

Sept. 13, 1949.

A. E. MILLER ET AL
ROAD BUILDING MACHINE

2,481,679

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4 Sheets-Sheet 1

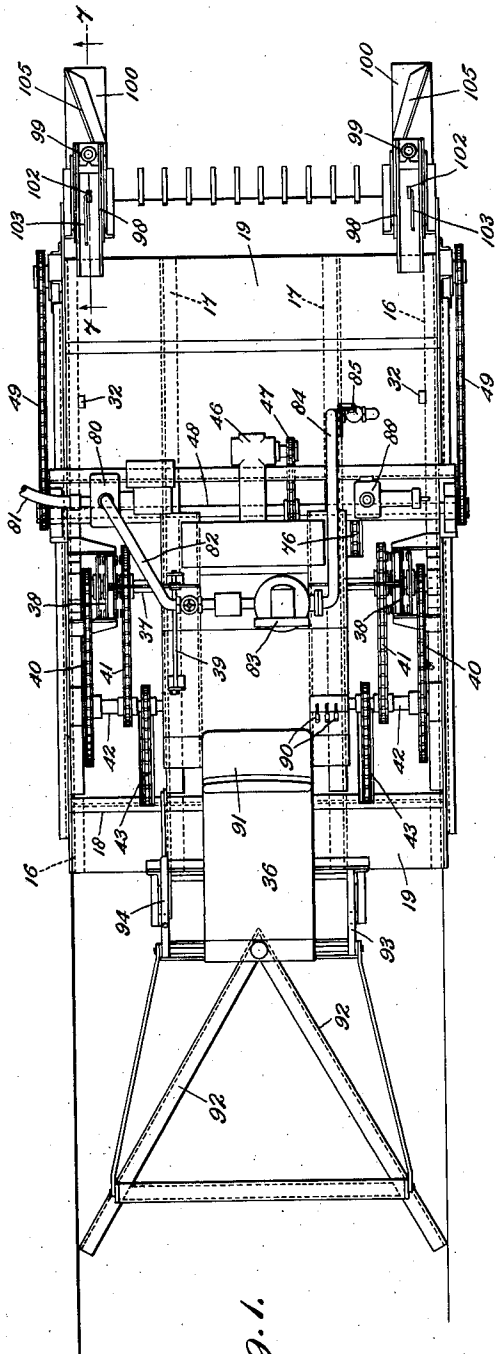


Fig. 1.

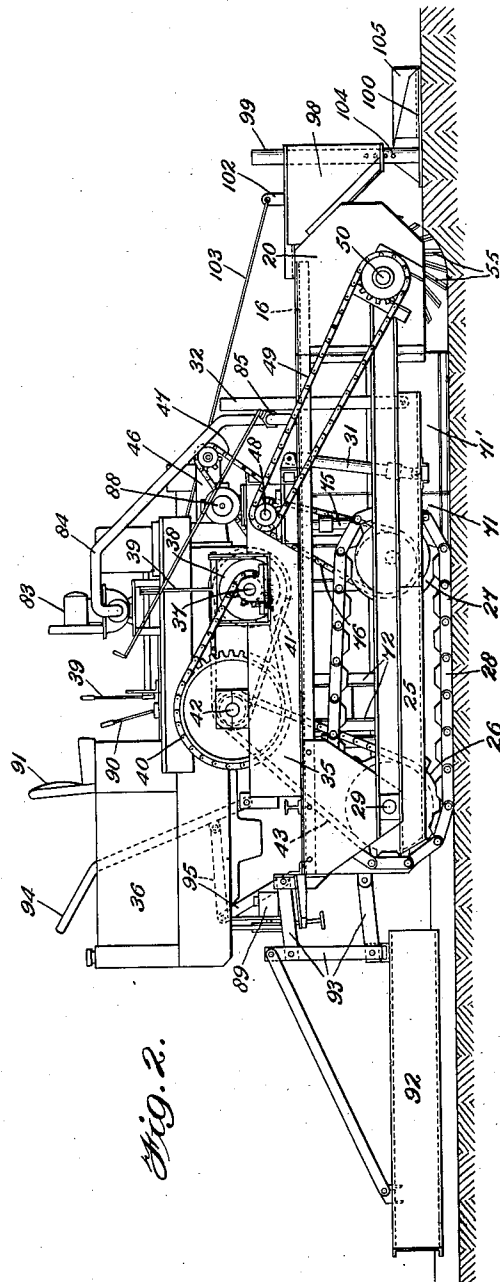


Fig. 2.

