

[54] SOIL STABILIZATION APPARATUS

[75] Inventors: Carleton L. Rank, Walnut Creek;
Ray T. Ryan, San Rafael, both of
Calif.

[73] Assignee: Metradon Associates, Lafayette,
Calif.

[22] Filed: Mar. 11, 1969

[21] Appl. No.: 806,121

[52] U.S. Cl.404/90, 404/92, 404/111

[51] Int. Cl.E01c 19/02

[58] Field of Search.....94/39, 40, 44;
172/117, 548, 556

[56] References Cited

UNITED STATES PATENTS

1,883,667	10/1932	Flynn.....	94/39 UX
2,090,290	8/1937	Gardner.....	94/44
2,473,770	6/1949	Seaman.....	94/44
3,224,347	12/1965	Seaman.....	94/40
3,318,209	5/1967	Schultz.....	94/50

Primary Examiner—Nile C. Byers, Jr.

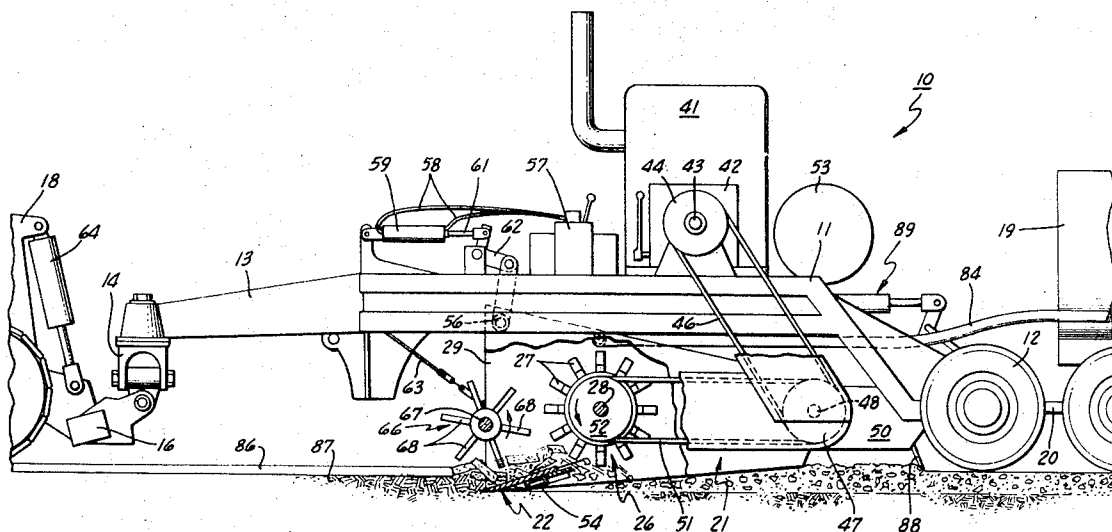
Attorney—Gardner & Zimmerman

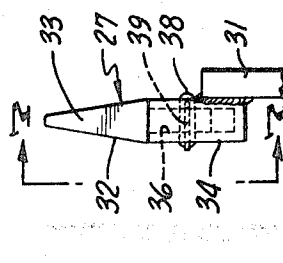
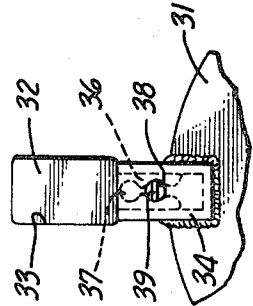
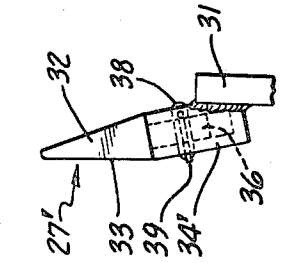
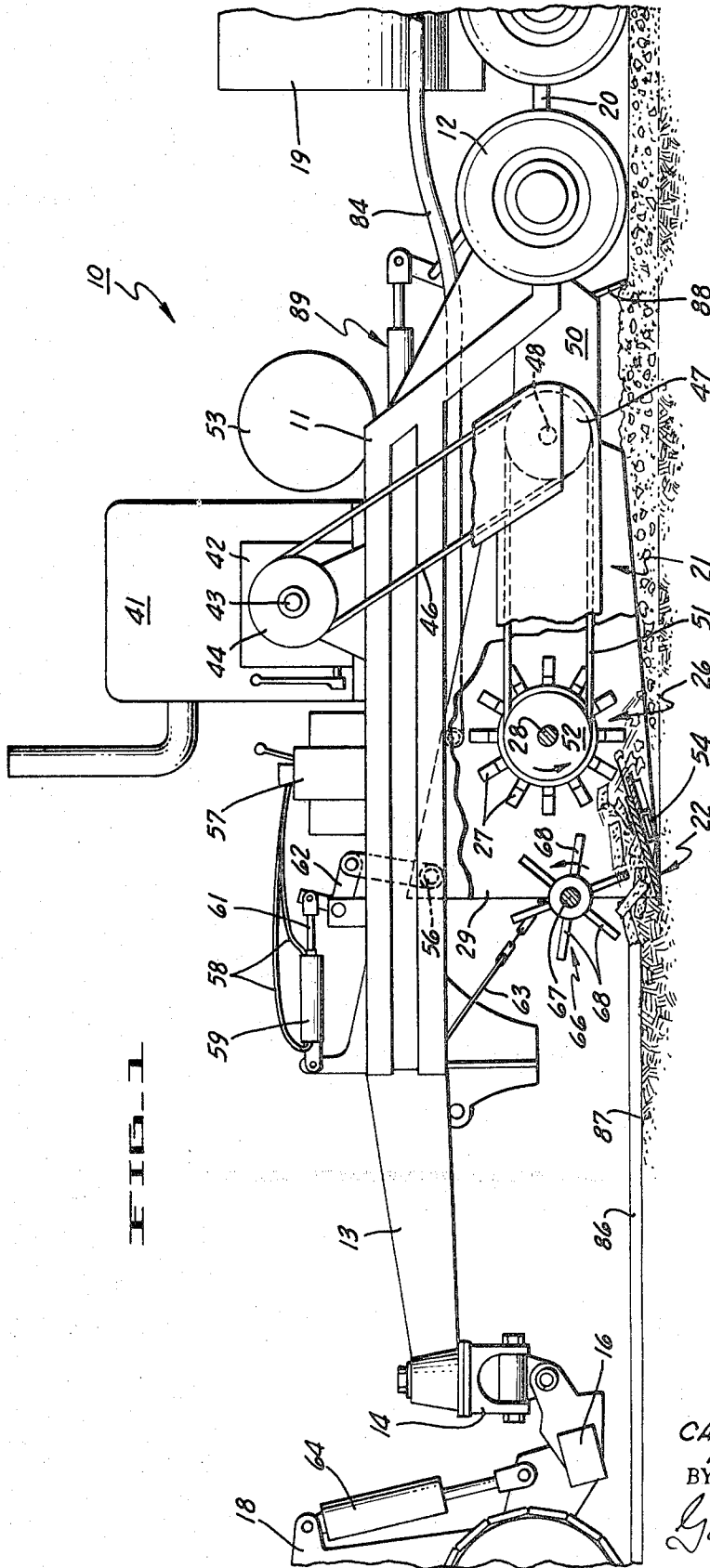
[57] ABSTRACT

Apparatus is described which makes it possible to utilize old asphalt and asphalt/concrete traffic bearing surfaces in forming a stabilized base for a new traffic bearing surface. Basically, the apparatus of the invention comprises a vehicle having a transversely extending cutting blade mounted in a location to sever an upper layer of the material over which it is traveling from the remainder of the material and feed such layer rearwardly relative to the traveling vehicle to a pulverizing and mixing rotor also extending transversely of the apparatus.

Besides pulverizing an old traffic bearing surface, the rotor mixes same with soil and a soil stabilizing medium such as lime or cement. The degree of pulverization and mixing, as well as the thickness of the surface layer removed, is controllable.

