

Feb. 2, 1937.

M. MADSEN

2,069,376

APPARATUS FOR PRODUCING MINERAL AGGREGATE ROADS

Filed Dec. 3, 1932

3 Sheets-Sheet 1

Fig. 5.

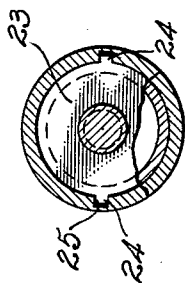
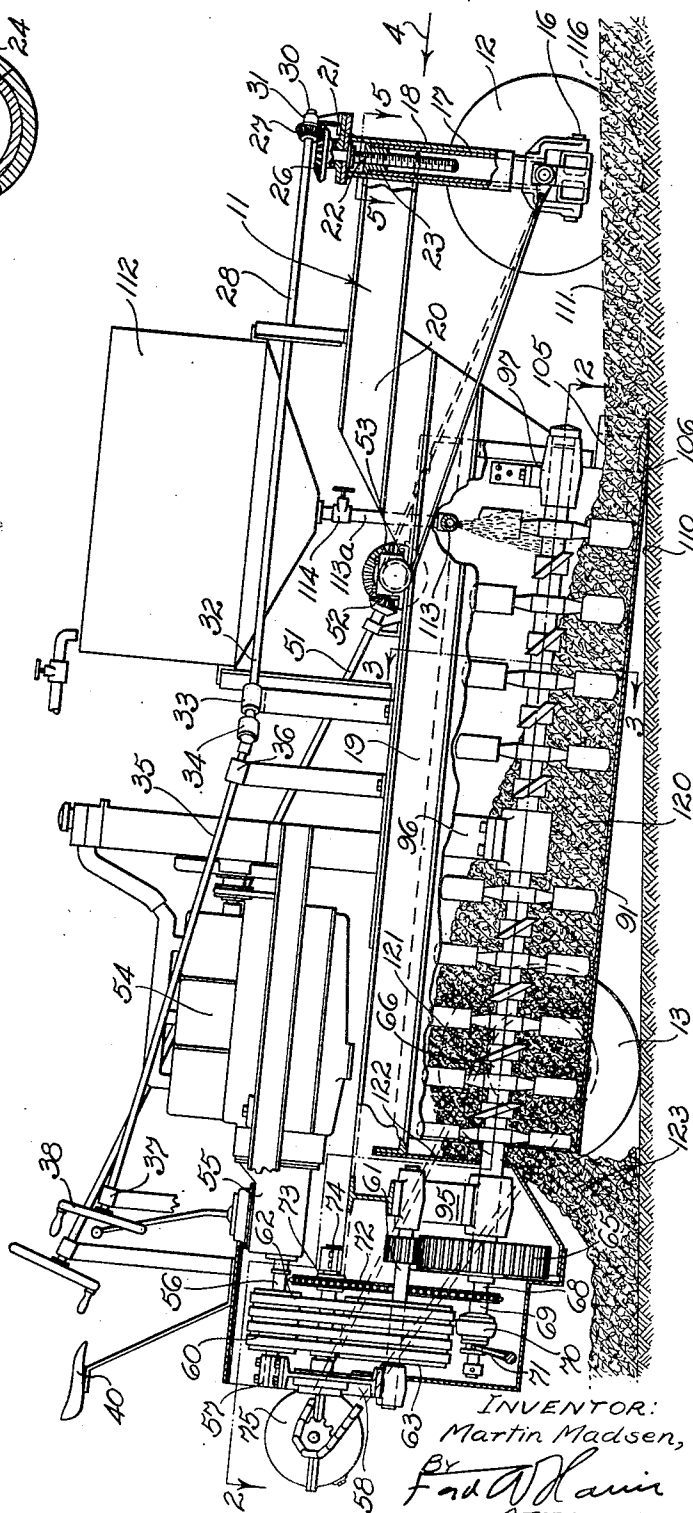


Fig. 1.