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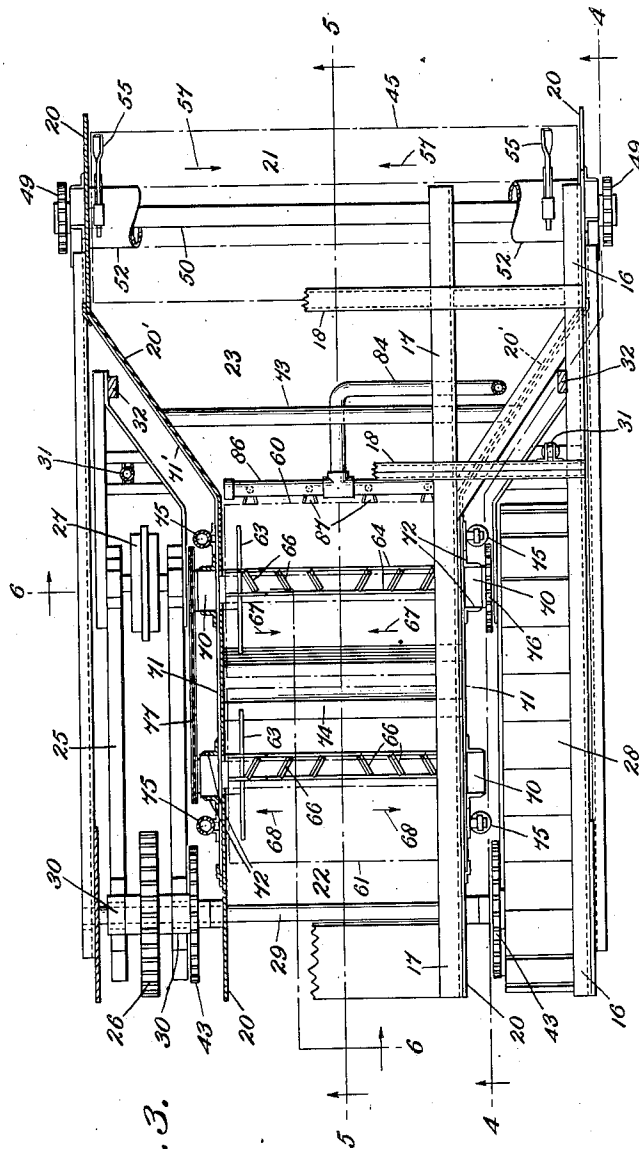


Fig. 3.

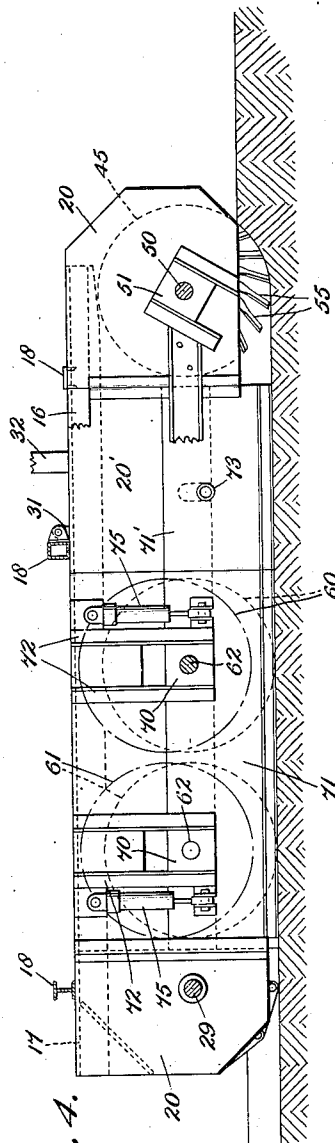


Fig. 4.

