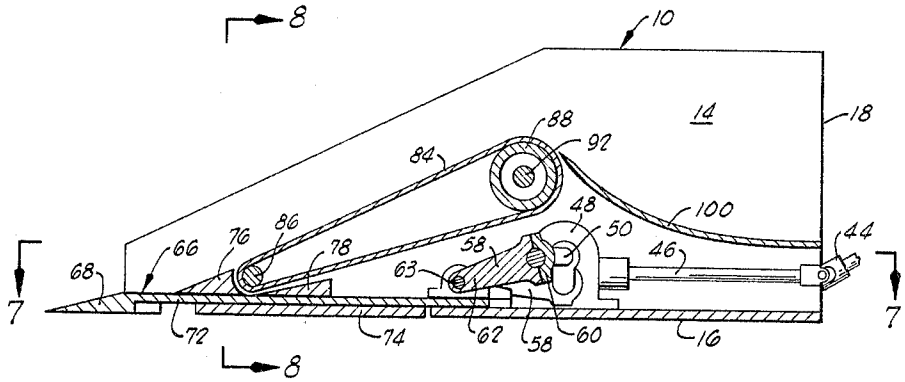


Fig. 5

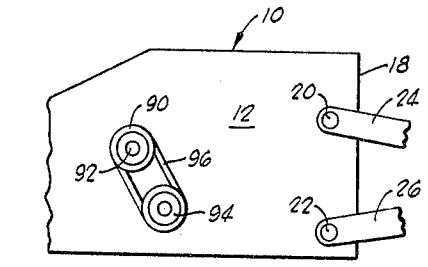


Fig. 9

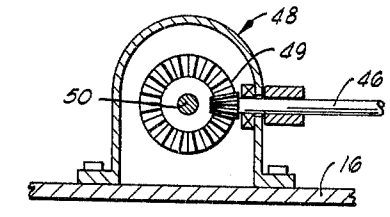


Fig. 6

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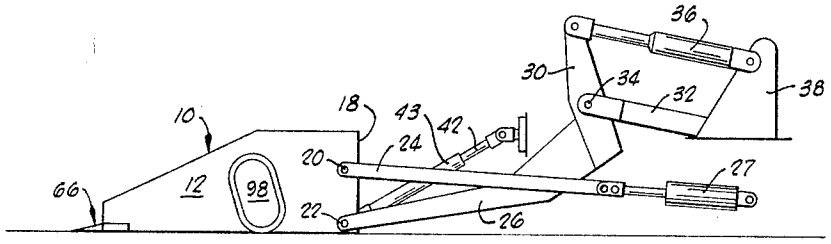


Fig. 2

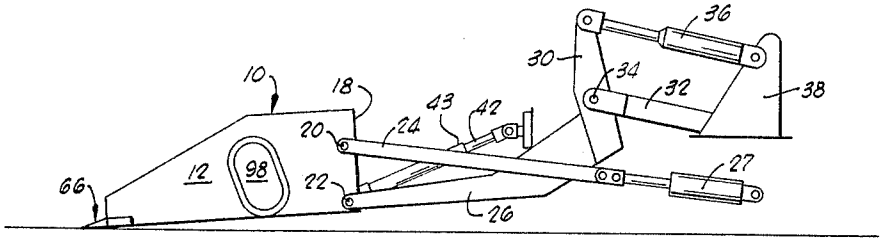


Fig. 3

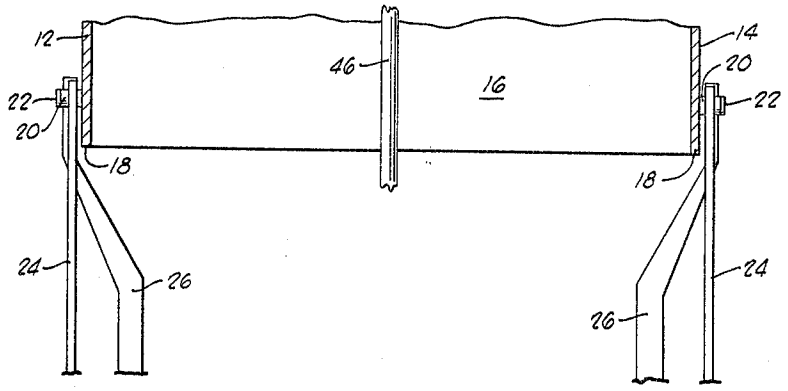


Fig. 4

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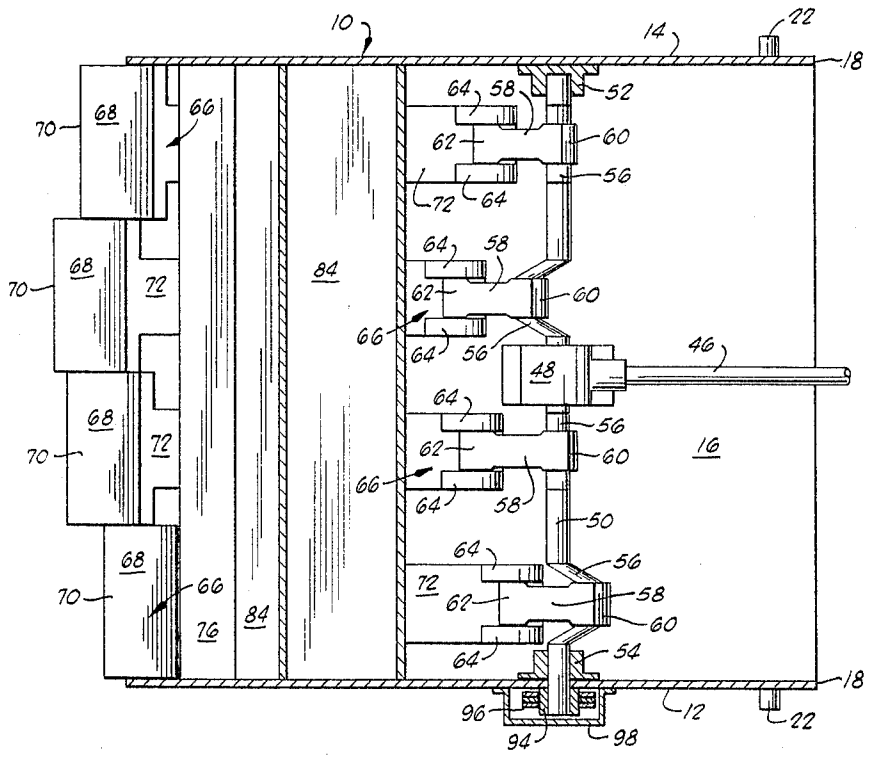


Fig. 7

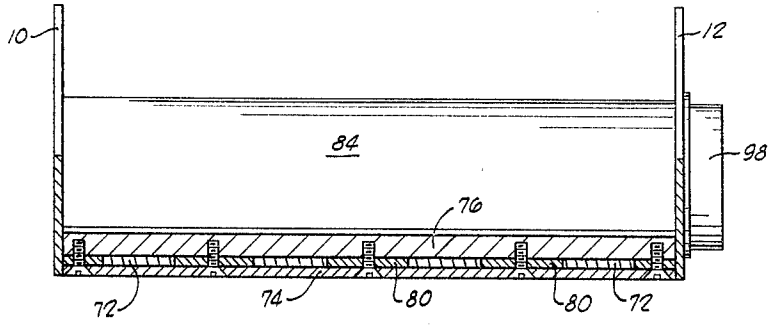


Fig. 8

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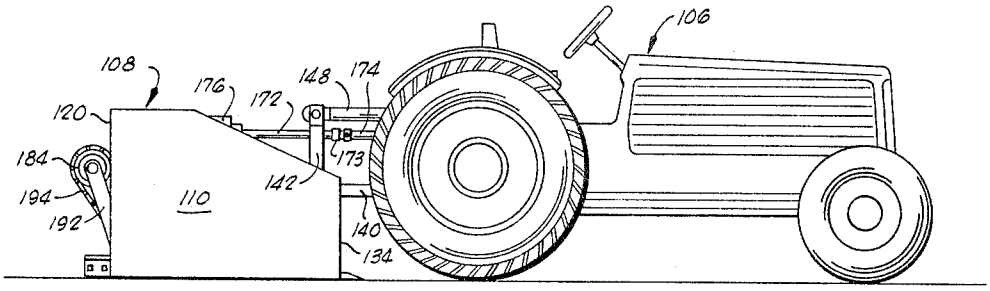


Fig. 10

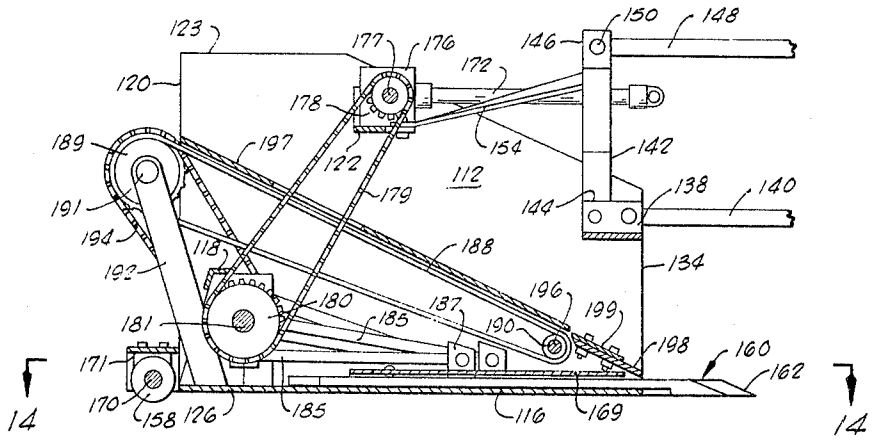


Fig. 11

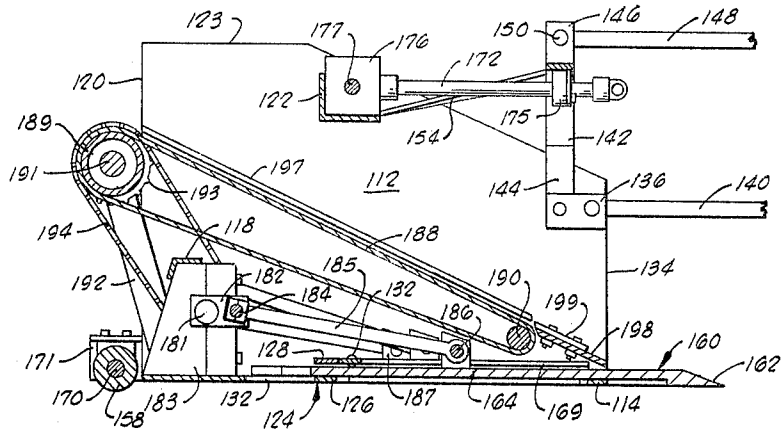


Fig. 12

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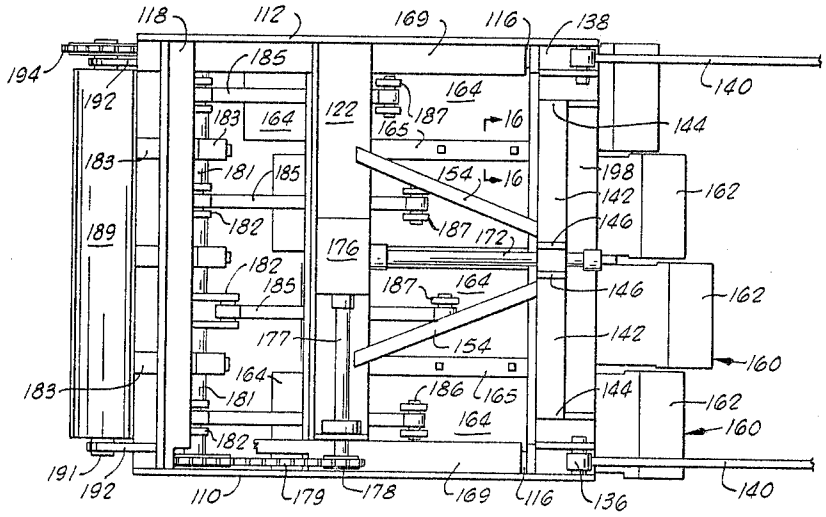


Fig. 16

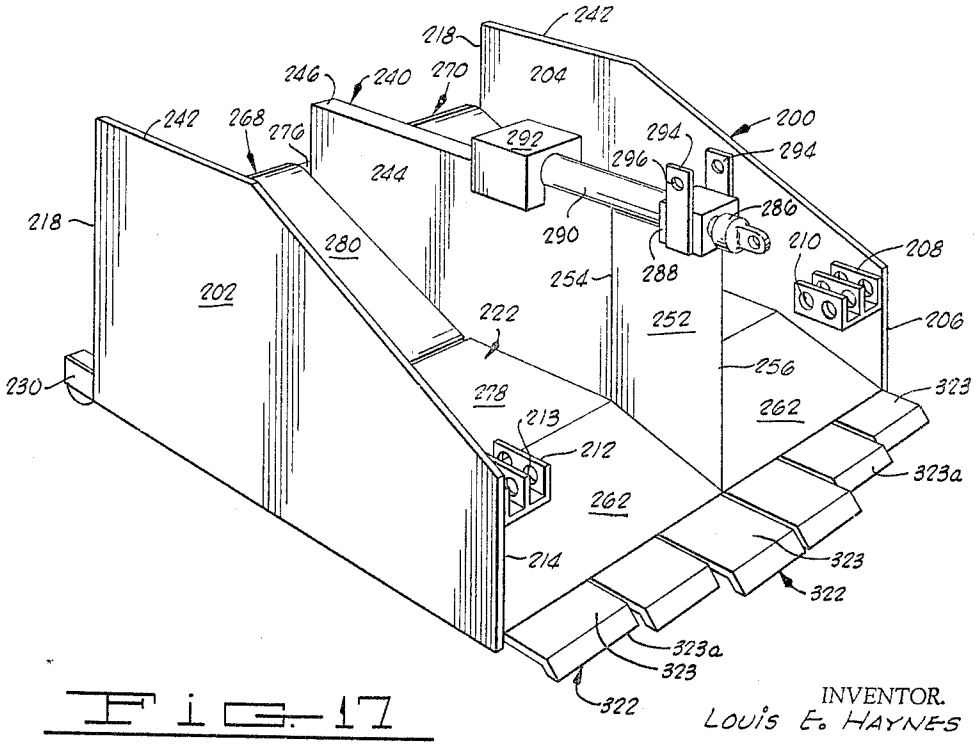


Fig. 17

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PAVEMENT CUTTING AND EARTH EXCAVATING DEVICE

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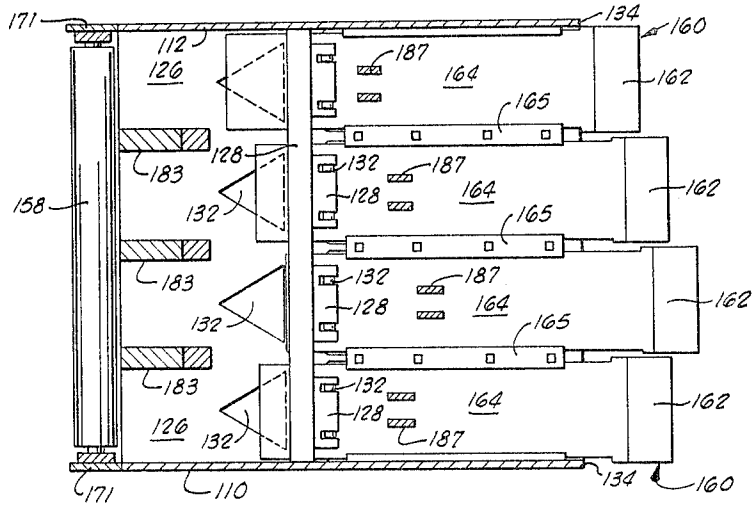