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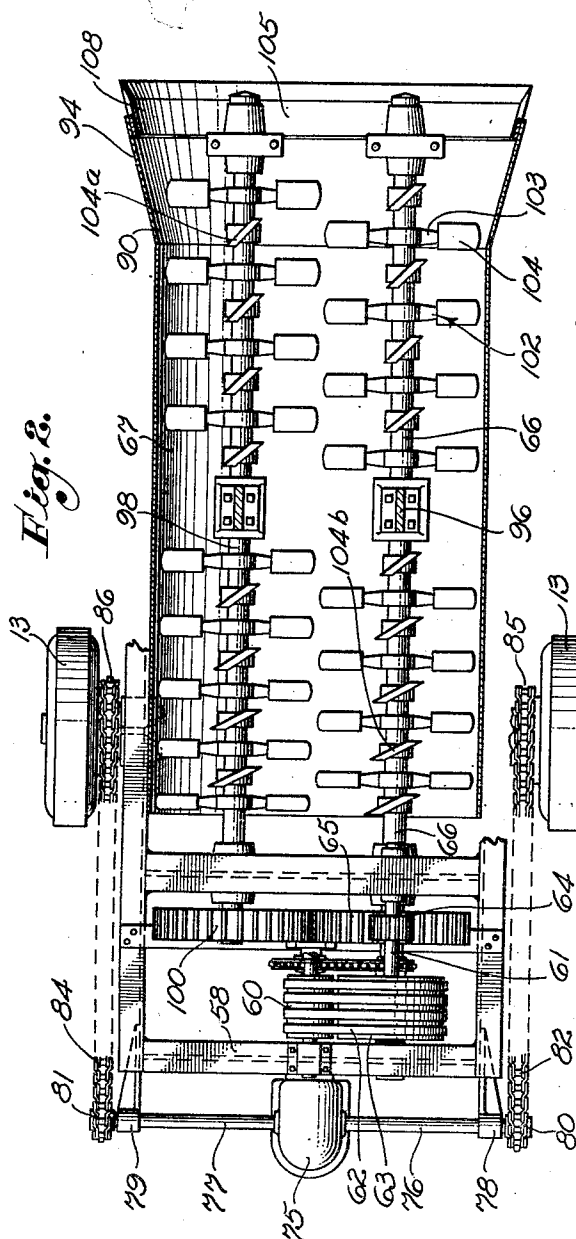
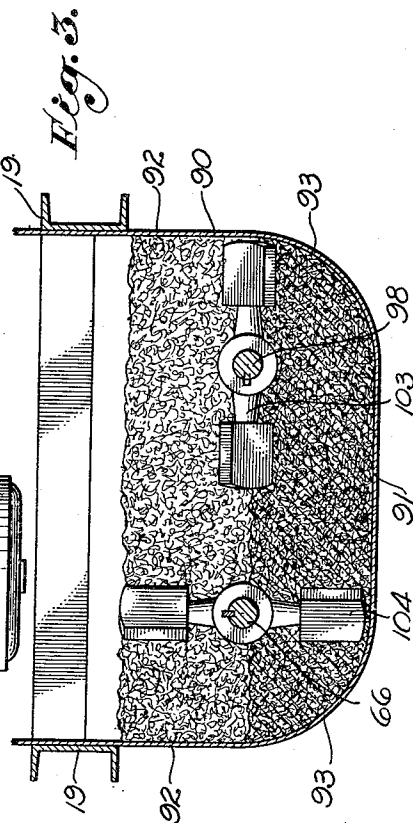
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3 Sheets-Sheet 2