4 Claims, 12 Drawing Figures





INVENTORS
 CARLETON L. RANK and
 RAY T. RYAN
 BY
Gardner & Zimmerman
 ATTORNEYS

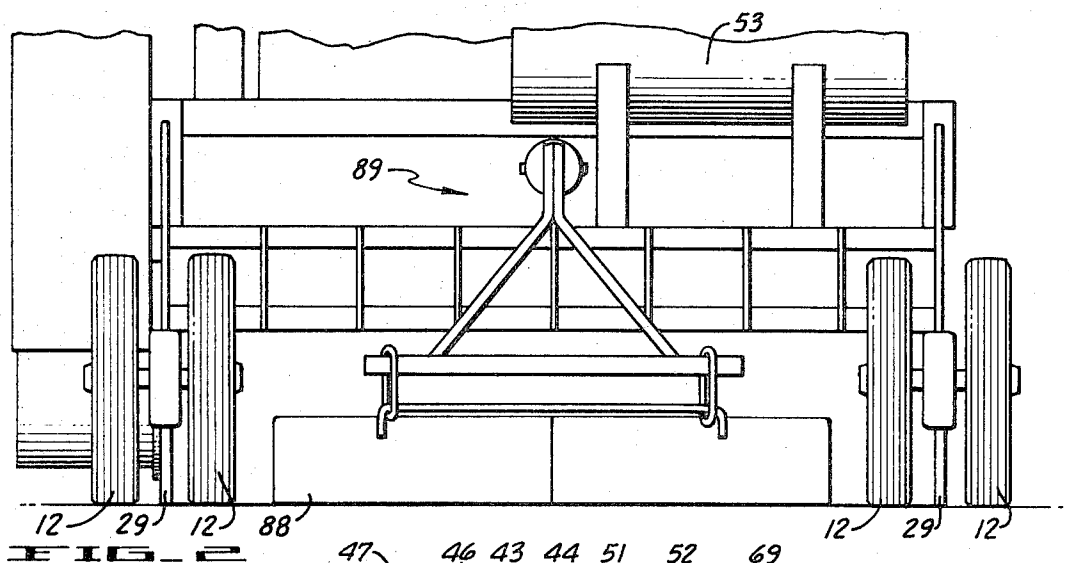


FIG. 2

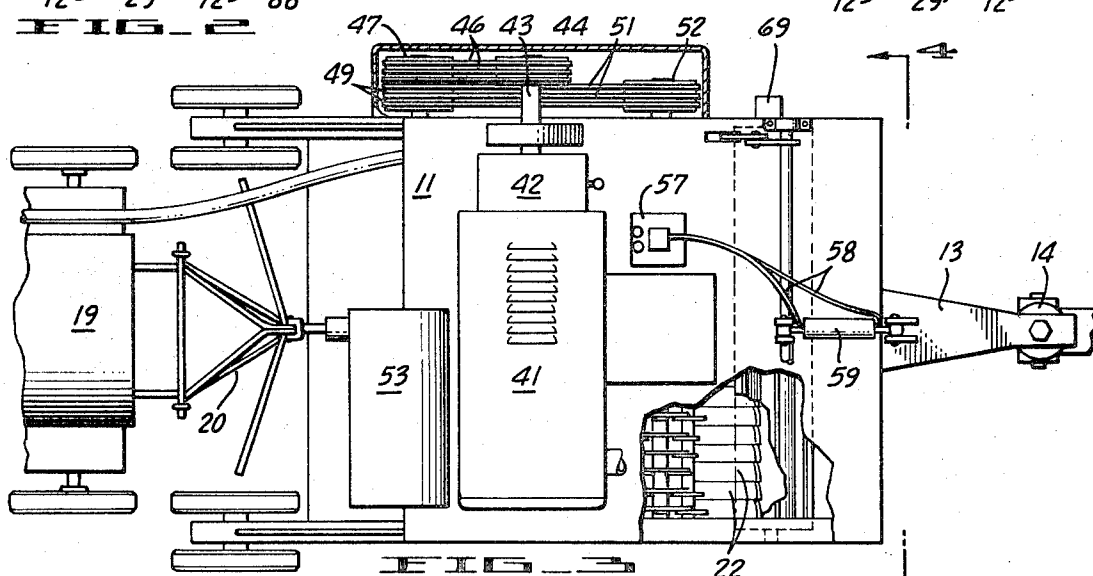


FIG. 3

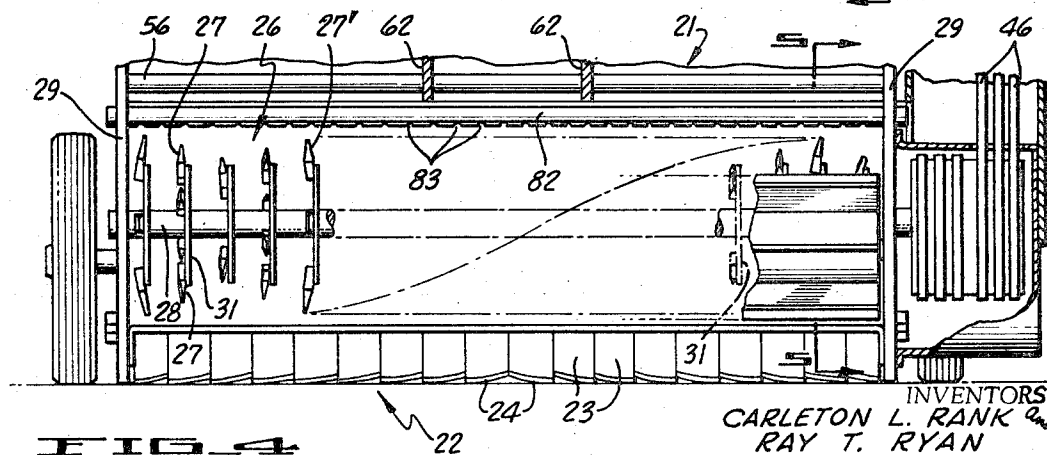


FIG. 4

INVENTORS
CARLETON L. RANK and
RAY T. RYAN

BY

Gardner & Zimmerman
ATTORNEYS

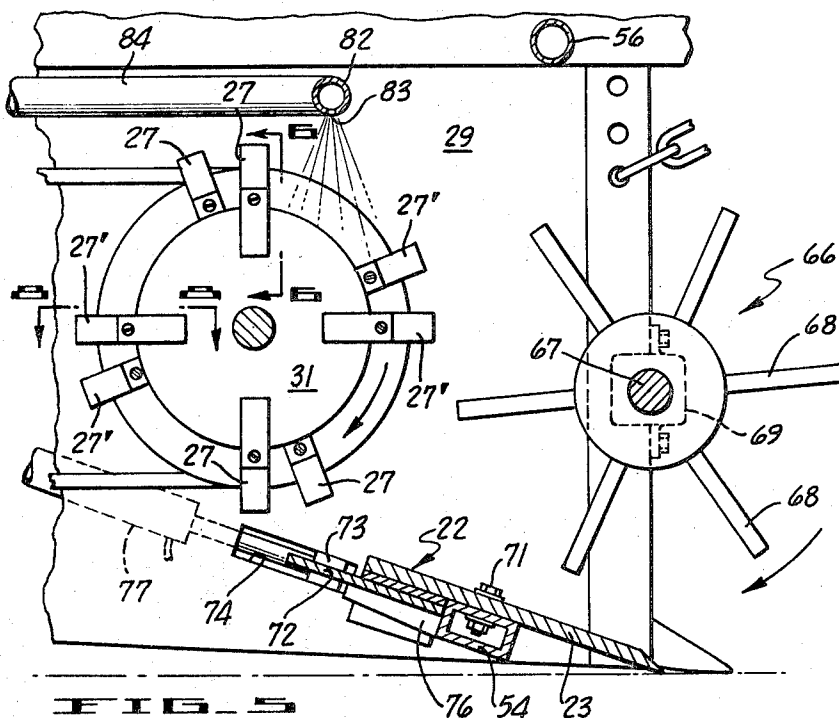


FIG. 5

FIG. 12

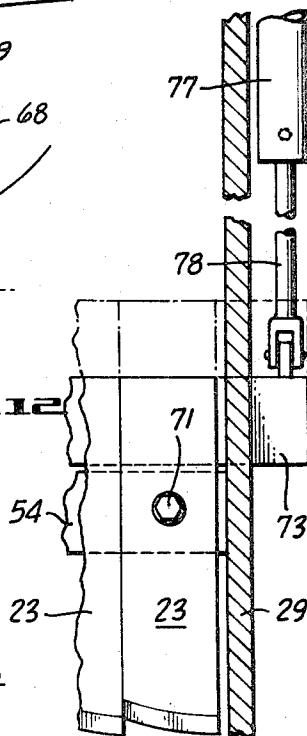


FIG. 11

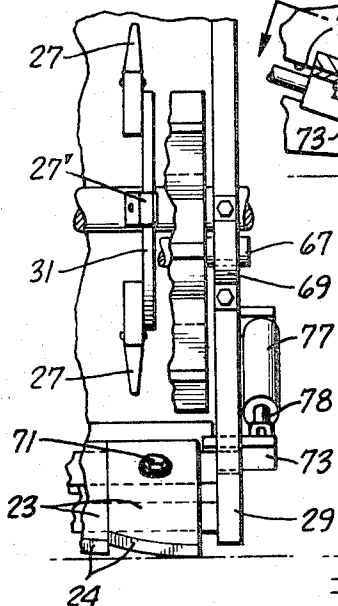
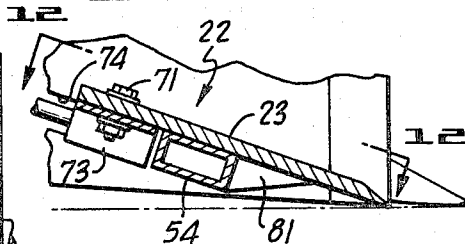


FIG. 9

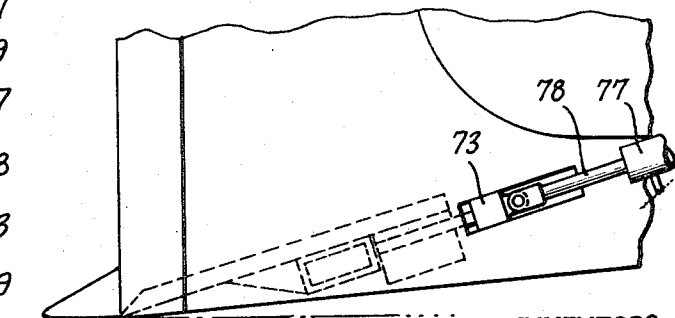


FIG. 10

INVENTORS
CARLETON L. RANK and
RAY T. RYAN

BY

Sadner & Zimmerman
ATTORNEYS

SOIL STABILIZATION APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to earth working machinery and, more particularly, to a soil stabilizing and pulverizing apparatus especially adapted for use in the construction of traffic bearing surfaces such as roadways and airport runways.

When a heavy traffic bearing asphalt or asphalt/concrete surface, such as the surface of a highway or airport runway, is to be renewed, the common practice is to first rip up the old hard surface and haul the chunks thereof away. Then the substrate or road base is "stabilized" to increase its density, such as by mixing the same with a lime or cement slurry. After the base has been brought up to a requisite density and hardness, an asphalt mixture, concrete, or other suitable material is then applied over the base to form the new traffic bearing surface.

It will be appreciated that the hauling away of the old traffic bearing surface constitutes a major expense in the road renewal process. Not only is the cost of trucking the material high, particularly when it must be trucked to a distant location, but the time involved in the removal of the old roadway adds greatly to the labor and total expense.