Fig. 14

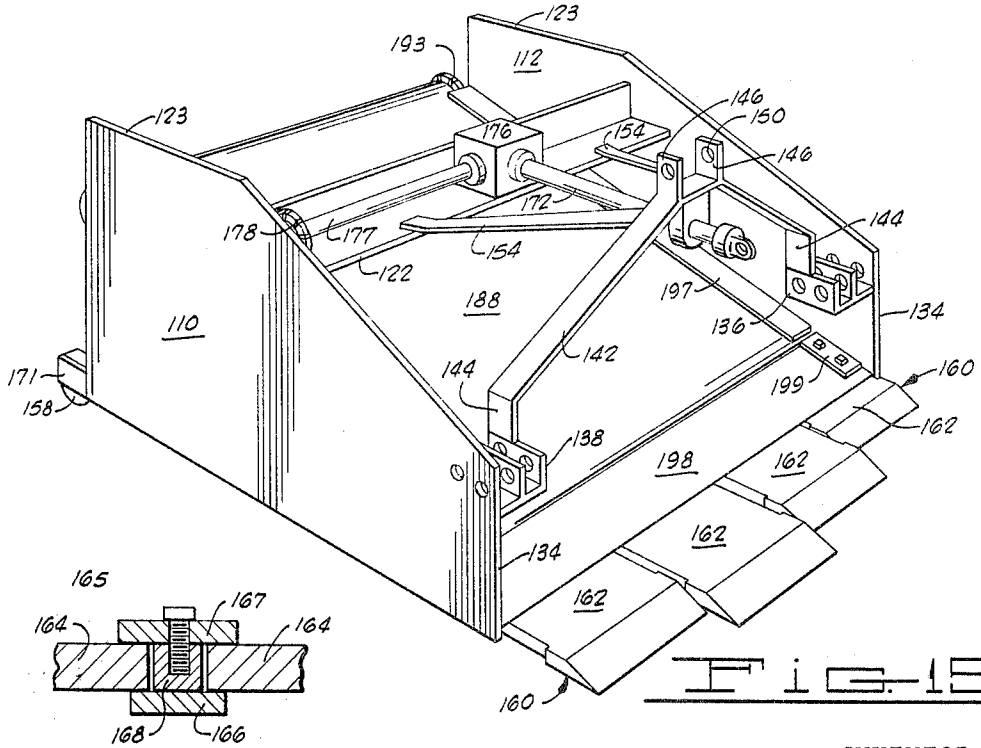


Fig. 15

Fig. 16

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PAVEMENT CUTTING AND EARTH EXCAVATING DEVICE

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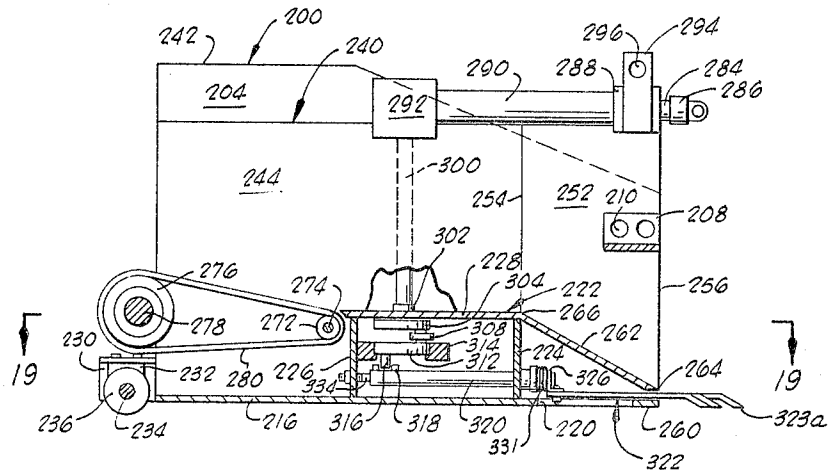


Fig. 18

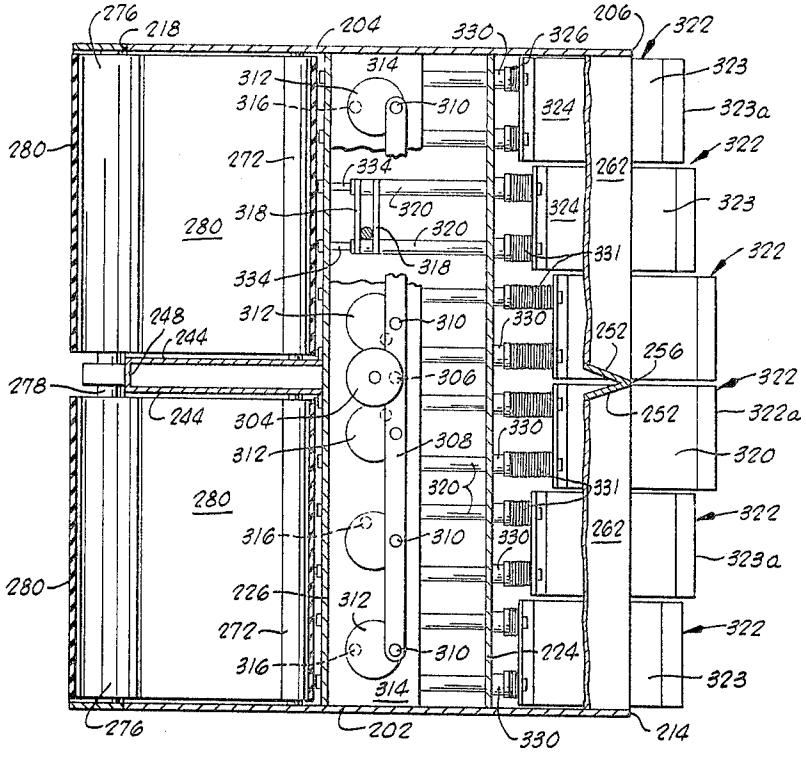


Fig. 19

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Filed June 21, 1965 9 Sheets-Sheet 8

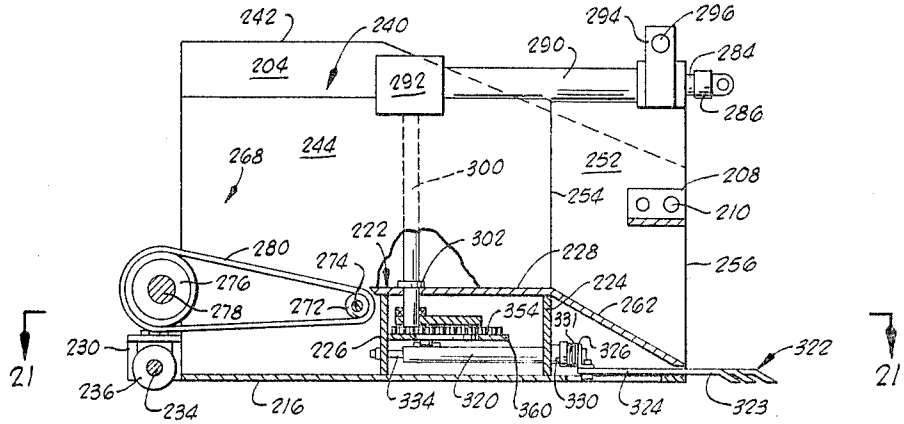


Fig. 20

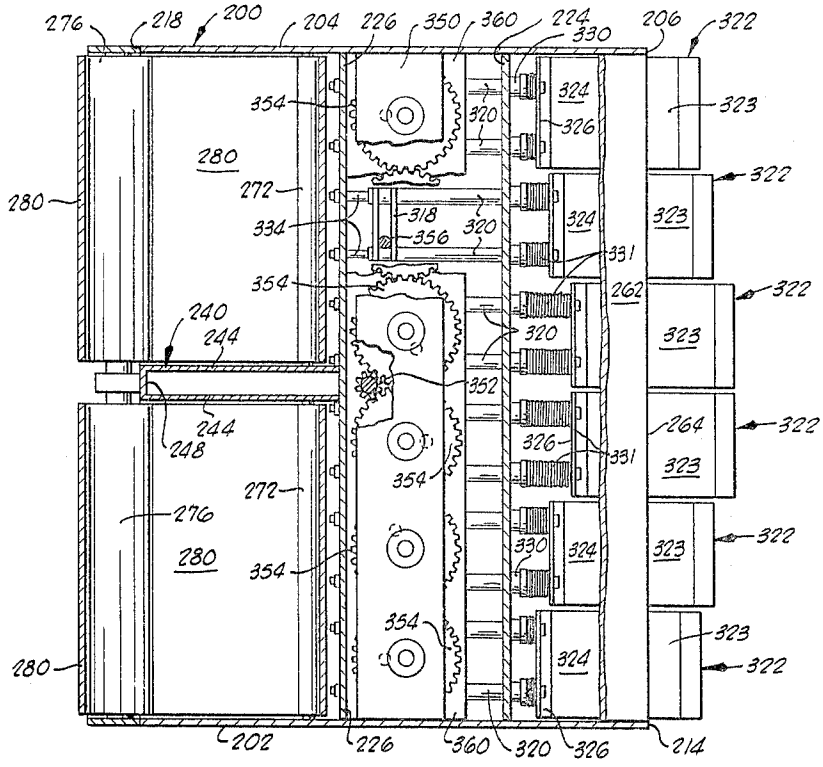


Fig. 21

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PAVEMENT CUTTING AND EARTH EXCAVATING DEVICE

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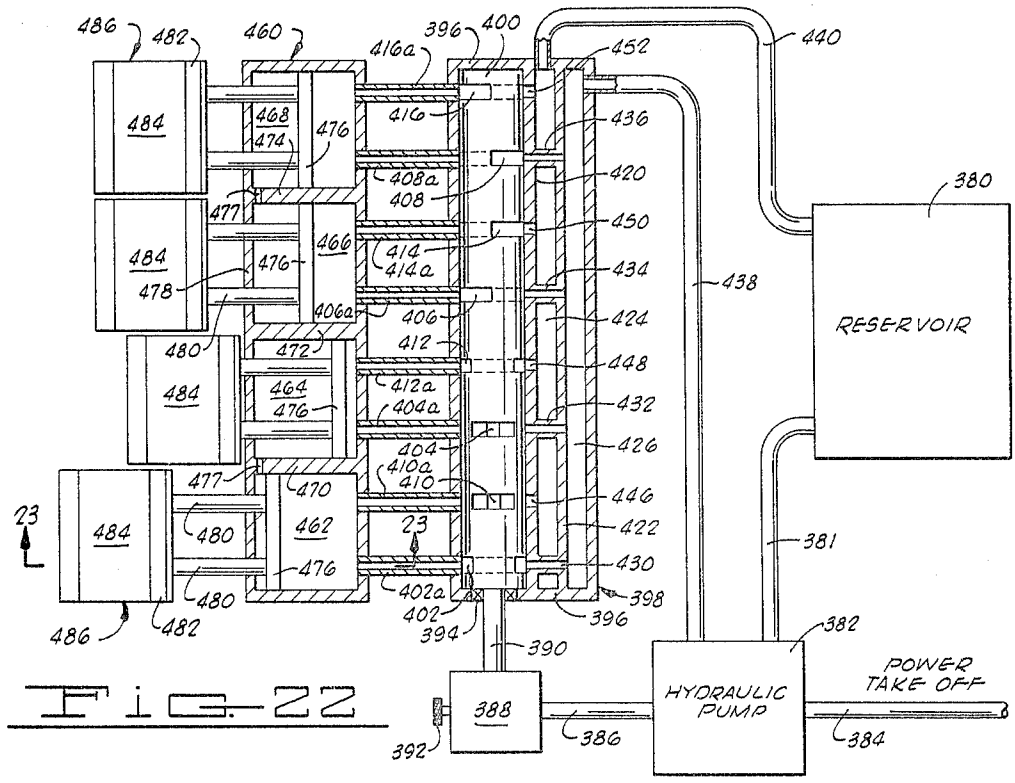


Fig. 22

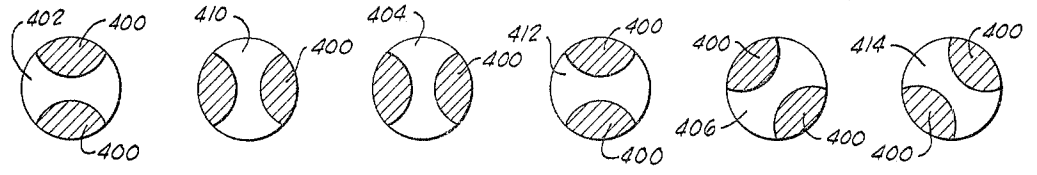


Fig. 24A Fig. 24B Fig. 24C Fig. 24D Fig. 24E Fig. 24F

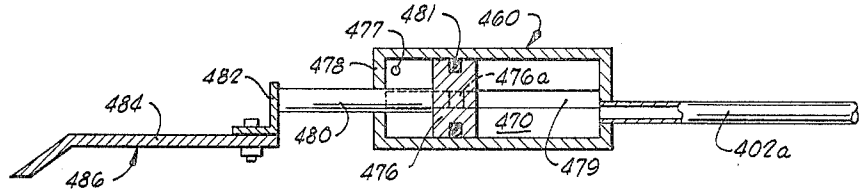


Fig. 23

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United States Patent Office 3,272,559 Patented Sept. 13, 1966

3,272,559

PAVEMENT CUTTING AND EARTH EXCAVATING DEVICE

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Filed June 21, 1965, Ser. No. 465,611
42 Claims. (Cl. 299—37)

This invention relates to a powered device for removing earth surfacing material, such asphalt, gravel or the like, or for removing large quantities of earth to a depth of up to about eighteen inches on a continuous basis. More particularly, but not by way of limitation, the present invention relates to an excavating or pavement cutting device which utilizes a plurality of sequentially reciprocated blades in conjunction with forward motions supplied by a tractor or other self-propelled machine for removing earth, asphalt and similar materials from the surface of the earth. This application is a continuation-in-part of my United States application 268,133 filed March 26, 1963 now United States Patent No. 3,219,388.

A great variety of earth working apparatuses of various types have been developed and many of such devices have been directed toward the removal of a substantial quantity of earth from the surface of the ground to varying depths, with such removal being effected in a continuous manner. Other devices related to the earth removing devices include machines which are designed to remove slabs of concrete or asphalt from the surface of a roadbed for the purpose of renewing the surface, or simply for the purpose of reclaiming some of the materials of construction for other uses. Machines of this type have generally been large and complicated and, in some instances, have functioned quite well for some specific utilization, such as removing large quantities of dirt, but have not been sufficiently versatile to permit their use in a variety of operations where surface materials of varying hardness or density and consistency are encountered.

The present invention comprises a machine which can be utilized for a variety of purposes, and which is characterized by an ability to remove larger quantities of surface materials from the earth than has heretofore been possible using different types of bladed structures in which the blades are fixed and power for scraping or removing the surface of the earth is developed primarily by a self-propelled vehicle to which the blades are attached. The apparatus of the invention is further characterized by great versatility in that the machine may be employed for removing stumps in the course of clearing new ground, removing without substantial disturbance, a layer of desired thickness of the earth and then relaying this layer in substantially the same position in which it was located prior to removal, removing and conveying from the site of removal substantial quantities of earth where it is desired to excavate the earth to a certain depth and removing hard surfaces, such as asphalt or pavement, in instances where it may be desired to resurface a roadbed or to destroy an old road while salvaging some of the materials of construction therefrom.

All of the principles which form the basis of the operation of the present invention have not been heretofore entirely unknown. The apparatus of the invention relies primarily upon two forces for developing the cutting, severing and excavating effectiveness of the apparatus, these forces being (a) a rectilinear reciprocating drive imparted to a plurality of blades which are driven in out-of-phase or sequential relation to each other, and (b) the forward motion which is applied to the machinery as a whole by a self-propelled vehicle, such as a tractor. Blades which move with a rectilinear or reciprocating motion have heretofore been utilized in small hand-driven machines for removing carpet or linoleum from

a floor, but such machines have been entirely unsuitable for uses of the type to which the present apparatus is adapted, and have not been required to have the mechanical strength of construction, or to deliver the power to the reciprocating blades which necessarily characterize the apparatus of the present invention.

Broadly described, the pavement cutting and earth excavating apparatus of the present invention comprises, in combination, a self-propelled vehicle including a prime mover or engine; a power takeoff from the prime mover; a framework spaced from the self-propelled vehicle and carrying a plurality of blades movably mounted on the framework for reciprocation or rectilinear motion in horizontal planes substantially even with or below the lower surface of the ground engaging portions of the self-propelled vehicle; power transmission means connected between the blades and the power takeoff for driving the blades in sequential, or out-of-phase relation to each other; multiple point hitch connection elements interconnecting the framework and the self-propelled vehicle; and actuating means on the self-propelled vehicle for actuating the multiple point hitch connecting elements to raise and lower the framework, and to incline the framework and the blades carried thereby with respect to a horizontal plane.

To more specifically describe certain aspects of the invention, the framework which is connected to the self-propelled vehicle by the multiple point hitch connecting elements includes a pair of vertically extending, horizontally spaced side walls or plates extending parallel to the direction of movement of the reciprocating blades; a material supporting inclined ramp positioned adjacent the blades and extending upwardly and rearwardly therefrom; and a material moving conveyor positioned adjacent the ramp for receiving material therefrom and extending transversely between the vertically extending side walls of the framework.