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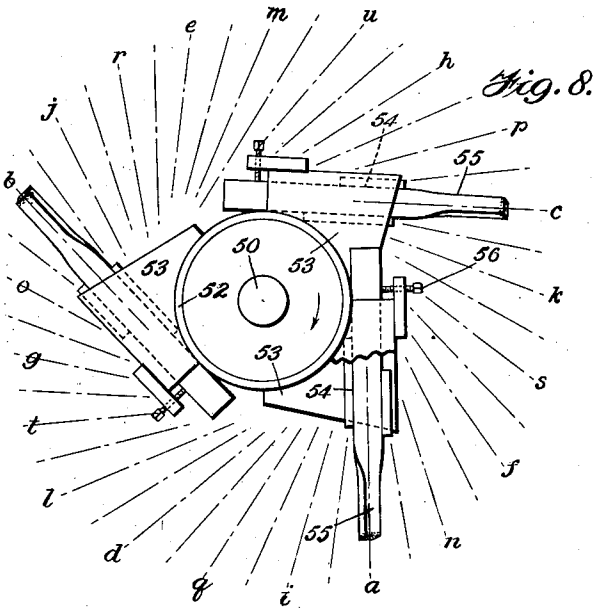
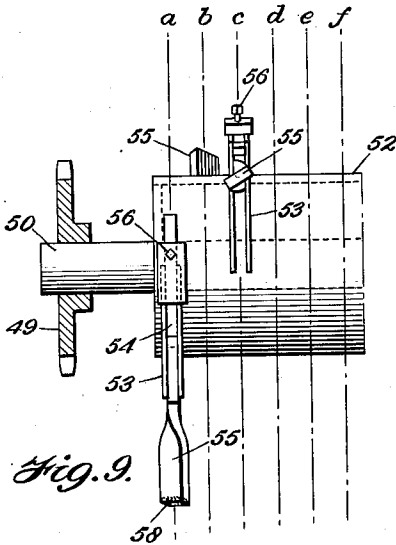
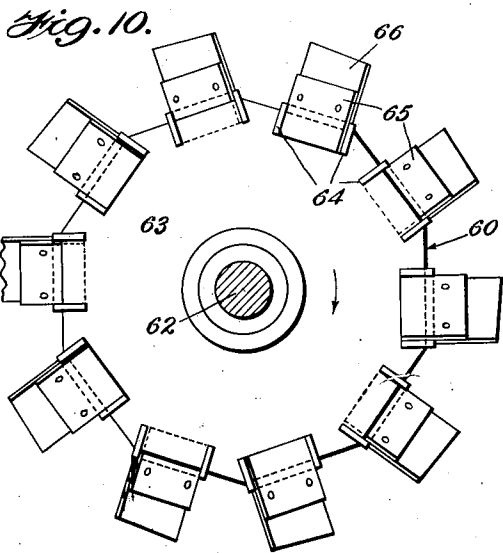
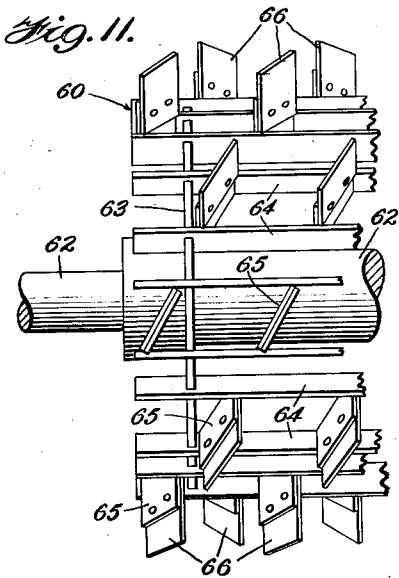
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ROAD BUILDING MACHINE

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2 Claims. (Cl. 94-44)

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The invention relates to road building machines, and has for its principal object the provision of an improved machine for use in the construction of "stabilized soil" bases for roads, pavements and the like.