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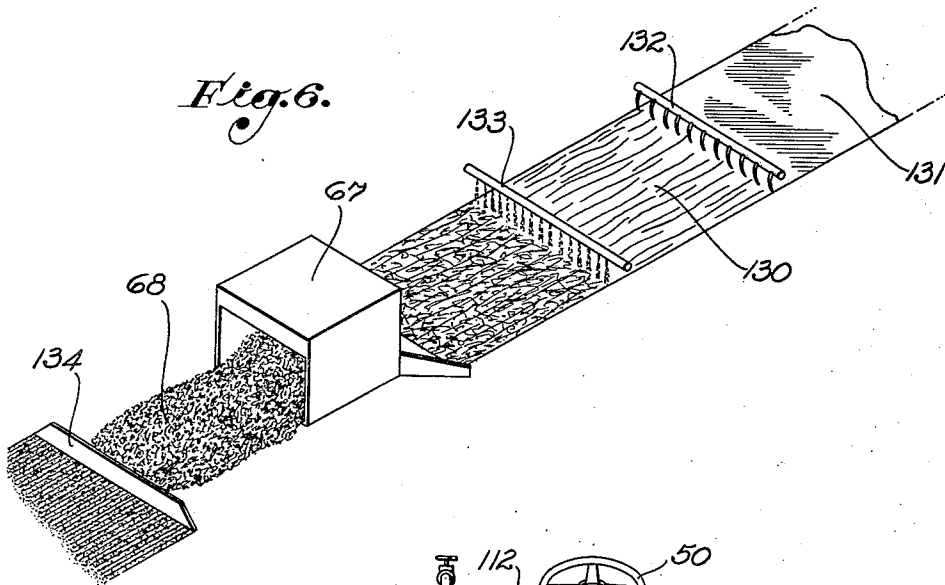
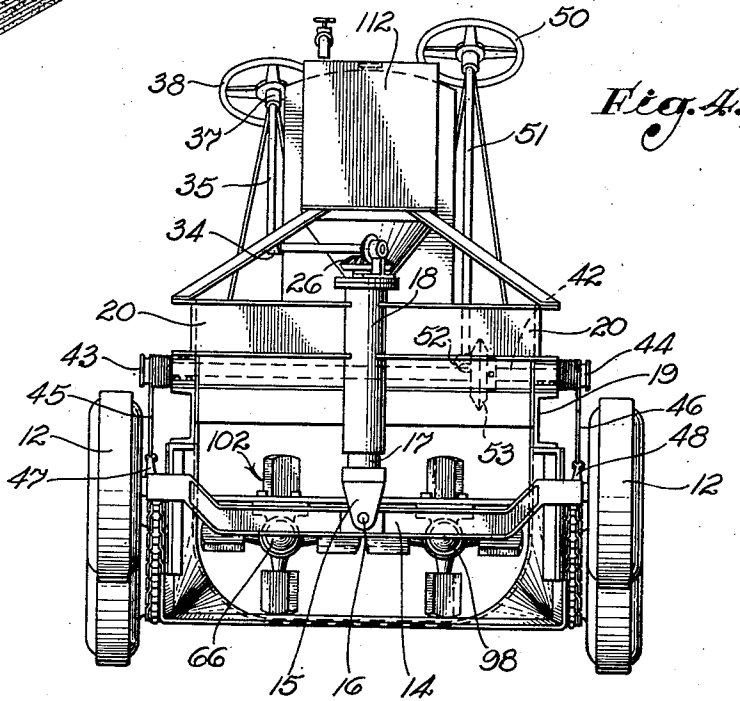
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APPARATUS FOR PRODUCING MINERAL AGGREGATE ROADS

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,069,376

APPARATUS FOR PRODUCING MINERAL
AGGREGATE ROADS

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Application December 3, 1932, Serial No. 645,499

18 Claims. (Cl. 94-41)

My invention relates to a device for making
surfaces of macadam character wherein ag-
gregate materials such as earth, clay, gravel, or
crushed rock are combined with a bituminous
material such as asphalt or road oil, and relates
particularly to a machine for making roads
either from the aggregate materials present in
the surface mixture from which the road is to
be made or from aggregate materials which are
obtained from other sources.