SUMMARY OF THE INVENTION

The instant invention is an apparatus which eliminates the necessity of removing an old asphalt or asphalt/concrete traffic bearing surface before a new traffic bearing surface can be formed and, in fact, utilizes the old surface to provide an exceptionally well stabilized base for the new roadway. More particularly, the instant invention is capable of pulverizing in situ asphalt and asphalt/concrete surfaces and mixing the pulverized material with lime, cement, or emulsified asphalt to create the stabilized base for the new roadway. In its basic aspects, the invention comprises a vehicle adapted to travel over a material surface such as an old traffic bearing surface. A cutting and lifting blade is mounted on the vehicle with a horizontal front cutting edge located to cut a layer of the material from the surface and direct the same rearwardly over such blade to a mixing and pulverizing rotor having cutting teeth for engaging the layer of material to chop and mix the same. The cutting of the surface layer of the material by the blade from the road, and the relationship of the cutting blade to the rotor are important in providing the degree of pulverization of the material necessary for its reuse in forming the new road bed. As will be described hereinafter, the degree of pulverization and mixing obtained, as well as the thickness of the layer pulverized, is controllable. The specific design of the rotor and its teeth are also important in assuring that the necessary mixing and pulverization is obtained.

The instant invention therefore eliminates the necessity of hauling old traffic bearing surfaces away before new ones can be provided. Moreover, it utilizes the old roadway to provide an enhanced stabilized base for the new roadway. In fact, the stabilization obtained with the instant invention and its use of the old roadway is sufficiently great that in many applications it is not necessary to apply a new layer of asphalt, oil or cement or the like to provide the traffic bearing surface. The stabilized base obtained with use of the instant inven-

tion is hard and stable enough for use as the traffic bearing surface itself.

BRIEF DESCRIPTION OF THE DRAWINGS:

FIG. 1 is an overall side elevational view of a preferred embodiment of the instant invention with portions thereof broken away and shown in section;

FIG. 2 is a rear elevational view of the preferred embodiment illustrated in FIG. 1 with the upper portion thereof broken away;

FIG. 3 is a top plan view of the apparatus of FIG. 1 showing the same in a reduced scale and with portions broken away;

FIG. 4 is a front broken away cross-sectional view taken on a plane indicated by lines 4—4 in FIG. 3 and illustrating details of the construction of the apparatus;

FIG. 5 is an enlarged partial cross-sectional view taken on the plane indicated by the lines 5—5 in FIG. 4;

FIG. 6 is a partial cross-sectional view taken on a plane indicated by the lines 6—6 in FIG. 5 and illustrating one of the teeth of the rotor in edge elevation;

FIG. 7 is a partial cross-sectional view taken on the plane indicated by lines 7—7 in FIG. 6 and showing the tooth of FIG. 6 in side elevation;

FIG. 8 is a partial cross-sectional view on a plane indicated by the lines 8—8 in FIG. 5 illustrating another one of the teeth of the rotor;

FIG. 9 is a partial end view illustrating certain aspects of the construction of the apparatus;

FIG. 10 is a partial side elevational view depicting a preferred manner by which the cutting blade is adjustable relative to the rotor;

FIG. 11 is a partial cross-sectional view illustrating an alternate means of adjusting the cutting blade relative to the rotor; and

FIG. 12 is a partial cross-sectional view taken on a plane indicated by the lines 12—12 in FIG. 11 and depicting further details of the alternate embodiment shown in FIG. 11.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawings, particularly FIG. 1, it will be seen that the stabilizing and pulverizing apparatus of the invention comprises a vehicle 10 adapted to travel over a material surface such as over an old traffic bearing surface. More particularly, the vehicle 10 includes a main frame 11 having adjacent its rear end a plurality of soft tire wheels 12 and extending forwardly from its front end a heavy duty pulling tongue 13. As is shown, tongue 13 includes at its free end a mount 14 allowing universal movement of tongue 13 relative to the draw bar 16 of a pulling tractor 18 or the like. As is shown, a tank trailer 19, for purposes subsequently to be described, may be secured to the rear of vehicle 10 by means of a suitable conventional hitching arrangement 20 for travel therewith.

The apparatus of the invention is adapted to cut a layer of material from the surface over which it is traveling and mix and pulverize the same. More particularly, the apparatus includes a carriage, generally referred to by the reference numeral 21, which supports a cutting and lifting blade 22 in a horizontal position transversely of the apparatus in a location at which

it can be made to extend beneath the surface of the material. As is best illustrated in FIG. 4, blade 22 is defined by a plurality of closely adjacent or overlapping teeth 23, the forward edge 24 of each of which is sharpened to provide for the full cutting blade a generally horizontally extending front cutting edge. As the apparatus of the invention travels over a material with the blade lowered thereinto, the front cutting edge of the blade acts to sever an upper layer of the material from the remaining material. As is illustrated, blade 22 extends angularly upward somewhat from its cutting edge. Therefore, as the blade travels through the material, it not only directs the severed layer rearwardly relative to the apparatus, but also lifts the severed layer from the remaining material.

Means are provided on the apparatus for mixing and pulverizing the layer of material severed by cutting blade 22. More particularly, a mixing and pulverizing rotor, generally referred to by the reference numeral 26, is mounted on carriage 21 widthwise of the vehicle rearwardly of the blade cutting edge at a location at which cutting teeth 27 thereof engage the material passed over the blade and chop and mix the same. As is best illustrated in FIG. 4, rotor 26 includes a central rotor shaft 28 which extends transversely of the vehicle in a generally horizontal plane and is suitably journaled within bearings (not shown) in side plates 29 of carriage 21. A plurality of rotor discs 31 are mounted coaxially on shaft 28 in equally spaced apart relationship. As shown, discs 31 act as supports for teeth 27, each of which extends generally radially outward from its associated disc.