Largely because at least a major portion of the materials necessary for the preparation of a stabilized soil road base is usually to be found on the right of way, this type of base has come to be recognized as particularly suitable for so-called "secondary" roads, since it can be constructed at materially less cost than can the concrete bases, which are deemed essential for high speed, heavy duty primary roads. While several modes of procedure, varying somewhat in detail, have been employed, in general the preparation of a stabilized soil road base has involved the loosening and substantial pulverization of the natural soil of the road bed, the thorough incorporation therewith of a binder such as Portland cement, an asphaltic or petroleum oil, etc., and the subsequent compacting and smoothing of the mixture, the entire operation being carried out while the soil, although loosened, remains substantially in place upon the road bed. Sometimes, if a preliminary study of the soil indicates that it is not wholly suitable for this type of work, additions in the form of sand and/or gravel, etc. are made to it previous to or simultaneously with the introduction of the binder. Occasionally all the materials used in stabilizing are hauled in and deposited on the road bed.

When the binder employed is Portland cement, this is usually distributed in its dry state as a substantially uniform layer or blanket on the soil, either before or subsequent to its loosening from the road bed, after which as thorough a mixture as possible of the soil, cement, and the water necessary for the hydration of the latter, is secured in various ways. Likewise, where an oil binder is used, it may be sprayed or otherwise deposited as uniformly as possible over the surface of the soil, and then dispersed throughout the latter by mechanical mixing; or the binder may be supplied to the soil substantially simultaneously with the excavation of the latter. In this case, as well as when either type of binder is supplied to the soil prior to the loosening thereof, at least a portion of the mixing of the soil and binder is accomplished as an incident to the excavation.

Any of the procedures just outlined may also be followed when it is considered necessary or desirable to add constituents such as sand, gravel and the like to the natural soil. In these cases, the additional materials are usually placed upon the soil surface before the binder is supplied.

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Sometimes when additional constituents are being added, instead of distributing them more or less uniformly over the surface of the soil, they together with the binder (particularly if it be cement) are deposited in the form of a long pile or windrow, from which they are dispersed and mixed with the soil incidental to the excavation of the latter. This mode of procedure is designated "working out of a windrow," whereas whenever the binder and/or added constituents are initially widely distributed over the soil surface, the procedure is known as "working out of the flat."

Various machines have been employed in carrying out the above mentioned operations. In some instances ordinary farm machinery, such as plows, harrows, disk cultivators and the like have been used to effect the excavation of the soil and the mixing of the added constituents and/or binder therewith. On the other hand, several specialized machines for carrying out one or both of these operations have been developed with the particular problems incident to the in situ preparation of stabilized soil road or pavement bases in mind. The present machine falls in the latter category.

One of the problems is to secure a finished base having a reasonably uniform composition. The soil is being worked from more or less its natural state, in view of which considerable variation in its character may occur within the width of the average road. For instance, at one side of the road bed the soil may be, say, a sandy loam, whereas a few feet away at the other side of the bed there may be a pocket of clay or gravel. While if sufficiently intermixed these different materials may result in an acceptable product, if they are merely mixed with a binder in the relative positions in which they are encountered, without any particular intermixing between themselves, the base will be of non-uniform composition with some portions being weaker than others.

The same undesirable result may follow from non-uniform placement of the binder and/or the added materials, when they are necessary. While effort is ordinarily made at reasonably uniform distribution of these constituents, whether in layer form blanketing the entire surface, or in windrow form, it is not always possible to secure this within practical limits of cost.

In the light of the above discussion, further primary objects of the invention are to provide a machine for soil stabilization road and pavement work which will both excavate natural soil and efficiently mix it with a suitable binder and additional aggregate materials if necessary; which

will work either "out of the flat" or "out of the window"; and which will produce a more uniform product by tending to eliminate the effects of non-uniform character of the soil and/or non-uniform distribution of the binder and/or added aggregate materials. Additional more or less secondary objects will appear as the description proceeds.