My invention comprehends a simple but su-
perior method and apparatus adapted to re-
place the methods and apparatus at present
employed in road construction. Some roads
are made or resurfaced by scarifying the road
surface and then applying a coating of oil which
is either left to soak into the divided materials on
the road surface produced by scarification or
mulching thereof, or a layer of sand or gravel
or both may be spread over the oil. Roads of
this character are very temporary in their na-
ture owing to the fact that the bonding effect
of the road oil or asphalt penetrates only the
surface structure of the road. Other methods
employed include the mixing of asphalt ma-
terials with aggregate materials at a plant
situated at more or less distance from the place
of road construction, the road surfacing ma-
terial thus formed being spread over the road
surface and rolled down to a finished condition.
My invention provides a portable structure com-
prising a vehicle having means whereby it may
be driven slowly along the road which is to be
made or a road which is to be resurfaced, this
device having a mill adapted to pick up aggre-
gate material from the road surface and to
thoroughly mix and knead the material with a
binder such as heavy road oil or asphalt and
to discharge the mixture again to the road sur-
face whereby it may be spread and rolled to
produce a road structure of relatively durable
character at a minimum cost and with a mini-
mum expenditure of time. The divided ma-
terials or aggregate which are taken into the mixer
may be formed by scarifying the surface of a
road which is to be refinished so as to break up
the materials constituting the road surface into
such small sizes that they will enter the mixer.
As the device is moved slowly along the road
these materials are delivered into the mixer
and a proper quantity of binder is added thereto,
with the result that the mixed materials deliv-
ered from the mixer to the road surface are of
proper consistency and are thoroughly mixed
together, so that a road surface structure of

maximum durability is obtained. Although it
is preferable to add the binder to the divided
aggregate materials as they enter the mixer or
mill, such binder may, of course, be applied to
the aggregate by spraying road oil along the
path ahead of the movement of the machine.
To the divided materials produced by scarify-
ing the surface of the road reinforcing ma-
terials such as sand, gravel or crushed rock may
be added so that a better consistency of road
surfacing materials is produced. As a further
alternative all of the materials entering into
the surface structure of the road may be brought
from distant points and placed in windrows or
continuous ridge-like piles along the path of the
road to be made.

The machine hereinafter disclosed is capable
of a forward speed of twenty-two feet per minute
and of handling nine cubic yards of aggregate
materials for each one hundred feet of forward
movement, this permitting the completion in
one eight-hour day of one mile of full width
roadway of eighteen cubic yards of road sur-
facing materials per each one hundred lineal
feet at a cost much lower than the present cost
of producing a road structure of the same
strength, quality and durability.

Accordingly, it is an object of my invention
to provide a machine whereby my simple road
making method may be employed, having a mix-
ing mill supported by a vehicle, and simple
means for delivering the divided materials from
the road surface into the mixing mill.

It is a further object of the invention to pro-
vide a road making machine of the above char-
acter having an improved and novel device for
mixing the divided materials with a very thor-
ough kneading action, whereby a complete inter-
mixture of the divided materials with the binder
is obtained.

It is an object of the invention to provide a
mixing mill or pug mill adapted to receive ma-
terials to be mixed at one end thereof and to
transport the materials to the other end of the
mill during the mixing thereof. It is an impor-
tant object of this invention to provide therein
means for bringing the divided materials pres-
surally together during the mixing action, where-
by to obtain the improved mixing effect present
in my device.

A further object of the invention is to provide
a pug mill of the above character having mixing
vanes or paddles placed at varying angles to the
lines of movement thereof, so as to accomplish
the forcing of the materials being operating on

into coengagement with sufficient pressure to produce a thorough kneading of the mix.

Further objects and advantages will be brought out in the following part of the specification and will be shown in the drawings in which:

Figure 1 is a partly sectioned side elevation of a preferred embodiment of my invention.

Figure 2 is a horizontal section taken substantially as indicated by the line 2—2 of Fig. 1.

Figure 3 is an enlarged cross-section on a plane represented by the line 3—3 of Fig. 1.

Figure 4 is an end view looking at the front end of Fig. 1 along an upwardly sloping line, as indicated by the arrow 4 of Fig. 1.

Figure 5 is a cross-section on a plane represented by the line 5—5 of Fig. 1.

Figure 6 is a diagrammatic perspective view illustrating my new method of making surface structures of the character herein described.