As has been mentioned previously, the invention is particularly suited for the pulverization of old asphalt and asphalt/concrete traffic bearing surfaces. It will be appreciated that because of the hardness of such surfaces, the design of the rotor and the cutting blade and their relationship are important in assuring the desired pulverization and mixing of materials. In this connection, FIGS. 6 through 8 illustrate a tooth design which has been found to be particularly effective in the combination to provide the pulverization and mixing. With reference first to FIGS. 6 and 7, it will be seen that tooth 27 includes a cutting portion 32 which is generally wedge shaped to define a triangular edge surface 33 which is normal to the disc 31 with which such tooth is associated. Triangularly shaped edge surface 33 thereby acts as the cutting edge of the tooth which engages the layer of material during rotation of the rotor.

Each tooth 27 is mounted to its associated disc 31 in a manner which permits quick release of the tooth if it becomes necessary, and substitution therefor of a new tooth. More particularly, the mounting means for each tooth includes a rectangular channel shaped holder 34 which extends radially outward from its associated disc 31 and is suitably secured thereto such as by welding. Each of the teeth 33 includes a shank portion 36 which fits snugly within the cavity of its associated holder. As is best illustrated in FIG. 7, the shank 36 of each tooth includes an open ended slot 37 which extends longitudinally into the shank from its free end, and the inner side surfaces of slot 37 are provided with opposing circular shaped recesses which register with an aperture extending through holder 34. A split bolt 38 of the type

having a resilient central portion 39 extends through the aperture in holder 34 and a pair of the opposed recesses in tooth 27 to thereby secure such tooth within the holder. It will be appreciated that with this construction each of the teeth 27 may be released from the holder by simply driving the pin 38 therefrom, and a replacement tooth may be secured to the rotor by merely inserting its shank into the holder cavity and driving the pin 38 through the registering apertures in the holder and cooperating recesses in the tooth.

As will be noted, there are four teeth secured to each disc at regular 90° angles. Moreover, the location of the teeth on each disc is angularly offset a small amount from the location of the teeth on adjacent discs so that, as will be seen from FIG. 4, the teeth are spirally arranged transversely of the rotor. This equal spacing and spiral arrangement of the teeth assures that the loads imparted to the rotor as the teeth engage the layer of material to be mixed and pulverized are generally uniform throughout each full revolution of the rotor.

Every alternate tooth on each disc is mounted on the disc to extend, as shown in FIG. 8, angularly toward an adjacent disc to assure contact of such tooth with material passing between the planes of such discs. More particularly, the cavity within the holder 34' of each alternate tooth 27' is angled transversely away from the plane of the disc to which such holder is secured. The result is that when tooth 27' is secured within such cavity, the tooth will also be angled away from the plane of the disc and thus project into the area between the planes of the disc with which it is associated and of one of its adjacent discs. It should be noted that all of the teeth 27' are canted in the same direction and substantially the same amount.

Because of the hardness of old traffic bearing surfaces, it will be appreciated that a high horse power and torque driving means is necessary to rotate rotor 26. In this connection an internal combustion engine 41 is suitably mounted on the upper portion of main frame 11 of the apparatus. Engine 41 drives through a suitable transmission 42 an output shaft 43 having mounted thereon a plurality of belt pulleys 44. Pulleys 44 are coupled by means of the belt 46 to corresponding pulleys 47 on one end of an idler shaft 48 which extends transversely of carriage 21 rearwardly of rotor 26. Shaft 48 is suitably journaled within opposite sidewalls 29 of carriage 21 and also to flanges 50 on opposite sides of main frame 11. A second set of pulleys 49 on shaft 48 adjacent pulleys 47 are coupled by means of belts 51 to pulleys 52 on an end of rotor shaft 28 extending outwardly of the adjacent flange 50. A suitable fuel tank 53 for engine 41 is mounted on frame 11 adjacent to such engine.

It will be readily apparent from the above that the driving arrangement and coupling discussed will cause the output of engine 41 to rotate rotor 26. The belt and pulley arrangement allows slippage between the engine and the rotor if for some reason the rotation of such rotor is hindered such as because of engagement with rocks or the like.

Means are provided for adjusting the depth to which the cutting blade 22 extends beneath the surface of the material to be stabilized and, hence, the thickness of the layer being fed to rotor 26. For this purpose, the carriage 21 carrying cutting blade 22 and rotor 26 is

mounted adjacent its rear end flanges 50 of main frame 11 by idler shaft 48. In this connection, sidewalls 29 of carriage 21 are rigidly secured together for simultaneous movement by suitable supporting structure including a transversely extending box channel 54 beneath cutting blade 22 and adjacent their forward upper ends by a transversely extending tubular structural member 56.