In the accompanying drawings forming a part of this specification, and illustrating a commercial exemplification of the machine:

Figure 1 is a plan view of a machine constructed in accordance with the invention;

Fig. 2 is a side elevational view thereof;

Fig. 3 is a plan view, partly in section and partly diagrammatic, of the lower portion of the machine, the view being taken approximately on the line 3—3 of Fig. 6;

Fig. 4 is a longitudinal sectional view on approximately the line 4—4 of Fig. 3, looking in the direction of the arrows;

Fig. 5 is an enlarged central longitudinal sectional, on approximately the line 5—5 of Fig. 3;

Fig. 6 is an end elevational view, partly in section on approximately the line 6—6 of Fig. 3;

Fig. 7 is a detail sectional view, on approximately the line 7—7 of Fig. 1;

Fig. 8 is an end elevational view, partly diagrammatic, of the excavating or disintegrating rotor;

Fig. 9 is an elevational view of the parts illustrated in Fig. 8, as seen from the right thereof;

Fig. 10 is an end elevational view of one of the mixing rotors; and

Fig. 11 is a fragmentary front elevational view thereof, as seen from the right of Fig. 10.

Referring more particularly to the said drawings, the machine has a main frame comprising longitudinal angle members 16 and 17 rigidly connected by transverse members 18 and top plates 19, and carrying depending side plates 20. The rearward portion of these side plates is carried by the inner pair of angle members 17 and the forward portion by the outer pair of angles 16, which rearward and forward portions are connected by angularly disposed intermediate portions 20', as will be clear from Fig. 3. The side plates 20 and top plates 19 thus provide a tunnel-like housing, having a relatively wide forward cutting or excavating chamber 21 and a narrower rearward mixing chamber 22 which chambers are connected by a converging portion 23.

This frame and tunnel structure is mounted for ground traverse by a pair of portable-track crawler units, disposed one at either side of the narrower rear chamber 22 of the tunnel. The units are more or less conventional, and each comprises a frame 25, a drive wheel 26, an idler wheel 27 and an endless track element 28. The plates 20 of the tunnel structure carry a non-rotating shaft or dead axle 29 the end portions of which project beyond the said plates and mount the rear ends of the respective crawler frames 25 by means of bearings 30. The forward end of each crawler frame carries a hydraulic jack 31 the upper end of which is attached to one of the transverse main frame members 18, and by admitting fluid to and releasing it from such jacks, the forward end of the main frame may be raised and lowered, such frame pivoting about the axis of shaft 29, as will be readily understood. Since the forward ends of the crawler units are not otherwise attached to the main frame, vertically extending guide members 32 are preferably pivotally attached to the crawler frames 25 and

extend upwardly through apertures in the top plate 19, whereby to preserve alinement of the crawler units relative to the main frame.

The main frame is surmounted by a superstructure 35 which carries, within a housing 36, an internal combustion engine which supplies power for all or most of the instrumentalities of the machine. Through conventional power transmitting gearing and manual controls therefor (not shown), this motor drives a countershaft 37, each end portion of which carries a double clutch device 38, see Fig. 1. These clutch mechanisms are simultaneously controllable by manually operable clutch shifting linkage 39, whereby to alternatively transmit power from the shaft 37 to one or the other pair of chain and sprocket drives 40 and 41 which in turn drive jack shafts 42. The relative sizes of the sprockets of the drives 40 and 41 are such that the latter drives 41 provide a higher speed than do the drives 40 with the result that the shafts 42 may be driven at either of two speeds, depending upon the setting of the clutch devices 38. A chain and sprocket drive 43 connects each jack shaft 42 with the drive wheel 26 of the corresponding crawler unit whereby the latter may be actuated from the motor to cause travel of the machine over the ground. Conventional controls (not shown) are provided for reversing the drive, and for independently breaking the drive to each crawler unit, whereby the direction of travel of the machine, forward and backward, and to right or left, may be varied at will.