Various types of drive systems may be used for driving the blades in reciprocation from the power takeoff of the self-propelled vehicle. Several preferred types of these will be described in the detailed description of the invention which follows hereinafter. In each instance, however, the blades are reciprocated in a direction corresponding to the direction of travel of the self-propelled vehicle and framework, and the blades are moved in out-of-phase relation to each other; that is, one of the blades will complete a cutting stroke as another is commencing its cutting stroke, and as yet another is retracting from its cutting stroke, etc. The cutting forces which come into play to remove the surface of the earth or surfacing material, such as pavement, are thus (a) the forward motion of the self-propelled vehicle and (b) the reciprocating motion of the cutting blades. In a preferred embodiment of the invention, means is provided for synchronizing these two motions so that the machine can be used efficiently in varying types of soils, or in removing surfacing materials of varying hardness and consistency.

Since less force is required to move materials to the rear of the framework away from the cutting blades if the inclination of the inclined ramp and conveyor is relatively small, a preferred construction of the invention further contemplates a low profile conveyor arrangement in which the transmission between the power takeoff and the blades is a novel combination of elements compactly constructed for occupying a minimum of space below the conveyor.

In operation, the framework carrying the reciprocating blades is driven or pulled by a tractor or the like so as to cause the reciprocating blades to bite into the earth or through the pavement or other surface material, according to the purpose to be accomplished. As the framework is pulled along the ground, the blades are sequen-

tially reciprocated into and out of the earth at a depth determined by an initial setting on the multiple point hitch connection. The excavated earth or removed surface material is forced to the rear of the framework and onto the conveyor. Any desired disposition may be made of the dirt moved by the conveyor. It has been found that a considerably greater rate of earth and surfacing material removal can be accomplished with the apparatus of the invention than has been attainable with any device known to applicant which has heretofore been used for this same general purpose.

From the foregoing description of the invention, it will have become apparent that it is an important object of the present invention to provide an earth excavating and pavement cutting, or surface material removing, device which can quickly and efficiently remove large quantities of earth or surfacing material, and convey such material to a location where it may be conveniently disposed of in any manner desired.

A further object of the present invention is to provide a mechanically rugged, self-propelled apparatus which can be used to slice away a surface layer of the earth to any depth desired up to about eighteen inches.

An additional object of the present invention is to provide an earth excavating apparatus which includes a plurality of reciprocating blades driven in sequence by novel, mechanically rugged drive systems which can be operated from a power takeoff on a tractor or similar self-propelled vehicle.

Another object of the invention is to provide a self-propelled earth excavating apparatus which can effectively remove a layer of earth without an undesirably high degree of disturbance to the earth, and then permit the earth to be redeposited in substantially the same location from which it was removed.

Another object of the present invention is to provide a device which can effectively remove asphalt from a roadbed and convey the cut portions of the asphalt to a suitable heated tank where the asphalt can be quickly remelted and respread, thus saving considerable cost.

A further object of the invention resides in the provision of a device which can be quickly and effectively attached to a conventional land surface self-propelled vehicle in a manner which permits the device to be driven into the earth to a desired depth, at which the depth the device will automatically level off and proceed to remove the earth along a horizontal plane therein.

Another object of the invention is to provide means connected to the cutter blades of the device for removing asphalt or other surfacing materials so as to reciprocate some of these blades out of phase with other blades to thereby make the device continuously effective for cutting pavement or asphalt.

An additional object of the invention is to provide an earth excavating and surfacing material removing device which can be driven by a self-propelled vehicle using a power takeoff therefrom, and including means for synchronizing the rate of movement of the self-propelled vehicle and excavating device along the ground with the reciprocating movement of the cutting blades which are provided in the device.

Another object of the invention is to provide an earth excavating device which is efficient in operation, and which requires a minimum number of parts and maintenance.

An additional object of the invention is to provide an earth excavating and pavement cutting device which is very strongly constructed, is mechanically durable and is characterized by a long and trouble-free operating life.

In addition to the foregoing described objects and advantages, other objects and advantages will become apparent as the following detailed description of the invention is read in conjunction with the accompanying drawings which illustrate various aspects and embodiments of the invention.

In the drawings:

FIGURE 1 is a side elevational view of one embodiment of the present invention showing a tractor vehicle in use to control the orientation of excavation elements relative to the ground and to propel the apparatus in its operation.

FIGURE 2 is a detail view illustrating the elements utilized to connect the earth excavating and pavement cutting device of the invention to a tractor by a four point hitch connection, and showing the manner in which the hitch links and the driving elements connected thereto are used to adjust the elevation and vertical inclination of the pavement cutting device with respect to the ground.

FIGURE 3 is a view similar to FIGURE 2 illustrating the earth excavating and pavement cutting device as it is positioned by the actuating elements of a tractor preparatory to driving the device into the ground.

FIGURE 4 is a plan view further illustrating the manner in which the earth excavating and pavement cutting device is connected to the tractor by a plurality of hitch links.

FIGURE 5 is a longitudinal sectional view through the center of one embodiment of the apparatus of the invention, and illustrating the relationship of the various components utilized in the invention, except for the self-propelled vehicle or tractor which supplies the power for operation of the apparatus.

FIGURE 6 is a sectional view showing the interior of the gear box which houses the gearing used to interconnect a drive shaft with a crankshaft used in the invention.

FIGURE 7 is a sectional view taken substantially along the plane of the line 7—7 of FIGURE 5.

FIGURE 8 is a sectional view taken substantially along the plane of the line 8—8 of FIGURE 5 and illustrating the guide means used for guiding the reciprocating cutter blades utilized in the embodiment of the invention illustrated in FIGURES 1 through 9.

FIGURE 9 is a fragmentary side elevational view of the apparatus of the invention with the cover housing for the conveyor drive assembly removed to more clearly illustrate the latter.

FIGURES 10 through 16 illustrate a different embodiment of the present invention, various aspects and details of which are depicted in the several figures as follows:

FIGURE 10 is an elevational view illustrating the manner in which the earth excavating and pavement cutting framework and reciprocating blades are connected to a self-propelled vehicle, such as a farm tractor, using a three point hitch connection.

FIGURE 11 is a longitudinal sectional view taken in a vertical plane through the earth excavating and pavement cutting portion of the apparatus illustrated in FIGURE 10 and showing the moving parts of this portion of the apparatus as such parts would appear if one of the vertically extending side walls or plates of the framework were removed.

FIGURE 12 is a longitudinal sectional view taken in a vertical plane and extending through the earth excavating and pavement cutting portion of the invention illustrated in FIGURE 11 with the FIGURE 12 section being taken near the centerline of the framework used to support the dirt moving conveyor and the reciprocating blades.

FIGURE 13 is a plan view of the earth excavating and pavement cutting portion of the invention as it appears when viewed from the above with the conveyor belt and lowermost conveyor roller removed in order to better illustrated certain elements of the invention.

FIGURE 14 is a horizontal sectional view taken through the earth excavating and pavement cutting portion of the machine along line 14—14 in FIGURE 11.

FIGURE 15 is a perspective view of the earth excavating and pavement cutting portion of the assembly shown in FIGURE 10.

FIGURE 16 is a section taken along line 16—16 in FIGURE 13.

FIGURES 17, 18 and 19 illustrate yet another embodiment of the invention which is particularly useful by reason of the low profile conveyor, and low surfaces over which the excavated dirt is moved, and which incorporates a novel transmission system which is enclosed in a sealed lubricating chamber, and a particularly sturdy drive system for the reciprocating blades. The several figures in this series may be described as follows:

FIGURE 17 is a perspective view illustrating the modified embodiment of FIGURES 17 through 19 as it appears when detached from the self-propelled vehicle to which it is adapted to be attached by a three point hitch connection.

FIGURE 18 is a side elevational view of the earth excavating and pavement cutting device depicted in FIGURE 17 as the same would appear with one of the vertically extending side plates removed. A portion of the hollow central partition which houses the vertically extending drive shaft utilized in this embodiment of the invention has been broken away to better show the position of the drive shaft.

FIGURE 19 is a sectional view taken along the horizontal plane defined by line 19—19 in FIGURE 18.

FIGURES 20 and 21 illustrate yet another embodiment of the invention in which yet a different drive system is used to convey power from the power takeoff on a self-propelled vehicle to the reciprocating blades used in the earth excavating and pavement cutting portion of the invention. In these figures, FIGURE 20 is a view of the earth excavating and pavement cutting portion of the apparatus similar to that shown in FIGURE 18, i.e., this portion of the apparatus as it would appear when viewed in elevation with one of the vertically extending side plates removed, and a portion of the hollow central partition broken away to better illustrate the drive shaft.

FIGURE 21 is a horizontal sectional view taken along the plane defined by line 21—21 in FIGURE 20. A portion of the gear drive used in this embodiment of the invention has been broken away in order to better illustrate the manner in which the several gears carrying eccentric studs or pins are utilized to drive the reciprocating blades in out-of-phase relation to each other.

FIGURE 22 is a partially schematic view of a modified drive system which is utilized in a preferred embodiment of the invention for driving the reciprocating cutting blades used in the invention in out-of-phase relation. This figure depicts the manner in which the hydraulic drive system is adapted to permit the rate at which the blades are reciprocated to be synchronized with the rate at which the self-propelled vehicle used to move the earth excavating and pavement cutting device is advanced along the ground.

FIGURE 23 is a sectional view taken along line 23—23 of FIGURE 22.

FIGURES 24*a*–24*f* are schematic sectional views taken through several of the fluid injection and discharge ports used in the hydraulic drive system depicted in FIGURES 22 and 23, and showing the manner in which these ports are circumferentially spaced around a solid cylinder through which they extend.

Referring now to the drawings in detail, and particularly, to FIGURES 1 through 4, the main framework used in the earth excavating and pavement cutting device of the invention is designated generally by reference character 10. The framework 10 includes a pair of horizontally spaced, vertically extending side walls 12 and 14 which are connected to each other by a transversely extending plate 16 which is secured to the vertically extending plates 12 and 14 at the lower edges thereof. The vertically extending side walls 12 and 14 each have secured adjacent the rear edge 18 thereof, a pair of vertically spaced connecting pins, the uppermost of which are designated by reference character 20, and the lowermost of which are designated by reference character 22. Pivotally connected to the pins 20 and 22 are pairs of elongated hitch links 24 and 26. The links 24 connected to the uppermost pins 20 are utilized for canting or inclining the framework 10 with respect to the surface of the earth, as hereinafter explained. The hitch lengths 24 are connected at their other ends to a hydraulic cylinder 27 or other actuating mechanism disposed on a suitable self-propelled vehicle, such as a tractor designated generally by reference character 28 and illustrated in FIGURE 1. The large hitch lengths 26 which are connected at one of their ends to the lowermost pins 22 on the framework 10 are rigidly secured at their other ends to an arm 30 on the tractor 28, which arm 30 is pivotally connected to a support beam 32 for pivotation about a pivotal axis 34. The arm 30 is driven in its pivotal movement by a suitable hydraulic cylinder 36 mounted on the tractor and fixed to an upright stanchion 38.

Power for the operation of the earth excavating and pavement cutting apparatus of the invention is developed by the engine 40 of the tractor 28, and is transmitted to the reciprocating blades mounted on the framework 10 (as hereinafter described) by a suitable power takeoff 42 from the engine 40. The power takeoff 42 is connected to a coupling shaft 43 which is connected through a universal joint 44 to a drive shaft 46 which enters a gear box 48 mounted on the horizontally extending transverse plate 16. A bevel ring and pinion type gear 49 is mounted in the gear box 48 as illustrated in FIGURE 6. The bevel ring and pinion gear 49 is used to drive a crankshaft designated generally by reference character 50 from the drive shaft 46.

The crankshaft 50 extends transversely across the framework 10 and is journaled at its ends in a pair of bearings 52 and 54 mounted on the vertically extending side plates 12 and 14 (see FIGURE 7). The crankshaft 50 is provided with a plurality of radially offset, circumferentially spaced throw portions 56 which are spaced from each other along the longitudinal axis of the crankshaft. The number of throws 56 which are provided correspond in number to the number of reciprocating blades which will be utilized in the invention as hereinafter explained. The circumferential spacing of the throws is preferably equal and corresponds to 360° divided by the number of throws which are provided (four in the illustrated embodiment).

Connecting rods or crank arms 58 are pivotally journaled at one of their ends 60 on each of the throws 56. At their opposite ends 62, the crank arms 58 are pivotally connected by means of crank pins 63 (see FIGURE 5) to knuckle bearings 64 which are rigidly secured in horizontally spaced relation to the rear portions of each of a series of elongated cutter blades designated generally by reference character 66. The construction of the cutter blades may perhaps best be understood by referring to FIGURES 5 and 7. Each of the cutter blades 66 includes an enlarged head 68 which is tapered to a sharp cutting edge 70 at the forward end thereof. The cutter blades 66 further include a transversely reduced shank portion 72 which is connected to, or formed integrally with, the enlarged head 68, and which supports at its rearmost end the bearing knuckles 64. It will also be noted in referring to FIGURE 5 that the enlarged head 68 of each of the cutter blades is thicker in its vertical dimension than the reduced shank portion 72 of the blade.

In order to support the cutter blades 66 in their reciprocating movement, hereinafter described, a cutter blade supporting bar 74 extends transversely across the framework 10 and is secured to the lower edges of the vertically extending side plates 12 and 14. Spaced above the cutter blade supporting bar 74 by a distance sufficient to permit the reduced portions 72 of the cutter blades to be extended therethrough is a cutter blade retaining

bar 76. The cutter blade retaining bar 76 is provided with a relatively flat lower surface and an arcuate or concavely dished upper surface so as to permit the reduced shank portions 72 of the cutter blades 66 to slide against the lower surface of the cutter blade retaining bar and to permit a conveyor to be mounted in juxtaposition to the forward, upper surface of the cutter blade retaining bar for a purpose hereinafter explained.

In order to guide and to maintain the position of the cutter blades 66 in the course of their reciprocating motion, a plurality of spacer guide plates 80 are provided between the cutter blade supporting bar 74, and the cutter blade retaining bar 76 at spaced intervals along the transverse extent of these members, with the spacing between the spacer guide plates corresponding to the width of the reduced shank portions 72 of the cutter blades 66. It will thus be seen in referring to FIGURE 8 that the spacer guide plates 80, the cutter blade supporting bar 74 and the cutter blade retaining bar 76 provide channels in which the cutter blades may move during reciprocation, which channels function to maintain the alignment of the cutter blades and guide them in their movement.

For the purpose of preventing an accumulation of dirt around the cutter blades 66, and to permit excavated dirt to be moved to a position for permitting more convenient disposal, the apparatus of the invention is provided with an endless conveyor belt 84 which is extended over a forward roller 86 positioned in the concavely dished upper surface of the cutter blade retaining bar 76, and a rear roller 88 spaced vertically above the crankshaft 50. The drive for the conveyor 84 is obtained by mounting a sprocket or pulley 90 on the end of a shaft 92 which carries the roller 88. The pulley 90 is positioned above a sprocket or pulley 94 carried on one end of the crankshaft 50 which projects through the side wall 12, as best illustrated in FIGURES 7 and 9. An endless belt 96 drivingly interconnects the pulleys 90 and 94 so that the rotary motion of the crankshaft 50 is transmitted to the shaft 92 to which the conveyor roller 88 is keyed. A suitable cover or housing 98 is secured to the vertically extending side wall 12 and covers the pulleys 90 and 94 and the belt 96, as best illustrated in FIGURES 3 and 9.

An arcuate slide plate 100 is secured between the vertically extending side walls 12 and 14 of the framework 10 and is positioned to the rear of the conveyor belt 84 to receive dirt therefrom and convey the dirt to the rear of the framework. Any suitable means of disposal may be provided on the framework in addition to the conveyor 84 and slide plate 100, such as a heated hopper for receiving materials such as asphalt or pavement for melting these materials for reutilization. There may also be an additional conveyor system (not shown) connected to the rear of the framework 10 for removing dirt excavated by the apparatus to a remote location, or for loading the dirt into a hopper, dump truck or similar device.