Hydraulic means are provided for pivoting carriage 26 about shaft 48 to thereby raise and lower cutting blade 22 with respect to main frame of the apparatus. That is, a hydraulic pump and reservoir 57 mounted on frame 11 forwardly of engine 41 is suitably connected by means of lines 58 with a hydraulic cylinder 59. The free end of piston rod 61 of cylinder 59 is secured by linkage 62 mounted on frame 11 and connected to tubular cross member 56 of carriage 21 for pivoting such carriage about shaft 48 upon extension and retraction of rod 61. A supporting rod and chain 63 is also provided for supporting carriage 21 in selected positions, to thereby reduce the strain on the hydraulic system during use of the apparatus.

Further control of the depth to which blade 22 extends into the material being worked can also be obtained by pulling the apparatus with a tractor having a draw bar as shown whose vertical position can be adjusted. In the illustrated arrangement, draw bar 16 is hydraulically operated by means of a pair of adjacent jacks, one of which is denoted at 64 in FIG. 1. It will be appreciated that raising and lowering of draw bar 16 will pivot the frame 11 about the axle of the ground engaging wheels 12 with a consequent raising and lowering of cutting blade 22 relative to the material surface. If an embodiment of the invention is always to be pulled by a tractor having such an adjustable draw bar, the separate hydraulic adjusting means mounted on the apparatus as described above is not necessary. However, it is preferred that it be included so that no undue limitations are placed on the type of pulling vehicle which can be utilized with the apparatus.

In some instances, it is desirable to provide means to assist blade 22 in the feeding of the material to rotor 26. In the embodiment of the invention illustrated, an auxiliary feed roller 66 is mounted on carriage 21 above blade 22 for this purpose. Feed roller 66 includes a shaft 67 which extends between carriage side walls 29 and is suitably journaled therein for rotation. A plurality of feed paddles 68 extend radially outward from shaft 67 for engagement with material severed by blade 22 to aid in feeding such material rearwardly to rotor 26. A hydraulic motor 69 (FIG. 3) mounted on the exterior side of one of the plates 29 has its output connected to shaft 67 for rotating the same. Hydraulic pressure to drive motor 69 may be suitably provided in a conventional manner such as from pump 57. Since feed roller 68 is not necessary or desirable for feeding all materials, it is removably secured to the carriage. In this connection, as shown in FIG. 5, shaft 67 is mounted between plates 29 by a conventional split bearing 69.

As a particularly salient feature of the invention, means are provided for controlling the degree of pulverization of the material fed to rotor 26. This is important since the amount of stabilization which can be obtained with various old traffic bearing compositions de-

pends on the maximum size of the particles of the old composition which are mixed with other stabilizing materials such as lime or cement. The degree of pulverization of the layer of material passing over cutting blade 22 is dependent upon the amount of space between the cutting blade and the teeth of rotor 26. To control the degree of pulverization, therefore, the distance between the cutting blade and rotor is adjustable. More particularly, with reference to FIGS. 5, 9 and 10, it will be seen that cutting blade includes a forward portion defined by the teeth 23 which is rigidly secured between side walls 29 of the carriage such as by being bolted to channel cross member 54 by bolts 71. The rear portion of blade 22, however, is comprised of a plate 72 which is supported for slidable movement with respect to the remainder of the cutting blade by blocks 73 riding in slots 74 in the opposite side walls 29 of carriage 21. As illustrated, the forward portion of plate 72 is supported beneath the blades 23 by spaced apart supports 76 projecting rearwardly from channel 54 to define a slot for plate 72 between the supports and the rear portion of the teeth 23. A hydraulic cylinder 77 is mounted on the outside of each of the side walls 29 and has its piston rod 78 suitably secured to the block 73 within the slot 74 in its associated side wall 29. Cylinders 77 are conventionally in communication with hydraulic pump 57 so that their piston rods 78 may be simultaneously extended or retracted to move plate 72 longitudinally relative to the teeth 23 of the cutting blade.

The above arrangement provides the desired means of adjusting the distance between the cutting blade 22 and the rotor teeth. That is, with reference to FIG. 5, it will be seen that upon retraction of the piston rods 78 to slide a portion of plate 72 out from beneath teeth 23, the distance between plate 72 and the teeth 27 and 27' on the discs 31 will be lessened. The result is that there is less room for material to pass between the rotor and the blade, with the consequence that the material must be pulverized to a finer degree before it can pass between the blades and rotor. However, upon extension of piston rod 78, the plate 72 will be slid beneath the teeth 23 to thereby enlarge the space between the rotor and the cutting blade. The result is that the material need not be pulverized to as great an extent to pass between the blade and rotor and, therefore, larger particles of the old traffic bearing surface will be provided.

FIGS. 11 and 12 show another arrangement permitting adjustment of the distance between the rotor and the cutting blade. In this embodiment, the blocks 73 which are secured to the ends 78 of the piston rods 77 are secured directly to the cutting blades 23. The channel 54 acts as a support for such blades, but such blades are slidable with respect thereto. A plurality of spaced apart flange plates 81 extend longitudinally outward from channel 54 to provide further support for blades 23. It can be seen that with this construction the blades 23 themselves are movable forwardly and rearwardly with respect to the rotor to change the distance therebetween for the purposes discussed above. It will be appreciated that with this arrangement it may be necessary to adjust the vertical location of blade 22 by means of the hydraulic jack 59 or the draw bar 16 to assure that blade 22 is cutting to the required depth after its location relative to the rotor has been varied.