Mounted in the wide forward portion 21 of the tunnel structure is an excavating or disintegrating rotor 45, arranged to be driven from the power plant 36 through a power take-off device 46, a chain and sprocket drive 47, a transverse shaft 48, and chain and sprocket drives 49. This rotor is indicated only diagrammatically in Figs. 3 and 5, but its construction will be readily understood from Figs. 8 and 9. It comprises a horizontal shaft 50, which is journaled in bearings 51 carried by the side plates 20, and which shaft has rigidly secured to it a concentric tubular member 52 of a length to extend substantially the full distance between the plates 20. Rigidly secured to the periphery of the member 52 is a plurality of tooth holders 53 having sockets 54 disposed substantially tangentially to the said periphery, for removably receiving and holding the cutting teeth 55, which may be retained in the sockets by set screws 56. The tooth holders 53 are staggered upon the tubular member 52, both longitudinally and circumferentially of the latter so that no two teeth 55 are disposed in either the same transverse or tangential plane. The circumferential lead of each tooth over the next adjacent one is preferably such as to result in the disposition of the cutting tips of the teeth in the form of a helix of relatively low pitch; and at least the cutting portions of the teeth are disposed at an angle to the plane of rotation, whereby to tend to move the severed particles of soil axially of the rotor as well as rearwardly. The teeth to one side of the longitudinal center line of the machine are set at an angle opposite to that of the teeth at the other side of said center line, whereby all teeth will tend to move the material inwardly toward said center line as indicated by the arrows 57 in Fig. 3. The teeth may be and preferably are tipped with a hard, wear-resisting material, as indicated at 58.

Disposed within the narrower rear chamber 22 of the tunnel structure is a pair of mixing

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rotors or drums 60 and 61. These are indicated rather diagrammatically in Figs. 3-6, with their construction being shown in detail in Figs. 10 and 11. As will be clear from these latter figures, these rotors comprise a horizontal shaft 62 which carries adjacent each end a disk 63. A plurality of pairs of longitudinal bars 64 are secured around the peripheries of these disks, thus forming a cage-like structure, and between each pair of such bars there is secured a plurality of axially spaced, angularly disposed blade supports 65 to each of which is removably secured a mixing blade 66. The open cage-like structure of these rotors permits the materials to pass or work to their interior whereby the bars 64 as well as the blades 66 may perform a mixing function, while by reason of their angularity with respect to their plane of rotation, the blades 66 will tend to impart axial as well as rearward movement to the particles of the material. The angularity of the blades to either side of the center line of the machine is reversed so that the blades will move the material in opposite axial directions; on the forward rotor 60 the blade angles are such that the axial component of movement of material is from each end of the rotor toward the machine center line, as indicated by the arrows 67 in Fig. 3, while on the rearward rotor 61 the blade settings are such as to tend to move the material outwardly from the center line, as indicated by the arrows 68.

The ends of rotor shafts 62 are journaled in bearing blocks 70 carried by the side walls or plates 71 of a rotor box or frame, which blocks are slidably mounted in guides 72 carried by the main frame or tunnel plates 20. The rotor box plates 71 are braced transversely by cross members 73 and 74, and the box and its rotors 60 and 61 are vertically adjustable in the guides 72 by means of hydraulic jacks 75, whereby the position of the rotors relative to the cut grade may be varied within the limits indicated by the dotted and broken lines in Fig. 4. The shaft 62 of the forward rotor 60 is driven from the transverse shaft 48 by a chain and sprocket drive 76, while the rear rotor 61 is driven from the forward one, preferably at a slightly higher speed, by a chain and sprocket drive 77. The mixing rotors 60 and 61, as well as the excavating rotor 45, all turn in a clockwise direction, as viewed in Figs. 4 and 5.

For supplying the water necessary for hydration of the cement when the latter is used as the binder, a centrifugal pump 80 is provided, see Fig. 1. A hose 81 leading from any available source of supply, is connected to the inlet side of this pump, while a pipe 82 leads from the discharge side thereof to a volume meter 83. From this meter the water is conducted by a pipe 84 having a control valve 85 to a header or manifold 86 disposed adjacent the front mixing rotor 60 (see Figs. 3 and 5) which header is provided with a plurality of jets or spray nozzles 87 which discharge the water against the said rotor. The machine is also equipped with a gear pump 88 which may be used in lieu of the water system just described when oil is employed as the binder.

A pump 89 (see Fig. 2), driven directly from the motor, is provided for supplying fluid under pressure for operating the jacks 31 and 75. The connections between this pump and the jacks, and the valves for controlling the same, are not shown, as they are conventional and form no part of the invention. However, the control valves may be manually actuated by levers 90 located adjacent the operator's seat 91.