In the operation of the embodiment of the invention illustrated in FIGURE 1, the framework 10 can initially be elevated and inclined with respect to the surface of the earth by means of the hitch links 24 and 26 as illustrated in FIGURES 2 and 3. The heavy, more mechanically sturdy links 26 are employed for bodily lifting the framework 10 out of the earth, or above the surface of the earth, and the links 24 are utilized to cant or incline the framework with respect to the surface of the earth. After positioning the apparatus, as illustrated in FIGURE 3, the tractor 28 or other driving, self-propelled vehicle is moved forwardly in the direction of the framework 10 and, at the same time, power is transmitted to the cutter blades 66 via the power takeoff 42 and shafts 43 and 46. As the tractor 28 moves forward, the framework 10 is forced into the earth and is then leveled out by the use of the hitch links 24, accompanied by a gradual lowering of the hitch links 26. The power input to the gear box 48 drives the crankshaft 50 through the ring and pinion gearing 49 located in the gear box. As the crankshaft 50 is rotated, the horizontally spaced eccentric throws 56 located thereon are also rotated and cause the connecting rods 58 to move with an oscillating movement which is translated to rectilinear or reciprocating motion by reason of the pivotal connection between the connecting rods and the throws 56 at one of their ends, and the bearing knuckles 64 via the crank pins 63 at their other ends.

It will be noted in referring to FIGURE 5 that the forward or power stroke delivered to the cutter blades 66 through the connecting rod 58 occurs at the time when the connecting rods are most nearly aligned with the path of motion of the cutter blades. Stated differently, the forward or cutting stroke of the cutter blades 66 commences as the eccentric throws 56 approach the transverse plate 16 in their clockwise rotating movement and continues as the throws pass through their point of nearest approach to the transverse plate 16. This construction considerably improves the mechanical strength of the power transmission structure, and increases the operating life of the cutter blade drive mechanism.

As the cutter blades are reciprocated or driven in rectilinear motion, they are guided in this motion by the cutter blade supporting bar 74, the cutter retaining bar 76 and the spacer guide plates 80. The cutter blades 66 are driven forwardly into the earth by the motion of the crankshaft 50 and through the connecting rods 58 so that the cutter blades have a compound motion imparted to them by the drive system from the power takeoff 42, as well as the forward motion of the tractor 28. The motion of the tractor 28 and the cutter blades can be synchronized to give maximum digging effectiveness in soils of varying consistencies and hardness. The level at which the blades 66 cut through the earth can be adjusted by proper manipulation of the hitch links 24 and 26, and the machine is capable of removing earth at depths up to nearly two feet.

As the earth removed by the cutter blades 66 moves toward the tractor 28 by reason of the forward motion of the tractor, it passes over the cutter retaining bar 76 and onto the conveyor belt 84. The conveyor belt moves the loose earth upwardly and onto the slide plate 100. From the slide plate 100 the dirt may be removed to a remote location for disposal, or may be permitted to return to the earth as in a plowing operation, or in an operation where it is merely desirable to loosen or move the upper surface of the soil. The machine as thus far described can also be used for removing a hard surfacing material, such as asphalt or other paving material when it is desired to renew or replace the surface of a roadbed. The asphalt is sheared away or cut to a desired depth by the cutter blades 66 and the pieces of asphalt are carried upwardly by the conveyor belt 84 and deposited on the slide plate 100. From the slide plate 100 the asphalt may be deposited in a melting vat (not shown), further conveyed to a dump truck or disposed of in any other suitable manner.

Another form or embodiment which the invention may assume is illustrated in FIGURES 10 through 16 of the drawings. In referring to these figures, a tractor vehicle 106 of the agricultural type is positioned ahead of a framework 108 which carries the earth excavating and pavement cutting apparatus used in the invention. The framework 108 includes, similarly to the embodiment illustrated in FIGURES 1 through 9, a pair of vertically extending, horizontally spaced side walls 110 and 112. A horizontally extending, forward transverse blade support member 114 is connected at each of its opposite ends to the side walls 110 and 112, as well as to the forward end of a pair of horizontal

blade support plates 116 secured to the lower edge of each of the side walls 110 and 112.

The side walls 110 and 112 are further interconnected by a transverse, generally L-shaped brace 118 which is spaced upwardly from the lower ends of the side walls 110 and 112 and toward the rear, vertical edges 120 thereof. Another structural element interconnecting the side walls 110 and 112 is a large angle iron, gear box-supporting, transverse beam 122 which extends between the side walls adjacent the upper edges 123 thereof and provides a support for a gear box and drive shaft as hereinafter explained.

A blade shank guideway designated generally by reference character 124 extends transversely between the side walls 112 and 110 and is secured at its opposite ends to the lower edges thereof. The blade shank guideway 124 includes a lower plate 126, an upper plate 128 and a plurality of spacer members (not visible) which function to retain the upper and lower plates 128 and 126, respectively, in spaced relation to each other, and also to guide the cutter blades in their reciprocation motion, as will be hereinafter explained. The lower plate 126 of the blade shank guideway 124 extends rearwardly in the framework 112 in horizontal coplanar alignment with the lower edges of the side walls 112 and 110 to a point slightly beyond the rear edges 120 of the side walls.

The lower plate 126 is provided with a plurality of slots or apertures 132 in transversely spaced relation therealong to permit dirt moved rearwardly by the cutter blades and infiltrating under the conveyor (hereinafter described) to gravitate from the machine during the operation thereof. The upper plate 128 of the blade shank guideway 124 carries a plurality of rollers which are journaled therein and are positioned to bear against the upper surface of the shanks of the cutter blades as the same are reciprocated through or between the upper and lower plates 128 and 126, respectively, as hereinafter explained.

Welded or otherwise suitably secured to each of the side walls 110 and 112 at positions adjacent the forward edge 134 thereof, and spaced well up on the respective side walls are a pair of outer hitch brackets 136 and 138, respectively. The outer hitch brackets 136 and 138 are provided with a plurality of channels having apertures in the sides thereof to permit the outer hitch links which are secured therein to be transversely adjusted in their points of attachment as may be desired. In referring to FIGURE 10, it will be noted that the framework 112 is connected to the tractor 106 by a three point hitch connection which includes outer hitch links 140 which extend from the brackets 136 and 138 to the tractor 106, and which are connected to suitable actuating means on the tractor to permit the framework 108 to be raised or lowered in a vertical direction, as hereinafter more fully explained.

A third bracket for connecting the third and central hitch link which extends between the tractor 106 and the frame 108 is provided by a pair of braces 142 which are welded or otherwise suitably secured at one of their ends 144 to the outer hitch brackets 136 and 138, and which are bent inwardly over a major portion of their length and then upwardly at their upper ends 146 to provide parallel opposed ears forming a hitch bracket to receive one end of the central hitch link 148. The upper ends 146 of the members 142 are apertured as designated by reference character 150 (see FIGURE 11) to permit a pin to be passed through the end of the central hitch link 148 and the upper ends 146 of the members 142. The hitch link 148 is connected at its forward end to an actuating mechanism (not visible), such as a hydraulic piston and cylinder assembly, on the tractor 106 to permit the framework 108 to be pivoted about a horizontal axis extending through the points of connection of the outer hitch links 140 to their respective hitch brackets 136 and 138. In order to add structural strength and support to the members 142, a pair of angle braces 154 are extended between the transverse angle iron beam 122 and the members 142, as best illustrated in FIGURE 13.

The cutter blades employed in the embodiment of the invention illustrated in FIGURES 10 through 16 are somewhat similar to the cutter blades illustrated in the embodiment of the invention depicted in FIGURES 1 through 9 and previously described. The cutter blades are designated generally by reference character 160 and include a sharpened cutting edge portion 162 and a shank portion 164 extending rearwardly from the cutting edge. The shank portion 164 of each cutter blade 160 is slidingly supported on the transverse blade support member 114 and the lower plate 126 of the shank guideway 124. It will also be noted in referring to FIGURE 12 that the shank portions 164 of the cutter blades 160 pass beneath the upper plate 128 of the shank guideway 124 and are in contact with the rollers 132 carried thereby.

In order to guide and further support the shank portions 164 of the blades 160 during the reciprocating motion of the blades, a plurality of double channel guide bars 165 are extended between the shank guideway 124 and the transverse blade support member 114, as illustrated in FIGURES 13 and 16. The channel guide bars 165 are horizontally spaced from each other and are positioned to slidingly engage the side edges of the shank portions 164 of the blades 160. The I-shaped cross-sectional appearance of the guide bars 165 is illustrated in FIGURE 16. In the illustrated embodiment, the guide bars 165 include a lower plate 166, a top plate 167 and a spacer bar 168 between the lower and top plates.

In order to protect the laterally outer edges of the shank portions 164 of the two outermost blades 160 from becoming impacted with dirt during operation of the apparatus, a pair of horizontally extending protective cover plates 169 are secured along each of the side walls 110 and 112 just above the blades. Confining guideways or channels are thus formed for these particular blade shank portions by the horizontal support plates 116 and the cover plates 169 attached in pairs to each of the side walls 110 and 112.

In order to better facilitate movement of the frame 108 along the ground during an earth excavating or pavement cutting operation, a shaft 170 is positioned at the lower rear end of the framework 108 and is journalled in horizontally spaced brackets 171 welded or otherwise secured to the lower plate 126 and the side walls 110 and 112. A roller 158 is keyed to the shaft 170 and projects slightly below the lower plate 126 to reduce the frictional drag of the framework 108 as it is pulled behind the tractor 106.

The transmission system utilized to drive the cutter blades 160 in reciprocating, out-of-phase motion includes a includes a power input shaft 172 which is adapted for connection through a universal joint 173 to a power take-off shaft 174 extending from the tractor 106. The power input shaft 172 extends through a journal block 175 supported from the upper ends 146 of the members 142 and into a gear box 176 mounted centrally on the transverse angle iron beam 122. A ring and pinion or other suitable gear (not seen) enclosed in the gear box 176 transmits the rotational movement of the power input shaft 172 to a transverse drive shaft 177. The transverse drive shaft 177 extends through a journal block mounted on the transverse angle iron beam 122 near the end thereof and is keyed at its outer end to a drive sprocket 178. A portion of the transverse angle iron beam 122 is cut away to permit a drive chain 179 to be extended around the drive sprocket 178 and downwardly along the side wall 110.

At its lower end the drive chain 179 is passed around a driven sprocket 180 which is mounted on one end of the crankshaft 181. The crankshaft 181 is shaped similarly to the crankshaft 50, as illustrated in the FIGURE 1 through 10 embodiment, and which has been described in referring thereto. Thus, the crankshaft 181 is pro-

vided with a plurality of radially offset, circumferentially staggered throws 182 spaced from each other over its length and corresponding in number to the number of cutter blades used in the apparatus. Similarly also, the throws 182 are arranged circumferentially around the crankshaft 181 to provide out-of-phase actuation of the blades 160. The crankshaft is extended through a plurality of journal-carrying, trapezoidally-shaped vertical blocks 183, and is rotatably supported in journals carried thereby. The vertical blocks 183 are secured at their lower ends or bases to the lower plate 126, and at their upper ends to the L-shaped brace 118.

Each of the throws 182 on the crankshaft 181 is connected by means of a crank pin 184 to one end of a connecting rod 185 which is secured by a pin 186 extending through its other end to a connecting bracket 187 secured to, and extending upwardly from, the shank portion 164 of one of the cutter blades 160. Thus, each of the cutter blades 160 is connected by a connecting rod 185 to one of the throws 182 of the crankshaft 181.

The conveyor system used in the embodiment illustrated in FIGURES 10 through 16 is best illustrated in FIGURES 11, 12 and 15 of the drawings. The conveyor system includes an endless belt conveyor 188 which is extended around a pair of rollers 189 and 190 mounted in the positions illustrated in FIGURE 11. The roller 189 is supported on a shaft 191 which is carried by a plurality of vertical shaft supporting members 192 secured at their lower ends to the lower plate 126 and projecting upwardly and rearwardly therefrom so as to position the roller 189 slightly to the rear of the framework 108. At its end which is most proximally positioned with respect to the side wall 112, the shaft 191 is provided with a drive sprocket 193 which permits the shaft to be driven in rotation by a chain 194 extended around the sprocket 193 at one end thereof, and around a second sprocket 195 which is connected to the opposite end of the crankshaft 181 from the end thereof which carries the driven sprocket 180.

The roller 190 is keyed to a shaft 196 which is rotatably journaled in the side walls 110 and 112 of the framework 108.

In order to protect the transmission mechanism and the moving blade shanks 164 from impaction by dirt which may slip off the conveyor belt 188 and gravitate downwardly within the framework 108, a pair of overhanging protective plates 197 are secured to the side walls 110 and 112 and extend outwardly over the opposed edges of the endless conveyor belt 188, and preferably bear lightly thereagainst to form a seal to prevent by-pass of dirt. It will be noted in referring to FIGURE 11 that the cover plate 197 which is secured to the side wall 110 is either slotted or is interrupted and broken away over a portion of its length in order to permit the chain 179 interconnecting the drive sprocket 178 with the driven sprocket 180 to be passed through the cover plate.

A final element which is incorporated in the embodiment of the earth excavating and pavement cutting apparatus illustrated in FIGURES 10 through 16 is a lift plate 198 which is utilized to receive dirt loosened and removed by the cutter blades 160, and to move this dirt upwardly onto the endless conveyor belt 188. The lift plate is illustrated in section in FIGURES 11 and 12, and in elevation in FIGURES 13 and 15 and is designated by reference character 198. It will be noted in referring to the sectional views of the lift plate 198 that the plate is inclined with respect to the vertical at approximately the same angle as the angle of inclination of the endless conveyor belt 188, and that the lift plate 198 is aligned with the conveyor belt so that dirt can move smoothly from the lift plate onto the conveyor belt. The lift plate 198 extends transversely across the framework 108 and is secured at its opposite ends by bolting to anchor plates 199 welded or otherwise suitably attached to each of the vertically extending side walls 110 and 112.

In the operation of the embodiment of the invention illustrated in FIGURES 10 through 16, the framework 108 is attached behind the tractor 106 by a three point hitch connection utilizing the outer hitch links 140 and the central hitch link 148. The outer hitch links 140 can be lifted upwardly to vertically elevate or lower the framework 108 when it is desired to pull the framework out of the ground or lower it into a resting position thereon. The central hitch links 148 can be extended in length by a conventional actuating mechanism on the tractor 106 to cause the framework 108 to pivot about a horizontal axis extending through the hitch brackets 136 and 138. By canting or inclining the framework 108 with respect to the surface of the earth, it may be caused to bite downwardly or dig into the earth, and the setting on the central hitch link 148 determines the depth to which the cutter blades 160 will dig before the framework levels out and assumes a horizontal position. An interesting aspect of the invention is that the framework will automatically level out at a selected depth without further actuation of the central hitch link 148 as a result of the change in the vertical position of the framework 108 with respect to the tractor 106 as the framework settles down to the desired depth. This action occurs because of the fixed radius of the central hitch link 148 once its length is set, and the manner in which the framework is pivoted on the two outer hitch links 140.

Once the cutter blades 160 have reached the desired cutting depth, the excavating operation commences or, alternatively, in a different use of the apparatus, the surfacing material, such as asphalt or other paving material, commences to be stripped away to a desired depth. The cutter blades are driven in rectilinear or reciprocating motion by power delivered from the power takeoff 174 of the tractor 106. Thus, the power input shaft 172 is driven in rotation and, through the gearing located in the gear box 176, drives the drive shaft 177 in rotation. Through the sprockets 178, chain 179 and drive sprocket 180, the crankshaft is caused to rotate in the journals provided in the journal-carrying blocks 183. Rotation of the crankshaft 181 in turn causes the cutter blades 160 to be rotated in out-of-phase relation because of the manner of connection of the connecting rods 185 to the throws 182 of the crankshaft, as hereinbefore explained.

As dirt or paving material is cut away by the cutter blades 160, it moves up over the lift plate 198 and moves onto the endless conveyor belt 188. The endless conveyor belt is driven in rotation by power delivered through the chain 194 to the sprocket 193 mounted on one end of the shaft 191 carrying the conveyor roller 189. As the endless conveyor belt 188 moves in a counterclockwise fashion, as viewed in FIGURE 11, the excavated dirt is moved rearwardly in the framework 108 and is deposited on the ground to the rear of the framework, or may be conveyed to a dump truck or otherwise handled as may be desired. The roller positioned to the rear of the framework 108 and projecting slightly below the lower surface of the lower plate 126 functions to reduce the frictional drag which the framework 108 imposes on the tractor 106 and permits the apparatus to be moved forward more easily.

A modified embodiment of the invention is illustrated in FIGURES 17, 18 and 19. The portion of this embodiment there illustrated comprises the frame carrying the conveyor mechanism and the cutter blades for slicing through the earth and removing the earth as the framework is advanced by a tractor or other suitable self-powered vehicle (not shown). The framework is designated generally by reference character 200 and includes horizontally spaced, vertically extending side walls 202 and 204. Mounted on the side wall 204 adjacent the forward vertical edge 206 thereof, and at a position relatively high on the side wall is an outside hitch bracket 208

having a plurality of horizontally spaced channels and apertures 210 for facilitating the connection of an outside hitch link thereto by use of a pin or other suitable means. A second outside hitch bracket 212 is provided in a corresponding position on the side wall 202 adjacent the front edge 214 thereof, and also includes a plurality of horizontally spaced channels defining horizontally aligned apertures 213 to accommodate a hitch pin. As in the case of the embodiment illustrated in FIGURES 10 through 16, the hitch brackets 208 and 212 provide points of connection for the outer or lateral hitch links used in a three point hitch connection for connecting the framework 200 to a tractor or other self-powered vehicle.