In some situations the teeth 27 and 27' will wear fairly rapidly due to the hardness of the material being pulverized and mixed. The length of such teeth therefore decreases, and to maintain the same distance between the teeth and the cutting blade it may be necessary to adjust the distance as described above. It will be further noted that while it is preferred that the cutting blade be adjustable in order to adjust the distance between the rotor and the blade, the location of the rotor may be made adjustable for the same purpose if desired.

In the use of certain materials for providing a stabilized bed for a traffic bearing surface, it is desirable to be able to mix the material being stabilized with a liquid at the time it is being pulverized and mixed by rotor 26. As is best illustrated in FIGS. 4 and 5, the apparatus of the invention includes a liquid distribution pipe 82 extending transversely between side walls 29 of carriage 21 at a location above the axis of rotation of rotor 26. Distribution pipe 82 is provided with a plurality of downwardly pointed orifices 83 spaced apart along its length. A suitable liquid, such as water, may be supplied to pipe 82 by means of a rearwardly extending flexible conduit 84 which is as shown in FIG. 1 in communication with tank trailer 19 hitched to the apparatus of the invention for movement therewith. A suitable pump (not shown) is mounted on tank trailer 19 for forcing liquid through conduit 84 and, hence, through orifices 83 of distribution pipe 82.

In the stabilization of a base for a traffic bearing surface, a layer of lime or cement 86 is first applied over the material with which it is to be mixed to form the stabilized base. In the environment illustrated in FIG. 2, the layer 86 is provided over an old traffic bearing surface, denoted by numeral 87. With some old traffic bearing surface compositions, it is desirable before the layer 86 is applied to rip up the old surface with a suitable ripping mechanism to facilitate its pulverization by the apparatus of the invention. Then the apparatus of the invention is utilized to mix the layer of stabilizing material 86 with the old traffic bearing surface 87 and the underlying soil to provide the stabilized base for the new surface. After passing between rotor 26 and cutting blade 22, the material will be discharged onto the surface from which it has been cut to provide a new top layer therefor. The apparatus of the invention includes means rearwardly of carriage 21 for leveling or smoothing the surface of the discharged material. That is, a leveling plate 88 is mounted on frame 11 transversely of the apparatus at a location immediately forward of wheels 12. The height of plate 88 relative to the apparatus can be adjusted by means of a hydraulic jack and linkage system 89 so that the height of the finished stabilized bed is controllable.

We claim:

1. A soil stabilizing and pulverizing apparatus comprising a vehicle adapted for travel over a material surface, a cutting and lifting blade mounted on said vehicle with a generally horizontally extending front cutting

edge located to cut a layer of said material from said surface and direct same rearwardly and upwardly over said blade, means for selectively altering the depth to which the cutting edge of said blade projects beneath the surface of said material to thereby change the thickness of the layer cut from said material, a mixing and pulverizing rotor mounted width-wise of said vehicle rearwardly of said cutting edge and having cutting teeth projecting generally radially outward from said rotor for engagement with the layer of material passed over said blade to chop and mix the same, the distance between the rotor teeth and said blade being adjustable independently of said blade depth to provide a selected maximum size to the particles of material discharged from between said rotor teeth and blade, and a feed roller mounted transversely of said vehicle above said cutting blade to assist said blade in feeding said layer of material rearwardly of said cutting edge and towards said rotor.

2. A soil stabilizing and pulverizing apparatus comprising a vehicle adapted for travel over a material surface, a cutting and lifting blade mounted on said vehicle with a generally horizontally extending front cutting edge located to cut a layer of said material from said surface and direct same rearwardly and upwardly over said blade, means for selectively altering the depth to which the cutting edge of said blade projects beneath the surface of said material to thereby change the thickness of the layer cut from said material, a mixing and pulverizing rotor mounted width-wise of said vehicle rearwardly of said cutting edge and having cutting teeth projecting generally radially outward from said rotor for engagement with the layer of material passed over said blade to chop and mix the same, the distance between the rotor teeth and said blade being adjustable independently of said blade depth to provide a selected maximum size to the particles of material discharged from between said rotor teeth and blade, and means for varying the location of said cutting blade in the general plane thereof and relative to said rotor to provide said distance adjustment.

3. The soil stabilizing and pulverizing machine according to claim 2 wherein said cutting blade includes a plate extending transversely of said vehicle and movable longitudinally relative thereto toward and away from said rotor to provide said distance adjustment.

4. The soil stabilizing and pulverizing machine of claim 2 wherein said rotor includes a rotor shaft extending transversely of said vehicle in a generally horizontal plane and a plurality of rotor discs spaced apart coaxially along said shaft and normal thereto, each of said discs having a plurality of equally spaced apart teeth projecting radially outward therefrom and towards said blade for engagement with said material, each of said teeth including a shank portion fitted within a channel shaped holder rigidly secured to the disc with which said tooth is associated, said tooth being secured within said holder by a split bolt passing through said holder and said tooth.

* * * * *