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As the machine moves forward, i. e. from left to right as viewed in Figs. 1-5, the rotor 45 will excavate and disintegrate the soil, throwing the particles thereof, and of the cement and any additional materials which may have been deposited on the surface in either blanket or windrow form, rearwardly and inwardly toward the longitudinal axis of the machine. Any portions of the materials which are not thus moved sufficiently inward will be engaged by the converging portions 20' of the tunnel plates 20, and/or the complementary portions 71' of the rotor box plates 71, and all of the material will thus be caused to enter the narrower mixing chamber 22. This in effect creates a windrow within the machine, regardless of whether it is working "out of the flat" or "out of a windrow." While in this condition the materials are acted upon successively by the mixing rotors 60 and 61, with the necessary water being supplied in metered quantities as the materials reach the first of these rotors. By reason of the transverse inward movement of the material particles secured by the action of the excavating rotor 45, the converging walls 20' and 71', and the angularly disposed blades 66 of the rotor 60, followed by the transverse outward movements imparted by the blades of the rotor 61, a thorough interchange and mixing of the materials is obtained which tends to overcome the normal effect of transverse variations in the composition of the soil and/or in the distribution of the cement and added materials, thereby producing a mixture which is substantially uniform throughout.

This mixture emerges from the rear of the tunnel in more or less of a windrow, and in order that it may be spread to the full width of the cut made by the rotor 45, a spreader comprising an A-frame 92 is attached to the rear of the machine. This spreader is supported by a parallel link arrangement 93 through which it may be raised and lowered as desired by means of an operating lever 94 and linkage 95. Ordinarily the spreader will occupy substantially the position shown in Fig. 2, but if for any reason it should be desired to leave the mixture in windrow form, the spreading frame may be raised by the lever 94 to clear the material leaving the tunnel. The spreader of course will also be raised when the machine is traveling to or from a job.

The depth to which the cutter 45 works, and consequently the volume of material passed through the machine, may be varied at will through the tilting of the main frame and superstructure about the axle 29 by means of the jacks 31, whereby the front end of the machine together with the rotor 45 may be raised and lowered. This may be accomplished through manipulation of the valve controlling the said jacks by the operator, but since he may have numerous other duties to perform, it is desirable to provide an automatic control in addition to the manual control for the jacks 31. Such additional control is of importance also from the standpoint of maintaining a substantially constant volume of material passing through the machine, which is usually desirable. That is to say, the ground surface in advance of the machine may be quite uneven, with alternating elevations and depressions, and since the crawler units are disposed adjacent the narrower portion of the tunnel structure, they travel on the substantially even surface of the grade cut by the rotor 45 and thus tend to advance such rotor

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in a relatively straight line. It is obvious however, that if the rotor be so advanced, it will cut less material upon encountering a depression, and more material upon encountering an elevation, and thus the volume cut and supplied to the mixing rotors 60 and 61 might vary widely. If the binder supplied be approximately uniform, such variations in aggregate volume will also result in a non-uniform product.

As will be best understood from Figs. 1, 2 and 7, the automatic control here provided comprises a pair of frame extensions 98 projecting forwardly from the main frame or tunnel structure, and having vertical posts 99 slidably mounted therein, which posts are provided at their lower ends with plates or shoes 100 adapted to rest upon and slide over the surface of the ground in advance of the cutter 45. Each post carries an arm 101 which is connected to one arm of a bell-crank lever 102 mounted in the extension frame 98, the other arm of which lever is connected by a rod or cable 103 to the valve which controls the jacks 31. The posts 99 and shoes 100 serve as pilot or feeler devices which are responsive to unevennesses in the ground surface ahead of the machine, and thus, if one of the shoes 100 encounters a depression or an elevation in the ground surface, its post 99 will fall or rise accordingly and through the connections 101, 102 and 103 will actuate the valve to cause the jacks 31 to lower or raise the forward end of the machine, resulting in a corresponding change in the position of the cutter and maintenance of substantial uniformity in the volume of material excavated by the latter and fed to the mixing rotors.