The vertically extending side walls 202 and 204 are interconnected by a horizontally extending base plate 216 which extends between and is secured to the lower edges of the vertically extending side walls. The horizontal base plate 216 extends from the rear edges 218 of the side walls 202 and 204 to a position about two-thirds of the way forward on the side walls where it terminates in a transversely extending forward edge 220. A transmission housing, designated generally by reference character 222, is welded or otherwise suitably secured to the upper surface of the horizontal base plate 216 at a position relatively close to the forward transverse edge 220 thereof, and extends horizontally across the framework 200 between the side walls 202 and 204. The transmission housing 222 includes a front wall 224, a back wall 226, and a horizontal cover plate 228. The construction of the transmission housing 222 is such that all of the intersecting walls and the cover plate are sealingly connected to each other so that the housing may be filled with a suitable lubricant, and the ingress of fine dust or water to the interior of the housing is prevented.

Secured to the lower rear corners of the side walls 202 and 204 are a pair of roller supporting brackets 230 which project rearwardly from the framework 200 and support suitable journal blocks 232 which receive the opposite ends of a shaft 234. The shaft 234 carries a roller 236 which is keyed thereto and is positioned to roll along the surface of the ground which is exposed after the cutter blades of the apparatus have removed the surface layer from the ground in the manner hereinafter described.

A vertically extending partition and shaft housing assembly designated generally by reference character 240 is positioned approximately midway between the side walls 202 and 204, and extends upwardly to a position slightly below the uppermost edges 242 of the vertically extending side walls 202 and 204. The vertical partition and shaft housing assembly 240 comprises a rear portion which is constructed to include horizontally spaced, vertically extending side plates 244, a top wall 246 interconnecting the vertically extending side plates and a vertically extending rear wall 248 interconnecting the side plates 244 (see FIGURES 17 and 19). To the rear of the transmission housing 222, the vertically extending side plates 244, and the vertically extending rear wall 248 are of a length to extend to, and contact, the horizontal base plate 216. A step is provided in the partition and shaft housing assembly to permit its forward end to fit over the transmission housing 222 so that the lower edges of the forward portions of the side plates 244 are secured to the cover plate 228 of the transmission housing.

At its forward end, the partition and shaft housing assembly 240 includes a pair of converging side plates 252 which are secured at their rearmost vertical edges 254 to the forward edge of the side plates 244, and which converge to a common leading edge 256, as illustrated in FIGURE 17. The shaft housing assembly 240 thus has a V-shaped forward portion which permits the earth removed by the cutter blades, as hereinafter explained, to be cleanly and evenly divided by the converging forward walls 252 of the shaft housing assembly and to flow past the shaft housing with a minimum of frictional resistance.

The forward portion of the shaft housing assembly 240 is supported upon a transverse blade support rod 260 which extends between, and is connected at its ends to, the side walls 202 and 204 of the framework 200. A pair of inclined lift plates 262 are welded or otherwise suitably secured at one of their end edges to the converging forward walls 252 of the shaft housing assembly 240, and at their other end edges to the side walls 202 and 204 of the framework 200 (see FIGURES 17 and 19). The lift plates 262 terminate with their leading edges vertically spaced above the transverse blade support rod 260, as best illustrated in FIGURE 18. The trailing edges of the inclined lift plates 262 are secured to the forward edge of the cover plate 228 of the transmission housing 222.

For the purpose of receiving and moving toward the rear of the framework 200, dirt moved onto the cover plate 228 of the transmission housing 222 by the lift plate 262, a pair of endless belt conveyor assemblies, designated generally by reference characters 268 and 270, respectively, are positioned between the shaft housing assembly 240 and the two side walls 202 and 204. The conveyor assemblies 268 and 270 each include a forward roller 272 keyed to a shaft 274 which is journaled at its opposite ends in the respective side plate 244 of the shaft housing assembly 240 and in the respective vertically extending side wall 202 or 204. The conveyor assemblies 268 and 270 each further include a rear roller 276 keyed to a shaft 278 which is journaled at its opposite ends in appropriate journal housings 279 supported by the side walls 202 and 204. The rollers 276 and 272 of each conveyor assembly support an endless belt 280 which supports and moves the dirt from the cover plate 228 of the transmission housing 222 to the rear of the frame 200. The endless belts 280 of the conveyor assemblies 268 and 270 may be moved by driving either of the rollers 272 and 276 in rotation by a suitable engine or motor carried on the framework 200 or, more desirably, by a driving belt or chain extended from the gearing located in a gear box mounted on the frame 200 and subsequently described, through the shaft housing 240 to the shafts 278 which carry the rollers 276.

The power transmission system used in the embodiment of the invention illustrated in FIGURES 17, 18 and 19 includes a power input shaft 284 having a coupling member 286 disposed on the end thereof for coupling through a universal joint to the power takeoff of a tractor vehicle or other self-propelled vehicle having a prime mover disposed thereon. A power input shaft 284 passes through a journal box 288 mounted on the forward end of the shaft housing assembly 240 and through a cylindrical, lubricant packed casing 290 into a gear box 292 which is mounted on the top of the shaft housing assembly 240 in the position best illustrated in FIGURE 18. The journal box 288 has secured thereto a pair of upwardly extending hitch plates 294 which are provided with aligned openings or apertures 296 and which thus form a hitch bracket facilitating the connection of the central hitch link (not shown) used in a standard three point hitch connection to the framework 200.

Suitable gearing, such as a ring and pinion gear of the type illustrated in FIGURE 9, is disposed in the gear box 292 and is used to transmit the rotational motion of the power input shaft 284 to a vertically extending drive shaft 300 illustrated in FIGURE 18. The vertically extending drive shaft 300 passes downwardly in the shaft housing 240 between the side plates 244 and through a journal 302 mounted in the cover plate 228 of the transmission housing 222. The lower end of the drive shaft 300 is connected to a drive disc 304 which carries adjacent the periphery thereof, a radially offset downwardly projecting stud 306 (see FIGURE 19) which is secured to an elongated drive plate 308.

The drive plate 308 extends a major portion of the entire distance across the frame 200 between the side

walls 202 and 204 thereof, and carries a plurality of connecting pins 310 which are spaced at longitudinal intervals along the drive plate. The pins 310 project downwardly from the drive plate 308 and are each secured at their lower ends to a cam plate 312. The cam plate 312 is supported by anti-friction bearings in a cam plate support member 314 which extends transversely across the housing 200 and is positioned entirely within the transmission housing 222. The cam plate support member 314 is secured in the transmission housing 222 by welding or otherwise suitably attaching its opposite ends to the side walls 202 and 204 of the framework 200.

Each of the cam plates 312 has a downwardly projecting drive stud 316 secured to the lower surface thereof in a position closely adjacent the periphery of the cam plate, and the drive studs 316 are, in the case of each of the cam plates 312, disposed at different circumferential spacings around the respective cam plates from the position of attachment thereto of the connecting pins 310 secured to the lower surface of the cam plate. The peripheral or circumferential spacing of the drive studs 316 and the pins 310 around the periphery of the several cam plates 312 is determined by the number of cutter blades, hereinafter described, which are to be utilized. The described spacing is incorporated in the apparatus for the purpose of driving the cutter blades in out-of-phase relation to each other, and the sector of the peripheral surface of the several cam plates which is interposed between the connecting pins 310 and the drive studs 316 is arrived at by dividing 360 degrees by the total number of cutter blades which are incorporated in the machine.

The drive studs 316 carried by the cam plates 312 are each engaged at their lower ends by an upwardly projecting keyway formed by a pair of transversely extending, parallel guide rods 318 welded or otherwise suitably secured across the top of a pair of tubular members 320. The tubular members 320 constitute portions of the cutter blade assembly which will next be described in detail.

The cutter blade assemblies are best illustrated in FIGURES 18 and 19 and are designated generally by reference character 322. A plurality of the assemblies are employed, and in the illustrated embodiment of the invention sixe of the assemblies are utilized. Each of the assemblies 322 includes a cutter blade 323 having a sharpened cutting edge 323*a* formed at the forward or leading end thereof. The cutter blades 323 each further include a shank portion 324 which has mounted thereon at the rear edge of the cutter blades 323 an angle iron bracket 326. The angle iron brackets 326 may be secured to the shank portions 324 of the respective cutter blades 323 by bolting, as illustrated in FIGURE 18, as well as by welding or other suitable means.

The forward ends of the tubular members 320 extend through the angle iron brackets 326 and are secured to the angle iron brackets so that the brackets and the cutter blades 323 carrying the respective brackets are made to move with the tubular members 320. It will be noted in referring to FIGURE 19 that a pair of the tubular members is extended through and connected to the angle iron bracket 326 on each cutter blade 323, and that each pair of tubular members 320 associated with each of the brackets 326 is provided with the guide rods 318 in which one of the drive studs 316 is caused to move, as hereinafter described. Each of the tubular members 320 extends through a sleeve 330 mounted on the outside of the forward wall 224 of the transmission housing 222. Each of the sleeves 330 includes a packing gland (not shown) which forms a fluid-tight seal around the respective tubular member 320 which passes therethrough so that the tubular member may reciprocate in the sleeve 330 without loss of lubricating fluid contained within the transmission housing 222. There is also provided a Sylphon or bellows structure 331 which has one of its ends secured around the sleeve 330 and its other end around the forward portion of each tubular member 320.

At their ends opposite the ends which are passed through and secured to the angle iron brackets 326, each of the tubular members 320 telescopingly receives a cylindrical guide rod 334 which projects inwardly from the rear wall 226 of the transmission housing 222 in the manner best illustrated in FIGURES 18 and 19. The guide rods 334 are of a length to project a major portion of the transverse distance across the transmission housing 222, and are firmly secured or anchored to the rear wall 226 of the transmission housing 222 by welding, bolting, or any other suitable means. The guide rods 334 fit slidingly within the tubular members 320 for purposes of guiding these members in their reciprocating or rectilinear movement, as will be hereinafter described in greater detail.

In the operation of the embodiment of the invention illustrated in FIGURES 17, 18 and 19, the framework 200 and the various structural elements carried thereby are connected to a suitable self-powered vehicle, such as a tractor of the type illustrated in FIGURES 1 and 10, using the three point hitch connection illustrated in FIGURE 10 with the outer hitch links being connected to the outer hitch brackets 208 and 212 provided on the side walls 202 and 204 of the framework 200. It should be pointed out that the framework 200 can be elevated by the use of the hitch brackets in the same manner as has been previously described in referring to the embodiment shown in FIGURES 10 through 16, and that the framework may be pivoted about an axis extending through the hitch brackets 208 and 212 by manipulation of the central hitch link which is attached to the central bracket formed by the vertical hitch plates 294. In this way, the excavating and pavement cutting apparatus of this embodiment may be regulated in the depth to which it penetrates the soil.

The power for driving the blade assemblies 322 in rectilinear or reciprocating motion is developed from the self-powered vehicle, and is transmitted to the blade assemblies through the power input shaft 284 which is connected through the coupling 286 to the power takeoff on the vehicle. The rotational motion of the power input shaft 284 is transmitted through suitable gearing in the gear box 292 to the drive shaft 300 which in turn drives the drive disc 304 in rotational movement. The rotational movement of the drive disc 304 is transmitted to the drive plate 308 which in turn drives each of the cam plates 312 in rotational movement. The cam plates can move freely in the support member 314, and in undergoing rotational movement, impart rectilinear motion to each pair of tubular members 320 connected to each of the cutter blades 323.

The timing of the stroke of each of the blades 323 is dependent upon the spacing of the respective drive stud 316 from the connecting pins 310 around the periphery of the respective cam plate 312, as hereinbefore described. As each cam plate 312 rotates, its drive stud 316 bears against the guide rods 318 and causes the tubular members 320 to move forwardly and rearwardly with respect to the frame 200. Any transverse component of movement of the drive studs 316 with respect to the tubular members 320 results in movement of the drive studs transversely in the track provided by the guide rods 318, but does not effect any lateral or transverse movement of the tubular members.

As the tubular members 320 are caused to reciprocate in the manner described, they are guided and supported by the cylindrical guide rods 334 which are telescoped within the tubular members 320. The tubular members 320 slide easily through the sleeves 330 mounted on the forward wall 224 of the transmission housing 222, and effectively push the cutter blades 323 forward from the framework into the earth during the cutting portion of the stroke, and then retract the blades toward the frame-

work following the cutting portion of the stroke. The several blades 232 carry out their strokes in out-of-phase relation to each other so that some of the blades are being retracted as other blades are moving forward on the cutting portion of the stroke.

In addition to the general features and salient advantages which have hereinbefore been described as characterizing the earth excavating and pavement cutting devices of the present invention, the embodiment illustrated in FIGURES 17 through 19 possesses several additional advantageous structural features which should be briefly described. In some operations in which it is desired to remove a crust or surface layer from the earth, and then redeposit this crust in substantially the same location from which it was removed in a relatively undisturbed state, it is desirable to provide a relatively low profile or slight inclination to the surfaces over which the dirt must move in passing from the front to the rear of the framework 200. The power transmission used to drive the blade assemblies 322 of the FIGURES 17 through 19 embodiment is particularly designed to permit this to be acomplished, being relatively compact and capable of confinement within a small space not requiring a large amount of room above the base plate 216.

Moreover, the manner in which the transmission is constructed and the specific mounting arrangement utilized for the tubular members 320 used to drive the blades 323 in their rectilinear motion lends itself to enclosure of the system within a fluid-tight transmission housing 222 which can be filled with a lubricant which constantly bathes all of the moving parts except the drive shaft 300 and the power input shaft 284 with the lubricant. The sealed system also has the advantage of preventing the ingress of any dirt or dust to the moving parts of the system. The manner in which the tubular members are supported and slide in the sleeves 330 and on the guide rods 334 permits the blade assemblies 322 to be operated with a minimum of frictional drag or resistance, and it will be apparent in referring to FIGURES 18 and 19 that the parts which are frictionally engaged during movement are constantly subjected to immersion in the lubricating fluid.

The conveyor assemblies 368 and 370 which are positioned toward the rear of the framework 200 and are sloped gently upwardly from the cover plate 278 of the transmission housing 222 also provide minimal resistance to the flow of excavated dirt through the framework and to the rear thereof. It is also to be pointed out that the converging plates 252 used in the forward portion of the shaft housing assembly 240 permit the dirt to be moved around and past the shaft housing assembly with a minimum of resistance or choking within the framework 200.

A further embodiment of the invention which is somewhat similar to that shown in FIGURES 17, 18 and 19, but employing a different power transmission system therein is illustrated in FIGURES 20 and 21. The similarity of the embodiment shown in these figures to the embodiment which has been described immediately above and depicted in FIGURES 17, 18 and 19 has prompted the use of identical reference numerals where identical parts are illustrated. It will thus be seen in referring to FIGURES 20 and 21 that the only difference in the construction of this embodiment from that illustrated in the foregoing described figures is in the manner in which the gearing and transmission elements located within the transmission housing 222 are constructed and arranged.

In FIGURE 20, the drive shaft 300 extends through the journal 302 mounted on the cover plate 228 of the transmission housing 222. The lower end portion of the drive shaft 300 passes through a bearing 348 in a gear supporting plate 350 which extends transversely across the housing 200, and is secured at its opposite ends to the side plates 202 and 204. Secured to the lower end of the drive shaft 300 in a position below the gear supporting plate 350 is a driving gear 352 which is positioned substantially midway between the side walls 202 and 204. The driving gear 352 is keyed to the drive shaft 300 for rotation therewith and engages by teeth located on its outer periphery, a pair of larger driven gears 354 disposed on opposite sides of the driving gear 352 and in transverse alignment beneath the transverse gear supporting plate 350. The driven gears 354 are but two of a plurality of driven gears corresponding in number to the number of cutter blades 323 which are employed. The driven gears 354 are disposed in a transverse line extending across the framework 200 and lying beneath the gear supporting plate 350. Each of the driven gears 354 meshes with the next adjacent driven gear so that all of the driven gears 354 are driven from the drive gear 352 located in the center of the framework 200 and keyed to the drive shaft 300. Each of the driven gears 354 is supported on a stub shaft 355 which is journaled in a suitable bearing carried by the drive gear support plate 350. The driven gears 354 are also preferably movably supported by suitable anti-friction bearings on a transverse lower support plate 360 which extends across the framework 200 and is secured at its opposite ends to the side walls 202 and 204.

Depending downwardly from the lower surface of each driven gear 354 is a drive stud 356 which is radially offset from the rotational axis of the respective driven gear 354. The drive studs 356 are circumferentially offset from each other in their relation to the rotational axes of the several driven gears 354, and it is this circumferential spacing of the several drive studs 356 which permits the cutter blades 323 to be reciprocated in out-of-phase relation to each other. As in the case of the drive studs 316 provided in the embodiment of the invention illustrated in FIGURES 17, 18 and 19, the drive studs 356 attached to the driven gears 354 and in the embodiment of the invention under discussion engage a trackway formed by a pair of transversely extending guide rods 318 which are connected to the upper surfaces of the pair of tubular members 320 used to drive the blades 323.

The operation of the embodiment of the invention illustrated in FIGURES 20 and 21 is substantially identical to that described in referring to the embodiment of FIGURES 17, 18 and 19. The advantage of the former embodiment, however, is that the construction of the transmission permits even a lower profile dirt supporting and moving surface to be achieved, and thus permits less disturbance of the earth when it is to be returned to its former position in certain types of agricultural operations. The power transmission structure used in the embodiment of the invention illustrated in FIGURES 20 and 21 functions by taking the rotational power input delivered by the drive shaft 300 and transmitting this to rotational movement of the driven gears 354 as they are driven by the driving gears 352. As the driven gears 354 rotate, their respective drive studs 356 engage the guide rods 318 and cause the various pairs of tubular members 320 included in the blade assemblies 322 to undergo a reciprocating motion, causing the blades 323 to bite into the earth in the manner hereinbefore described.

A different type of power transmission system used to drive the cutter blades in reciprocating movement is illustrated in FIGURES 22 and 23 of the drawings. This power transmission system is particularly useful in the earth evacuating and pavement cutting apparatus of the invention in that it permits a dirt supporting surface of very low profile to be obtained in the apparatus, and also facilitates synchronization between the speed at which the self-powered vehicle towing the cutter blade carrying framework is moved, with the rate at which the cutter blades per se are reciprocated. An advantage of such synchronization is to permit the machine to be used with maximum effectiveness in varying types of soils, or for

removing surfacing materials of varying hardness and consistencies. For example, in some instances it may be desirable to have the self-powered vehicle moving in the direction of travel of the apparatus at substantially the same linear rate of speed as the blades are moved forward in their cutting stroke, and retracted toward the framework following the cutting stroke. In this way, the relative movement of the blades with respect to the earth during the retraction portion of the stroke is zero and no frictional drag is imposed upon the machine as a result of the necessity for the blades to move backwardly or rearwardly through accumulated earth, and in scraping, frictional engagement with the exposed surface of the earth from which the upper layer has been removed.

Referring initially to FIGURE 22, a hydraulic fluid reservoir **380** is connected by a conduit **381** to a hydraulic pump **382** which is powered by a power input shaft **384** adapted to be connected to the power takeoff on the self-powered vehicle or tractor (not shown). A suitable power output shaft **386** is connected through suitable power transmission linkage (not shown) to the power input shaft **384** and is extended from the hydraulic pump **382** to a variable speed transmission housing **388**.

The variable speed transmission housing **388** encloses adjustable gearing (not visible) which permits the rotational movement of the power output shaft **386** to be transferred to a speed control shaft **390** through step-up or step-down transmission gearing which can be adjusted by use of a governor screw **392** to permit the revolutions ratio between the power output shaft **386** and the speed control shaft **390** to be varied as may be desired for purposes hereinafter explained in greater detail. The speed control shaft **390** extends through a fluid-tight bearing **394** provided in one of the end walls **396** of a manifold housing **398**. The opposite end of the speed control shaft **390** is journaled in the opposite end wall **396** of the manifold housing **398** to permit the speed control shaft to be rotated in the manifold housing.

The speed control shaft **390** carries a solid drum **400** which is keyed to the speed control shaft for rotation therewith. The drum **400** is formed with a plurality of fluid injection and fluid discharge ports extending diametrically through the drum, with the fluid injection ports being designated by reference characters **402**, **404**, **406** and **408**. The fluid discharge ports are designated by reference characters **410**, **412**, **414** and **416**. It will be noted that the fluid injection and discharge ports **402** through **416** which are provided in the drum **400** extend through the drum at different angles and have variously positioned openings on the periphery of the drum as shown in FIGURES 22 and 24. Each adjacent pair of fluid injection and discharge ports, such as, for example, the ports **402** and **410**, have openings on the periphery of the drum **400** which extends through arcs of 90° and are offset from each other in a circumferential direction by 90° (see FIGURES 24*a*–24*f*). The purpose of this arrangement will be subsequently explained.

The manifold housing **398** encloses a cylindrical drum housing **420** which sealingly surrounds the drum **400**. The manifold housing **398** also includes a partition **422** which divides the portion of the manifold housing **398** outside the drum housing **420** into a discharge manifold space **424** and an injection manifold space **426**. The injection manifold space **426** is placed in communication with the interior of the drum housing **420** by a plurality of tubular injection passageways **430**, **432**, **434** and **436** which correspond in number to the number of cutter blades used in the apparatus. A conduit **438** interconnects the injection manifold space **426** with the hydraulic pump **382** and a conduit **440** interconnects the discharge manifold space **424** with the reservoir **380**.

The drum housing **420** is provided with a plurality of fluid discharge passageways **446**, **448**, **450**, and **452** which place the interior of the drum in communication with the discharge manifold space **424**. The fluid injection passageways **430**–**436** are positioned in coplanar alignment with the fluid discharge passageways **446**–**452**, and the several passageways are longitudinally aligned with the transverse planes through the drum **400** which contain the respective fluid injection ports **402**–**408** and fluid discharge ports **410**–**416**.

Disposed on the opposite side of the drum housing **420** from the injection and discharge passageways **430**–**452**, and in coplanar alignment therewith, are a plurality of fluid injection and discharge conduits **402***a*–**416***a*, each of which communicates with the interior of the drum housing **420**. The fluid injection and discharge conduits are numbered according to the respective fluid and discharge ports with which they register during rotation of the drum **400**. Thus, the fluid injection conduit **402***a* registers with the fluid injection port **402**, the fluid discharge conduit **410***a* registers with the fluid discharge port **410**, the fluid injection conduit **404***a* registers with the fluid injection port **404**, etc. The period of registry or communication is in each case equal to one-fourth the period of one revolution of the drum **400**, and the communication is established between each port and its respective injection or discharge conduit twice during each revolution of the drum. The circumferential spacing of 90 degrees between the peripheral openings of the discharge ports **410**–**416** from the peripheral openings of the injection ports **402**–**408** (between each adjacent pair thereof) assures that upon completion of the period of communication between an injection port and its aligned injection conduit, the period of communication between the adjacent discharge port and its aligned discharge conduit will be commenced.

The fluid injection conduits **402***a*–**408***a*, and fluid discharge conduits **410***a*–**416***a* are connected at their ends opposite the ends entering the drum housing **420** to a piston housing designated generally by reference character **460**. The piston housing **460** is partitioned or divided into a plurality of piston chambers **462**, **464**, **466**, and **468** by a plurality of transversely extending partitions **470**, **472**, and **474** with the number of piston chambers provided being equal to the number of cutter blades which are to be used in the apparatus. Mounted within each of the piston chambers **462**–**468** for reciprocating movement therein is a piston **476**. Each of the pistons **476** is generally rectangular in configuration and carries studs or protuberances **476***a* at each of its ends which slidingly engage guide slots **479** formed in the respective partitions **470**–**474** with which the ends of the respective piston are in contact. This arrangement of the mounting of the pistons **476** is best illustrated in FIGURE 23. The peripheral surfaces of the pistons **476** are provided with a rubber gasket **481** or other suitable sealing member to prevent by-pass of fluid by the piston during operation of the apparatus.

The transverse partitions **470** and **474** are each provided with an air vent port **477** disposed in the forward portion thereof so as to permit the air located in the piston chambers **462**–**468** on the forward side of the pistons **476** to be vented into the next adjacent piston chamber during the cutting stroke of the pistons, as hereinafter described. Connected to each of the pistons **476** and extending through the forward wall **478** of the piston housing **460** are a pair of piston rods **480** which are secured to an angle iron or flange **482** bolted, welded, or otherwise suitably secured, to the shank portion **484** of a cutter blade designated generally by reference character **486**. Thus, each of the cutter blades **486** is driven through two piston rods **480** by one of the pistons **476** contained in each of the piston chambers **462**–**468**.

The operation of the power transmission system depicted in FIGURES 22–24 commences when the hydraulic pump **382** is energized by power delivered thereto from the power takeoff of the tractor via the power input shaft **384**. Simultaneously with the actuation of the hydraulic pump **382**, the power output shaft **386** is caused

to rotate. It should be pointed out that the power output shaft **386** may be merely an extension of the power input shaft **384**, or the two shafts may be connected by a suitable kinematic chain which does not interfere with the operation of the hydraulic pump **382**.

As the hydraulic pump **382** is actuated, hydraulic fluid is drawn from the reservoir **380** via the conduit **381** and is circulated through the conduit **438** from the hydraulic pump to the injection chamber **426** of the manifold housing **398**. Hydraulic power fluid contained within the injection manifold space **426** is passed through one of the injection passageways **430–436** at a time when the corresponding injection port **402–408** in the drum **400** is aligned therewith.

It has been previously pointed out that the injection ports **402–408** in the drum **400** are each provided with opposed peripheral openings on the drum which each extend over 90 degrees of the circumference of the drum. The injection ports thus each become aligned and in communication with their respective injection passageways **430–436** twice during each rotation of the drum, with each period of communication being equal to one-fourth the total period of one drum revolution. The circumferential arrangement of the injection ports **402–408** and discharge ports **410–416** is such that, for example, when the injection port **402** becomes aligned with its respective injection passageway **430**, the discharge port **410** which is paired with the injection port **402** is out of alignment with both its respective discharge passageway **446** and its respective discharge conduit **410***a*. It will thus be seen that hydraulic power fluid is injected into the piston chamber **462** via the injection passageway **430**, injection port **402**, and injection conduit **402***a* at this time, but no hydraulic power fluid is permitted to leave the chamber **462** by reason of the non-alignment of the discharge port **410** with the discharge conduit **410***a* and the discharge passageway **446**.

The piston **476** in the piston chamber **462** is thus driven forward to cause the blade **486** carried by its piston rods **480** to be driven into the earth ahead of the excavating apparatus. Air ahead of the piston is vented through the air vent port **476** into the adjacent piston chamber **464**, and thus forces the piston **476** carried therein rearwardly or into a retraction stroke. It is thus necessary that the discharge port **412** be aligned with its respective discharge conduit **412***a* and discharge passageway **448** during a major portion of the cutting stroke of the piston **476** located in the piston chamber **462**. Stated differently, the discharge port **412** is passed through the drum **400** at substantially the same angle, and opens at both ends over the same sector of the periphery of the drum, as the injection port **402** so that hydraulic power fluid contained within the piston chamber **464** may be discharged therefrom at the time that hydraulic power fluid is being introduced to the piston chamber **462**.

Upon completion of the cutting stroke of the piston **476** located in the piston chamber **462**, the injection port **402** will move out of registry or communication with its respective injection conduit **402***a* and injection passageway **430** so that the flow of hydraulic power fluid to the piston chamber **462** is interrupted. Just as the injection port **402** moves out of registry with the injection conduit **402***a* after 90 degrees of rotation of the drum **400**, the discharge port **410** is moving into registry with the discharge conduit **410***a* and the discharge passageway **446**. The piston **476** in the piston chamber **462** is thus ready to be retracted, and to discharge hydraulic fluid from the piston chamber **462** through the discharge conduit **410***a*, the discharge port **410**, and the discharge passageway **446** into the manifold discharge space **424**.

At the same time that the discharge port **410** moves into communication with the discharge conduit **410***a* and the discharge passageway **446**, the injection port **404** is moving into communication with the injection conduit **404***a* and the injection passageway **432**. Hydraulic power fluid can thus at this time be admitted to the piston chamber **464** from the manifold injection space **426** and can drive the piston **476** contained therein forward in a cutting stroke. The flow of air through the air vent port **476** is reversed and, combined with the resistance offered by the dirt ahead of the excavating apparatus to the movement of the blade **484** carried by the piston **476** located in chamber **462**, causes this piston to move rearwardly and force hydraulic power fluid out of the chamber **462** and into the manifold discharge space **424** via the discharge conduit **410***a*, the discharge port **410** and the discharge passageway **446**.

The manner in which the remaining two pistons located in the piston chambers **466** and **468** are synchronized in their movements is substantially identical to that which has been described with respect to the pistons located in piston chambers **462** and **464**. It should be pointed out, however, that the injection port **406** is set on a different angle, and its openings in the cylinder **400** include different circumferential angles on the drum, than either of the injection ports **402** or **404**, and the same is true of the injection port **408**. The discharge ports **414** and **416** also extend at an angle with respect to the discharge ports **410** and **412**. The effect of this angular arrangement is to cause the blades **486** carried by the pistons disposed in the piston chambers **466** and **468** to undergo the cutting and retraction phases of their strokes at different times from the cutting and retraction strokes of the blades carried by the pistons **476** located in the chambers **462** and **464**. Thus, the out-of-phase cutting action of the cutter blades which has been hereinbefore described in referring to other embodiments of this invention is attained in the hydraulic drive system depicted in FIGURES 22, 23 and 24.

As fluid is sequentially discharged through the respective discharge conduits **410***a–416a*, discharge ports **410–416** and discharge passageways **446–452**, the hydraulic power fluid accumulating in the manifold discharge space **324** returns to the power fluid reservoir **380** by way of the discharge conduit **440**. The cycle of the hydraulic power fluid is thus completed.

An important aspect of the type of drive system illustrated in FIGURES 22 and 23 as incorporated in the earth excavating and pavement removing apparatus of the present invention is the ability to synchronize the linear speed of the cutter blades **486** during their reciprocation with the forward movement of the self-powered vehicle which moves the framework carrying the transmission apparatus and blade assemblies along the ground during operation of the device. With a given speed of rotation of the power input shaft **384** as developed from the power takeoff on the tractor, the tractor will move at a corresponding linear speed or rate of advance over the surface of the ground. The power output shaft **386** will also be correlated to the speed of the tractor, and will increase or decrease in rotational speed as the speed of the tractor is increased.

The rate at which the cutter blades **486** are reciprocated by the hydraulic power fluid will, however, be determined by the rotational speed of the power output shaft **386**, and by the speed at which this shaft is permitted to drive the speed control shaft **390**. By a proper adjustment of the governor screw **392**, the gear ratio between the shafts **386** and **390** may be varied to vary the speed of the speed control shaft **390** and thus vary the speed of rotation of the drum **400**. By varying the speed of rotation of the drum **400**, the period of time over which the several injection ports **402–408** and discharge ports **410–416** are sequentially in communication with their corresponding injection conduits **402***a–408a* and discharge conduits **410***a–416a*, and also the corresponding injection and discharge passageways, can be varied as desired. Thus, the length of the strokes of the blades **486** can be controlled and, provided the hydraulic pump **382** develops sufficient power, the speed of the stroke of each of the blades **486** can also be controlled. This

arrangement thus permits correlation between the speed of the stroke of the several cutter blades 486, and the rate of advance of the tractor over the ground. Ability to function in this manner often presents a marked advantage where the consistency and hardness of the soil varies from one location to the other, or the type of pavement or surfacing material which is to be cut through and removed is substantially different from another type of operation which it may be desired to carry out using the apparatus of the invention at a different time.

From the foregoing description of the invention, it will have become apparent that the present invention provides an improved earth excavating and pavement cutting machine which is versatile in its capabilities, is relatively compact and not excessively expensive to construct, and is characterized by a long and trouble-free operating life. The apparatus is adjustable in the depth to which it may be permitted to penetrate the earth and remove a surface layer thereof, and is capable of digging through the earth in a horizontal plane disposed at a depth of up to two feet. The apparatus is especially well adapted to remove a surface layer of the earth and return it in a relatively undisturbed state to the position from which it was removed, such as may be desired in a plowing or planting operation.

Although several embodiments of the invention have been described herein by way of example, and to illustrate to those skilled in the art how the invention may effectively be practiced, many innovations in the arrangement of the structural elements, and the way in which they function, may be effected in the depicted illustrative embodiments without departure from the basic principles which underlie the invention. All such modifications and innovations which are made in the apparatus, but which do not involve a departure from the basic principles hereinbefore enunciated are deemed to be circumscribed by the spirit and scope of the invention except as the same may be necessarily limited by the appended claims or reasonable equivalents thereof.