The vertical posts 99 are also provided with a longitudinally arranged series of apertures 104 so that in instances where the automatic control is not necessary, the front end of the main frame may be supported by pins (not shown) which are inserted through the aperture giving the desired amount of depth to the cut. When so operating the rods 103 are disconnected and the cylinders 31 cut out of the hydraulic system, whereupon the frame will lower until the entire weight of its forward end is supported by the shoes 100. As the machine progresses forwardly, elevations or depressions in advance of the base being cut will cause a corresponding raising or lowering of the cutter 45, provided the base in advance of the machine is sufficiently compacted to support the shoes and the weight which they carry. Where the road bed is not sufficiently compacted it is preferable to employ the automatic system previously described. The broad soles on the shoes 100 distribute the weight when operating as frame supports rather than as "feelers."

In still a third instance and particularly where all the material is hauled in and deposited, say on an old macadam or other hard base, it may be desirable to support the front rotor 45 so that the depth of its cut is controlled not by the surface of the material added to the old road, but rather by the elevation of the old road itself, thereby insuring that the cutting elements will not dig into the old base but will work substantially all the material on the base. In this instance, sufficient of the added base material is removed in the locality of the shoes to permit lowering of the shoes until they rest on the old road bed or hard base. Pins are then inserted in the apertures 104 and the hydraulic pressure is cut off from the cylinders 31 so as to cause the main frame to rest

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on the shoes. As the machine progresses, the plow blades 105 which have sharp narrow forward edges cut through the added material, the soles of the shoes resting on the base at all times. By converging the blades 105 toward the rear, the material in the path of each shoe 100 is brought into the path of the cutter 45.

Whether the shoes 100 operate as pilot or feeder devices controlling the hydraulic jacks 31, or as supports which ride either on the surface of the material to be removed and mixed, or on the surface of some base below which it is not desired to cut, in any instance the shoes function to control the depth of the action of the rotor element 45 responsive to elevations or depressions encountered by the machine.

After passage of the machine the mixture left thereby may be compacted and smoothed in any desired manner by appropriate apparatus.

What is claimed is:

1. In a machine for progressively preparing a stabilized-soil base for roads and pavements, the combination of a housing having a pair of tandem communicating chambers; means supporting said housing for ground traverse; a rotor journaled in the forward chamber crosswise thereof and provided with an axially extending series of soil-disintegrating teeth each having a portion disposed at an angle to its path of rotation, the angularity of all teeth to one side of the median plane of the rotor being opposite to that of the teeth to the other side of said plane; whereby the teeth tend to move all soil toward such plane; a pair of mixing rotors journaled in the rearward chamber crosswise thereof and in tandem, each of which rotors is provided to each side of its median plane with a set of spaced mixing blades disposed at an angle to their paths of rotation, the angularities of the sets of blades on the forward rotor being opposite to one another and such that the blades tend to move the soil away from the median plane of such rotor, while the angularities of the sets of blades on the rearward rotor are opposite to one another and such that said blades tend to move the soil toward the median plane; means for driving the rotor in the forward chamber; and means for driving the mixing rotors at speeds different from one another.

2. In a machine for progressively preparing a stabilized-soil base for roads and pavements, the combination of a housing having a pair of tandem communicating chambers; means supporting said housing for ground traverse; a rotor journaled in the forward chamber crosswise thereof and provided with a helical series of soil-disintegrating teeth each having a portion disposed at an angle to its path of rotation, the angularity of all teeth to one side of the median plane of the rotor being opposite to that of the teeth to the other side of such plane, whereby the teeth tend to move all soil toward said plane; a pair of mixing rotors journaled in the rearward chamber crosswise thereof and in tandem, each of which rotors is provided to each side of its median plane with a set of helically spaced mixing blades disposed at an angle to their paths of rotation, the angularities of the sets of blades on the forward rotor being opposite to one another and such that said blades tend to move the soil away from the median plane of such rotor, while the angularities of the sets of blades on the rearward rotor are opposite to one another and to those of the complementary sets of blades on the forward rotor; means for driving the rotor in the forward chamber; and means for driving

both mixing rotors in the same direction, the rearward one at a speed higher than that of the forward one.

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