I claim:

1. Excavating appartus for removing a surface layer from the earth by cutting along a generally horizontal plane, said apparatus comprising:

a self-powered vehicle including a prime mover and a power takeoff from said prime mover;

a framework spaced from said prime mover and having a top portion, a forward portion, a rear portion and a ground engaging portion;

hitch means interconnecting the framework and the self-powered vehicle for concurrent movement along the ground;

actuating means on said self-powered vehicle and connected to said hitch means for actuating said hitch means to move said framework relative to a plane substantially coplanar with the surface of the ground over which said vehicle and framework are moved;

a plurality of cutter blades movably mounted on the forward portion of said framework in alignment with the ground engaging portion thereof;

dirt supporting means extending upwardly and rearwardly in said framework from a line in juxtaposition to the upper surface of said cutter blades to receive material severed by said cutter blades and support and lift said material as it moves rearwardly with respect to said framework; and

power transmission means on said framework and having an input end connected to said power takeoff and an output end connected to said cutter blades for reciprocating said blades on said framework in out-of-phase relation to each other and in a direction of movement advancing from, and returning to, the forward portion of said framework, said power transmission means including timing means adapted to move some of said blades forwardly with respect to said framework at a different time than the time at which other of said blades are moved forwardly with respect to said framework, said timing means being disposed beneath said dirt supporting means and to the rear of said cutter blades.

2. Excavating apparatus as defined in claim 1 wherein said framework comprises:

a pair of horizontally spaced, vertically extending side walls; and

means for reciprocably supporting said cutter blades in transversely aligned relation and in juxtaposition to each other between said side walls.

3. Excavating apparatus as defined in claim 1 wherein said framework is further characterized as including two horizontally spaced, side portions, and wherein said hitch means includes

a pair of outer hitch links connected to the side portion of said framework; and

a central hitch link pivotally connected to said framework between said side portions and having its point of connection to said framework spaced vertically from the points of connection to said framework of said outer hitch links.

4. Excavating apparatus as defined in claim 1 wherein said dirt supporting means comprises a conveyor sloping upwardly toward the rear portion of said framework and having an upper surface lying in a plane intersecting at an angle, the plane of movement of said cutter blades.

5. Excavating apparatus as defined in claim 1 wherein said power transmission means comprises:

a power input shaft connected at one of its ends to said power takeoff;

a crankshaft rotatably journaled on said framework beneath said dirt supporting means and having eccentric throws disposed in longitudinally spaced relation over the length thereof, said throws corresponding in number to the number of said cutter blades and being disposed at different circumferential positions around said crankshaft;

means drivingly connecting said crankshaft to said power input shaft; and

a plurality of connecting rods each connected at one of its ends to one of said eccentric throws and at its other end to one of said cutter blades whereby said cutter blades are reciprocated in out-of-phase relation to each other as said crankshaft is driven in rotation.

6. Excavating apparatus as defined in claim 1 wherein said power transmission means comprises:

shaft means connected to said power takeoff;

a drive disc drivingly connected to said shaft means for rotation in a horizontal plane disposed below said dirt supporting means;

a stud projecting downwardly from the drive disc and eccentrically offset from the axis of rotation of said drive disc;

an elongated drive plate positioned below said drive disc and connected to said stud and movable therewith as said drive disc is rotated;

a plurality of cam plates positioned below said drive plate and each supported on said framework for rotation about a vertical axis, said cam plates being spaced from each other along the length of said drive plate and having their vertical axes of rotation disposed in a common vertical plane;

a plurality of connecting pins spaced longitudinally along said elongated drive plate and each interconnecting said drive plate with a point on one of said cam plates eccentrically positioned with respect to the axis of rotation of the respective cam plate;

a drive stud projecting downwardly from each of said cam plates, the drive stud of each cam plate being circumferentially spaced from the respective point of connection to that cam plate of the respective connecting pin by a different angular distance than

the angular distances by which each of the drive studs on each of the other cam plates is spaced from the respective point of connection of the respective connecting pin thereto; and

keyway means connected to each of said cutter blades for movement therewith, each of said keyway means engaging one of said drive studs and permitting the engaged drive stud to slide freely therein in a transverse direction with respect to said framework while transmitting the forward and rearward motion of the engaged drive stud to the respective cutter blade whereby said cutter blades are each driven in rectilinear motion.

7. Excavating apparatus as claimed in claim 1 wherein said power transmission means comprises:

shaft means connected to said power takeoff;

a driving gear drivingly connected to said shaft means for rotation in a horizontal plane disposed below said dirt supporting means;

a plurality of horizontally spaced driven gears corresponding in number to the number of said cutter blades and disposed in transverse alignment across said framework, said driven gears each being rotatably supported in said framework for rotation about a vertical axis, and at least one of said driven gears engaging said driving gear and the remainder of said driven gears intermeshing with each other and being driven by the driven gears which engage said driving gear;

a drive stud depending downwardly from each of said driven gears for rotation therewith and disposed eccentrically with respect to the vertical axis of rotation thereof, each of the drive studs on each driven gear being disposed in a different radial direction from the axis of rotation of the respective driven gear from the radial direction at which each of the other drive studs on the other driven gears is disposed with respect to the axis of rotation of its respective driven gear when said driven gears and said driving gear are engaged and intermeshed as hereinbefore described; and

keyway means connected to each of said cutter blades for movement therewith, each of said keyway means engaging one of said drive studs and permitting the engaged drive stud to slide freely therein in a transverse direction with respect to said framework while transmitting the forward and rearward motion of the engaged drive stud to the respective cutter blades whereby said cutter blades are driven in rectilinear motion.

8. Excavating apparatus as defined in claim 1 wherein said power transmission means comprises:

a hydraulic pump;

shaft means drivingly interconnecting said hydraulic pump with said power takeoff;

a source of hydraulic power fluid connected to said pump for supplying hydraulic power fluid thereto;

piston means connected to each of said cutter blades;

a housing enclosing each of said piston means in a piston chamber and disposed beneath said dirt supporting means;

manifold means connected to said piston chambers for sequentially delivering hydraulic power fluid to each of said piston chambers in consecutive order, said manifold means being positioned beneath said dirt supporting means; and

conduit means interconnecting said manifold means with said hydraulic pump, and with said source of hydraulic power fluid for transmitting hydraulic power fluid from the pump to the manifold means, and returning hydraulic power fluid from the manifold means to said source of hydraulic power fluid.

9. Excavating apparatus as defined in claim 2 wherein said means for reciprocably supporting said cutter blades comprises:

at least one tubular member connected to each of said cutter blades and extending in a direction parallel to the direction of movement thereof and away from the cutting edge thereof; and

a rod fixed on said framework and extending coaxially into said tubular member for sliding in said tubular member.

10. Excavating apparatus as defined in claim 2 wherein said means for reciprocably supporting said cutter blades comprises:

at least one rigid structural member extending transversely across said framework beneath said cutter blades; and

generally I-shaped guide members positioned between adjacent cutter blades and extending substantially normal to said rigid structural member, said I-shaped guide members each receiving in opposed channels defined thereby lateral edges of the adjacent cutter blades which it separates.

11. Excavating apparatus as defined in claim 2 wherein said means for reciprocably supporting said cutter blades comprises:

a transverse cutter blade supporting bar extending across said framework beneath said cutter blades in a direction generally paralleling the forward and rear portions of said framework;

a transverse cutter blade retaining bar extending across said framework above said cutter blades in a direction generally paralleling the forward and rear portions of said framework; and

horizontally spaced guide plates positioned between said supporting bar and said retaining bar and defining guiding channels reciprocably receiving said cutter blades.

12. Excavating apparatus as defined in claim 9 and further characterized to include lubricant confining means enclosing each of said rods and the portion of said tubular members slidingly receiving each of said rods whereby the portions of said rods and tubular means which slidingly contact each other are immersed in lubricant.

13. Excavating apparatus as defined in claim 4 and further characterized to include an inclined lift plate extending between the upper surface of said cutter blades and said conveyor, and wherein said framework includes vertically extending side walls positioned on opposite sides of said conveyor and lift plate for confining material excavated by said apparatus to movement from said cutter blades up said inclined lift plate and onto said conveyor.

14. Excavating apparatus as defined in claim 13 and further characterized to include a downwardly inclined slide plate positioned between said conveyor and the rear portion of said framework for moving dirt and the like from the conveyor of the rear portion of the framework.

15. Excavating apparatus as defined in claim 5 wherein said crankshaft and the throws carried thereby are positioned with respect to said cutter blades so that said connecting rods extend in substantial alignment with the plane of reciprocation of said cutter blades during the cutting stroke of said cutter blades as the cutter blades are advanced forwardly from the forward portion of said framework.

16. Excavating apparatus as defined in claim 6 and further characterized to include a sealed transmission housing mounted on said framework and sealingly enclosing all of that portion of the power transmission means recited in claim 6 except said shaft means whereby all of said enclosed elements can be immersed in a lubricant.

17. Excavating apparatus as defined in claim 7 and further characterized to include a sealed transmission housing mounted on said framework and sealingly enclosing all of that portion of the power transmission means recited in claim 7 except said shaft means whereby all of said enclosed elements can be immersed in a lubricant.

18. Excavating apparatus as defined in claim 8 and further characterized to include speed control means con-

nected to said manifold means and controlling the rate at which said manifold means sequentially delivers hydraulic power fluid to each of said piston chambers.

19. Excavating apparatus as defined in claim 8 wherein said manifold means comprises:

a manifold housing;

a cylindrical drum housing inside said manifold housing;

a partition dividing the interior of said manifold housing outside said drum housing into an injection manifold space and a discharge manifold space;

a cylindrical drum rotatably mounted in said drum housing and having a plurality of injection ports and discharge ports extending diametrically therethrough, said ports each having openings on the periphery of said drum extending over about 90 degrees of the circumference of said drum, and said ports being arranged on said drum with one injection port and one discharge port provided adjacent each other on said drum in pairs corresponding in number to the number of said piston chambers, with the discharge port of each pair having its peripheral openings on said drum circumferentially spaced around said drum by 90 degrees from the peripheral openings of the injection port included in the same pair, the injection port in each pair having its peripheral openings on said drum circumferentially offset from the peripheral openings in the injection port in every other pair;

injection and discharge conduits connecting each pair of injection and discharge ports in said drum with one of said piston chambers;

injection passageways extending between said drum housing and said injection manifold space and placing said injection manifold space in communication with each of said injection ports;

discharge passageways extending through said drum housing and placing each of said discharge ports in communication with said discharge manifold space;

means for driving said drum in rotation; and

said conduit means including a conduit extending between said discharge manifold space and said source of hydraulic power fluid and a conduit extending between said injection manifold and said hydraulic pump.

20. Excavating apparatus as defined in claim 19 and further characterized to include speed control means including said means for driving said drum in rotation and connected between said shaft means and said drum.

21. Apparatus for removing a surface layer of earth, asphalt or the like from the ground comprising:

a framework having a pair of horizontally spaced, vertically extending side walls, a forward portion, a rear portion, and at least one horizontal plate extending transversely between the side walls adjacent the lower edges thereof;

a plurality of cutter blades reciprocally mounted on said framework adjacent the forward portion thereof for independent movement in a horizontal plane adjacent the lower portion of said framework;

conveyor means mounted in the framework between said side walls and including an upper, material supporting surface, said conveyor means being disposed in said framework so that a portion of each of said cutter blades reciprocates beneath the forward, lowermost portion of said conveyor means;

a lift plate extending transversely across said framework between the side walls of said framework and having a forward edge disposed in juxtaposition to the upper surface of said cutter blades, and a rear edge disposed in juxtaposition to the upper, material supporting surface of said conveyor means whereby material removed from the ground by said cutter blades can move across the lift plate to said conveyor means; and

power transmission means carried by said framework and spaced rearwardly from said cutter blades, said power transmission means including timing means positioned below said conveyor means and connected to each of said cutter blades for driving at least two of said cutter blades in out-of-phase sequence to each other.

22. Apparatus for removing a surface layer of earth, asphalt or the like from the ground comprising:

a framework having a pair of horizontally spaced, vertically extending side walls, a forward portion, a rear portion, and at least one horizontal plate extending transversely between the side walls adjacent the lower edges thereof;

conveyor means mounted in the framework between the side walls thereof and being inclined downwardly from the rear portion of said framework toward the forward portion thereof;

a plurality of cutter blades reciprocally mounted on said framework adjacent the forward portion thereof for independent movement in a horizontal plane adjacent the lowermost portion of said framework;

power transmission means carried by said framework and spaced rearwardly from said cutter blades, said power transmission means including timing means positioned below said conveyor means and connected to each of said cutter blades for driving at least two of said cutter blades in out-of-phase sequence to each other; and

a downwardly inclined slide plate extending transversely across said framework between said vertically extending side walls and positioned to the rear of said conveyor means for receiving material from said conveyor means and supporting said material as it moves to the rear of said framework.

23. Apparatus for removing a surface layer of earth, asphalt or the like from the ground comprising:

a framework having a pair of horizontally spaced, vertically extending side walls, a forward portion, a rear portion, and at least one horizontal plate extending transversely between the side walls adjacent the lower edges thereof, said framework further including a vertically extending partition assembly positioned between said side walls and extending substantially parallel thereto, said partition assembly including a pair of horizontally spaced, vertically extending side walls, a rear wall, a top wall and two converging forward walls connected to said side walls and converging to a line of intersection at the forward portion of said framework;

conveyor means mounted in the framework between the side walls thereof and being inclined downwardly from the rear portion of said framework toward the forward portion thereof, said conveyor means including a pair of endless belt conveyors positioned on opposite sides of said vertically extending partition assembly;

a plurality of cutter blades reciprocally mounted in said framework adjacent the forward portion thereof for independent movement in a horizontal plane adjacent the lowermost portion of said framework; and

power transmission means carried by said framework and spaced rearwardly from said cutter blades, said power transmission means including timing means positioned below said conveyor means and connected to each of said cutter blades for driving at least two of said cutter blades in out-of-phase sequence to each other.

24. Apparatus for removing a surface layer of earth, asphalt or the like from the ground comprising:

a framework having a pair of horizontally spaced, vertically extending side walls, a forward portion, a rear portion, and at least one horizontal plate extending transversely between the side walls adjacent the lower edges thereof;

upper surface of said cutter blades and the horizontal cover plate of said transmission housing whereby dirt removed by said cutter blades can move over said inclined lift plate and said transmission housing to said conveyor means.

28. Apparatus for removing a surface layer of earth, asphalt or the like from the ground comprising:

a framework having a pair of horizontally spaced, vertically extending side walls, a forward portion, a rear portion, and at least one horizontal plate extending transversely between the side walls adjacent the lower edges thereof;

conveyor means mounted in the framework between the side walls thereof and being inclined downwardly from the rear portion of said framework toward the forward portion thereof;

a plurality of cutter blades reciprocally mounted on said framework adjacent the forward portion thereof for independent movement in a horizontal plane adjacent the lowermost portion of said framework;

guide means slidingly supporting said cutter blades on said framework and comprising:

rods fixed on said framework and each extending forwardly toward one of said cutter blades; and

at least one tubular member carried by each of said cutter blades and extending therefrom rearwardly on said framework and telescopingly surrounding one of said rods for sliding movement thereon;

lubricant confining means enclosing at least a portion of said rods and a portion of the tubular members which are telescoped over said rods whereby said rods can be immersed in a lubricant during the operation of said apparatus as said cutter blades are reciprocated on said framework; and

power transmission means carried by said framework and spaced rearwardly from said cutter blades, said power transmission means including timing means positioned below said conveyor means and connected to each of said cutter blades for driving at least two of said cutter blades in out-of-phase sequence to each other.

29. Apparatus for cutting through soil in a horizontal plane comprising:

a framework including two opposed, horizontally extending side walls, a forward portion, a rear portion, a lower side and at least one horizontal plate extending between the lower edges of the side walls;

horizontally aligned outer hitch brackets disposed on said side walls for connecting two outer links between the framework and a tractor vehicle;

a central hitch bracket carried by said framework and positioned between said side walls at a point above the line of horizontal alignment of said outer hitch brackets;

a roller supported on the rear portion of said framework adjacent the lower side thereof for engaging the ground and supporting a portion of the weight of said framework;

a plurality of cutter blades reciprocably mounted on the forward portion of said framework adjacent the lower side thereof for reciprocation in a horizontal plane, said cutter blades having substantially coplanar horizontal upper surfaces;

drive means connected to said cutter blades and carried by said framework at a position therein between said cutter blades and said roller; and

dirt supporting means extending from the front portion of said framework to the rear portion thereof over said drive means and having a forward edge extending across said framework from side wall to side wall in juxtaposition to the upper surfaces of said cutter blades, and a rear edge spaced vertically above said roller.

30. Apparatus as defined in claim 29 wherein said drive means comprises:

a horizontal crankshaft extending in a direction normal to said side walls and rotatably supported in said framework, said crankshaft having eccentric throws spaced therealong, the horizontal axis of rotation of said crankshaft being spaced vertically above the horizontal plane of reciprocation of said cutter blades by a distance corresponding substantially to the distance of eccentricity of said throws; and

connecting rods interconnecting each of said throws with one of said cutter blades.

31. Apparatus as defined in claim 29 wherein said drive means comprises:

a plurality of piston chambers;

a piston in each of said chambers and drivingly connected to one of said cutter blades; and

means for supplying hydraulic power fluid consecutively to each of said piston chambers and for discharging hydraulic power fluid consecutively from each of said piston chambers.

32. Apparatus as defined in claim 29 wherein said drive means includes timing means for timing the reciprocation of said cutter blades so that said cutter blades undergo the cutting portion of their stroke in out-of-phase relation to each other.

33. Apparatus as defined in claim 31 and further characterized to include means for selectively varying the time period over which hydraulic power fluid is supplied to said piston chambers.

34. Apparatus as defined in claim 29 and further characterized to include a hollow, vertically extending partition and shaft housing assembly supported on said framework intermediate said side walls, said shaft housing assembly supporting said central hitch bracket;

and further characterized to include a drive shaft extending vertically in said hollow shaft housing assembly and drivingly connected at its lower end to said drive means.

35. Excavating apparatus for removing a surface layer from the earth comprising:

a prime mover;

a power takeoff from said prime mover;

a framework having a top portion, a forward portion, a rear portion and a ground engaging portion;

a pair of outer hitch brackets mounted on the forward portion of said framework adjacent the sides of said framework and in horizontaol alignment with each other;

a central hitch bracket mounted on said framework toward the center thereof and vertically offset from the line of horizontal alignment of said outer hitch brackets whereby said framework can be pivoted about a horizontal axis extending through said outer hitch brackets by a hitch link connected to said central hitch bracket;

actuating means connected to said hitch brackets for actuating said hitch brackets to move said framework relative to a plane substantially coplanar with the surface of the ground over which said excavating apparatus is moved;

a plurality of cutter blades movably mounted on the forward portion of said framework in alignment with the ground engaging portion thereof;

dirt supporting means extending upwardly and rearwardly in said framework from a line in juxtaposition to the upper usrface of said cutter blades to receive material severed by said cutter blades and support and lift said material as it moves rearwardly with respect to said framework; and

power transmission means on said framework and having an input end connected to said power takeoff and an output end connected to said cutter blades for reciprocating at least two of said cutter blades on said framework in out-of-phase relation to each other and in a direction of movement advancing from,

conveyor means mounted in the framework between the side walls thereof and being inclined downwardly from the rear portion of said framework toward the forward portion thereof;

a plurality of cutter blades reciprocally mounted on said framework adjacent the forward portion thereof for independent movement in a horizontal plane adjacent the lowermost portion of said framework;

a transmission housing mounted on said framework below said conveyor means;

timing means sealingly enclosed in said transmission housing whereby said timing means may be immersed in a lubricant carried in said transmission housing;

power transmission means including said timing means and carried by said framework and spaced rearwardly from said cutter blades, said power transmission means further including a shaft extending into said transmission housing, and said timing means comprising:

a drive disc drivingly connected to said power transmission shaft for rotation in a horizontal plane disposed below said conveyor means;

a stud projecting downwardly from the drive disc and eccentrically offset from the axis of rotation of said drive disc;

an elongated drive plate positioned below said drive disc and connected to said stud and movable therewith as said drive disc is rotated;

a plurality of cam plates positioned below said drive plate and each supported on said framework for rotation about a vertical axis, said cam plates being spaced from each other along the length of said drive plate and having their vertical axes of rotation disposed in a common vertical plane;

a plurality of connecting pins spaced longitudinally along said elongated drive plate and each interconnecting said drive plate with a point on one of said cam plates eccentrically positioned with respect to the axis of rotation of the respective cam plate;

a drive stud projecting downwardly from each of said cam plates, the drive stud of each cam plate being circumferentially spaced from the respective point of connection to that cam plate of the respective connecting pin by a different angular distance from the angular distances by which each of the drive studs on each of the other cam plates is spaced from the respective point of connection of the respective connecting pin thereto; and

keyway means connected to each of said cutter blades for movement therewith, each of said keyway means engaging one of said drive studs and permitting the engaged drive stud to slide freely therein in a transverse direction with respect to said framework while transmitting the forward and rearward motion of the engaged drive stud to the respective cutter blade whereby said cutter blades are each driven in rectilinear motion.

25. Apparatus for removing a surface layer of earth, asphalt or the like from the ground comprising:

a framework having a pair of horizontally spaced, vertically extending side walls, a forward portion, a rear portion, and at least one horizontal plate extending transversely between the side walls adjacent the lower edges thereof;

conveyor means mounted in the framework between the side walls thereof and being inclined downwardly from the rear portion of said framework toward the forward portion thereof;

a plurality of cutter blades reciprocally mounted on said framework adjacent the forward portion thereof for independent movement in a horizontal plane adjacent the lowermost portion of said framework;

a transmission housing mounted on said framework below said conveyor means;

power transmission means carried by said framework and spaced rearwardly from said cutter blades, said power transmission means further including a shaft extending into said transmission housing, and timing means sealingly enclosed in said transmission housing whereby said timing means may be immersed in a lubricant carried in said transmission housing, said timing means comprising:

a driving gear drivingly connected to said power transmission shaft for rotation in a horizontal plane disposed below said conveyor means;

a plurality of horizontally spaced driven gears corresponding in number to the number of said cutter blades and disposed in transverse alignment across said framework, said driven gears each being rotatably suported in said framework for rotation about a vertical axis, and at least one of said driven gears engaging said driving gear and the remainder of said driven gears intermeshing with each other and being driven by the driven gears which engage said driving gear;

a drive stud depending downwardly from each of said driven gears for rotation therewith and disposed eccentically with respect to the vertical axis of rotation thereof, each of the drive studs of each driven gear being disposed in a different radial direction from the axis of rotation of the respective driven gear from the radial direction at which each of the other drive studs on the other driven gears is disposed with respect to the axis of rotation of its respective driven gear when said driven gears and said driving gear are engaged and intermeshed as hereinbefore described; and

keyway means connected to each of said cutter blades for movement therewith, each of said keyway means engaging one of said drive studs and permitting the engaged drive stud to slide freely therein in a transverse direction with respect to said framework while transmitting the forward and rearward motion of the engaged drive stud to the respective cutter blades whereby said cutter blades are driven in rectilinear motion.

26. Apparatus for removing a surface layer of earth, asphalt or the like from the ground comprising:

a framework having a pair of horizontally spaced, vertically extending side walls, a forward portion, a rear portion, and at least one horizontal plate extending transversely between the side walls adjacent the lower edges thereof;

conveyor means mounted in the framework between the side walls thereof and being inclined downwardly from the rear portion of said framework toward the forward portion thereof;

a plurality of cutter blades reciprocally mounted on said framework adjacent the forward portion thereof for independent movement in a horizontal plane adjacent the lowermost portion of said framework;

a transmission housing mounted on said framework and positioned horizontally between said conveyor means and said cutter blades, said transmission housing including a horizontal cover plate horizontally aligned with the lowermost forward end of said conveyor means; and

power transmission means carried by said framework and spaced rearwardly from said cutter blades, said power transmission means including timing means sealingly enclosed in said transmission housing whereby said timing means may be immersed in a lubricant carried in said transmission housing, said timing means being connected to each of said cutter blades for driving at least two of said cutter blades in out-of-phase sequence to each other.

27. Apparatus as defined in claim **26** and further characterized to include an inclined lift plate extending between the side walls of said framework, and between the

and returning to, the forward portion of said framework, said power transmission means including timing means adapted to move at least one of said blades forwardly with respect to said framework at a different time than the time at which another of said blades is moved forwardly with respect to said framework, said timing means being disposed beneath said dirt supporting means and to the rear of said cutter blades.

36. Apparatus for cutting through the soil in a horizontal plane comprising:

a framework including two opposed, horizontally extending side walls, a forward portion, a rear portion, a lower side, and means interconnecting the lower edges of the side walls;

horizontally aligned outer hitch brackets disposed on said side walls for connecting two outer links between the frame work and a tractor vehicle;

a central hitch bracket carried by said framework and positioned between said side walls at a point above the line of horizontal alignment of said outer hitch brackets;

a roller supported on said framework adjacent the lower side thereof for engaging the ground and supporting a portion of the weight of said framework;

a plurality of cutter blades reciprocally mounted on the forward portion of said framework adjacent the lower side thereof for reciprocation in a horizontal plane, said cutter blades having substantially coplanar, horizontal upper surfaces;

drive means connected to said cutter blades and carried by said framework at a position therein between said cutter blades and said roller; and

dirt supporting means extending from the front portion of said framework toward the rear portion thereof over said drive means, and having a forward edge extending across said framework from side wall to side wall in juxtaposition to the upper surfaces of said cutter blades, a portion of said dirt supporting means being spaced vertically above said roller.

37. Apparatus for removing a surface layer of earth, asphalt or the like from the ground comprising:

a framework having a pair of horizontally spaced, vertically extending side walls, a forward potrion, a rear portion, and at least one horizontal plate extending transversely between the side walls adjacent the lower edges thereof;

a vertically extending partition assembly positioned between said side walls and extending substantially parallel thereto, said partition assembly including metal plates surrounding an enclosed space;

a pair of endless belt conveyors positioned on opposite sides of said vertically extending partition assembly, said endless belt conveyors each being inclined downwardly from the rear portion of said framework toward the forward portion thereof;

a plurality of cutter blades reciprocally mounted on said framework adjacent the forward portion thereof for independent movement in a horizontal plane adjacent the lower portion of said framework; and

power transmission means carried by said framework and spaced rearwardly from said cutter blades, said power transmission means being at least partially enclosed within said vertically extending partition assembly and protected thereby from dirt moving rearwardly in said framework on said endless belt conveyors, and said power transmission means including timing means positioned below said endless belt conveyors and connected to each of said cutter blades for driving at least two of said cutter blades in out-of-phase sequence to each other.

38. Apparatus for removing a surface layer of earth, asphalt or the like from the ground comprising:

a framework having a pair of horizontally spaced, vertically extending side walls, a forward portion, a rear portion, and at least one horizontal plate extending transversely between the side walls adjacent the lower edges thereof;

conveyor means mounted in the framework between the side walls thereof and being inclined downwardly from the rear portion of said framework toward the forward portion thereof;

a plurality of cutter blades reciprocally mounted on said framework adjacent the forward portion thereof for independent movement in a horizontal plane adjacent the lowermost portion of said framework;

a transmission housing mounted on said framework and sealingly enclosing a space for confining a lubricant; and

power transmission means carried by said framework and spaced rearwardly from said cutter blades, said power transmission means including timing means sealingly enclosed in said transmission housing for immersion in a lubricant and connected to each of said cutter blades for driving at least two of said cutter blades in out-of-phase sequence to each other.

39. Apparatus for removing a surface layer of earth, asphalt or the like from the ground comprising:

a framework having a pair of horizontally spaced, vertically extending side walls, a forward portion, a rear portion, and at least one horizontal plate extending transversely between the side walls adjacent the lower edges thereof;

conveyor means mounted in the framework between the side walls thereof and being inclined downwardly from the rear portion of said framework toward the forward portion thereof;

a plurality of cutter blades reciprocally mounted on said framework adjacent the forward portion thereof for independent movement in a horizontal plane adjacent the lowermost portion of said framework;

guide means slidingly supporting said cutter blades on said framework;

lubricant confining means enclosing said guide means whereby said guide means can be immersed in a lubricant during operation of said apparatus as said cutter blades are reciprocated on said framework; and

power transmission means carried by said framework and spaced rearwardly from said cutter blades, said power transmission means including timing means positioned below said conveyor means and connected to each of said cutter blades for driving at least two of said cutter blades in out-of-phase sequence to each other.

40. A device for cutting and removing pavement and the like comprising:

frame means including a pair of vertically extending opposite side walls;

a plurality of elongated horizontal cutter blades transversely spaced and slidably mounted on said frame means for longitudinal reciprocation;

a crankshaft journaled on said frame means for rotation about a transverse longitudinal axis and including a plurality of throws longitudinally spaced therealong, at least some of said throws being angularly disposed relative to each other about the axis of rotation of said crankshaft;

a plurality of connecting rods each having one of its ends journaled on one of said throws, and the other end journaled on one of said blades;

drive means drivingly connected to said crankshaft;

a pair of rollers rotatably journaled in said side walls of said frame means; and

a conveyor belt entrained over said rollers and positioned adjacent to, and rearwardly from, the cutting portion of said cutting blades for removing asphalt cut by the blades; and

means drivingly connecting said crankshaft to one of said rollers.

41. Apparatus for removing a surface layer of earth comprising:

a framework having a pair of horizontally spaced, vertically extending frame members, a forward portion, a rear portion, and a horizontal plate extending between said vertically extending frame members;

a plurality of cutter blades reciprocally mounted on said framework adjacent the forward portion thereof for independent movement in a substantially horizontal plane adjacent the lowermost portion of said framework;

a transmission housing mounted on said framework;

power transmission means carried by said framework and spaced rearwardly from said cutter blades and including a shaft extending into said transmission housing, and further including timing means enclosed in said transmission housing, said timing means comprising:

a driving gear drivingly connected to said shaft for rotation in a horizontal plane;

a plurality of horizontally spaced driven gears disposed in transverse alignment across said framework and each rotatably supported in said framework for rotation about a vertical axis, said driven gears being ultimately driven by said driving gears;

a drive stud depending downwardly from each of said driven gears for rotation therewith and disposed eccentrically with respect to the vertical axis of rotation thereof, each of the drive studs of each driven gear being disposed in a different radial direction from the axis of rotation of the respective driven gear from the radial direction in which each of the other drive studs on the other driven gears is disposed with respect to the axis of rotation of its respective driven gear; and

means carried by each of said cutter blades and receiving the drive stud of one of said driven gears whereby the circular motion of said studs is converted to rectilinear motion of said blades.

42. Excavating apparatus comprising:

a framework having a pair of horizontally spaced, vertically extending side walls for confining dirt moving through said framework, said framework further having a forward portion, a rear portion, and at least one horizontal plate extending transversely across said framework between said side walls and secured to the lower edges thereof;

a pair of horizontally aligned outer hitch brackets mounted on said framework adjacent said side walls and adapted to receive and be connected to hitch links for connecting the framework to a self-powered vehicle;

a central hitch bracket mounted on said framework between said side walls and vertically offset from the line of horizontal alignment of said outer hitch brackets whereby said framework can be pivoted about a horizontal axis extending through said outer hitch brackets by a hitch link connected to said central hitch bracket;

roller means rotatably supported by said framework at the rear portion thereof, said roller means including

at least one roller having a peripheral surface extending below said horizontal plate to support at least a portion of the weight of said framework as said framework is moved along the ground;

conveyor means mounted in the framework between the side walls thereof and being inclined downwardly from the rear portion of the framework toward the forward portion thereof, said conveyor means comprising:

a rear roller positioned adjacent the rear portion of said framework;

a forward roller positioned adjacent the forward portion of said framework and below the level of said rear roller; and

an endless conveyor belt extending around said rear roller and forward roller;

a plurality of horizontally aligned, spaced cutter blades reciprocably mounted on the forward portion of said framework below the level of said forward roller, and mounted for reciprocating movement in a common horizontal plane;

guide means mounted on said framework and supporting and guiding said cutter blades;

a horizontal crankshaft extending transversely across said framework between the side walls thereof and mounted on said framework for rotation about a horizontal axis;

a plurality of throws on said crankshaft eccentrically offset from the axis of rotation thereof and movable upon rotation of said crankshaft through the horizontal plane of reciprocation of said cutter blades, said crankshaft and the throws carried thereby being positioned below said conveyor means;

a connecting rod interconnecting one of said throws with each of said cutter blades;

means drivingly interconnecting said crankshaft with one of said conveyor rollers;

drive shaft means mounted on said framework and adapted for connection to a prime mover;

means drivingly interconnecting said drive shaft means to said crankshaft; and

dirt supporting means positioned between said conveyor means and said cutter blades for supporting dirt moving from said cutter blades to said conveyor means.

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