The preferred form of a machine embodying my invention and for exemplifying my new road making method includes a vehicle 11 having means for permitting movement thereof, such means being represented by front wheels 12 and rear wheels 13. As shown in Figs. 1 to 4 the front wheels 12 are carried by an axle 14 mounted so that it may rotate relative to a vertical axis for steering purposes and may rotate relative to a longitudinal axis for adjustment of the wheels to uneven road surfaces. For this purpose a forked member 15 or clevis is secured centrally to the axle 14 by means of a longitudinal pin 16, this clevis being secured to the lower end of a cylindrical member 17 which projects upwardly into a cylindrical column 18 mounted in a substantially vertical position at the forward end of horizontal frame members 20 of the vehicle, which may readily consist of structural channels mounted in converging relation at the forward ends of horizontal channels 19 and being secured to the column 18 by some such suitable means as welding. The upper end of the column 18 is provided with a cap or head structure 21 through which a vertical screw 22 extends into engagement with a threaded body 23 which is vertically slidable in the column and is prevented from rotation within the column 18 by interengagement therewith, as represented in Fig. 5, by radial projections 24 which extend into vertical grooves 25 in the inner face of the column 18. The upper end of the post 17 rests against a lower face provided by the threaded body or nut 23, and by rotating the screw 22 the column 18 may be vertically moved relative to the post 17 so as to raise or lower the forward end of the vehicle 11 for purposes which will be hereinafter explained. Rotation of the screw 22 is accomplished through the use of a bevel gear 26 mounted on the upper end of the screw 22 and adapted to be engaged by a bevel pinion 27 secured to a longitudinally extending shaft 28, the forward end 30 of which is supported by a bracket bearing 31 which extends upwardly from the head 21. The shaft 28 has its rearward end 32 supported in a bearing 33, and is connected through a universal joint 34 with a shaft 35 supported by bearings 36 and 37 and having a handle or hand wheel 38 at the rearward end thereof in position to be operated by the driver of the vehicle who occupies a driver's seat 40 situated at the rearward end of the vehicle 11. A cross shaft 42 extends between the channels 19 of the vehicle frame and has drums or spools 43 and 44 at the ends thereof on which cables 45 and 46 are respectively wound, the forward ends of these

cables being connected to attachment means 47 and 48 at the respective ends of the axle 14. One of the cables is wound clockwise and the other is wound anti-clockwise so that one cable will wind and the other will unwind when the shaft 42 is rotated, thereby producing a steering rotation of the axle 14 relative to a vertical axis. The shaft 42 is rotated by turning a hand wheel 50 disposed in proximity to the driver's seat 40 and on the forward end of the shaft 51 which has a bevel pinion 52 at its forward end engaging a bevel gear 53 mounted on the shaft 42.

For propelling the vehicle 11 a combustion motor 54 is shown which, through a selective transmission mechanism 55 of standard automotive type, drives a rearwardly projecting shaft 56 supported at its outer end by a bearing 57 carried on the upper face of a cross frame member 58 of the vehicle frame, which may be formed from a structural I-beam. On the shaft 56 is a grooved pulley 60 which drives a jack shaft 61 through the use of V-belts 62 which extend over a larger V-grooved pulley 63 mounted on the shaft 61, set to one side, as shown in Fig. 2, so that a pinion 64 thereon will engage a gear 65 mounted on the rearward end of the left hand shaft 66 of the mixing or pug mill 67. Extending rearwardly from the gear 64 is a shaft 68 rotatably carrying a sprocket 69 thereon adapted to be engaged by a clutch mechanism 70 carried by and rotating with the shaft 68. A shift yoke 71 is shown in Fig. 1 for operation of the clutch 70, it being understood that this shift yoke is to be manipulated by the driver through the use of a shift lever of standard form. Through a chain 72 the sprocket 69 drives a sprocket 73 keyed to a horizontal shaft 74 which projects rearwardly into a differential 75 mounted on the cross member 58. The differential has shafts 76 and 77 extending laterally therefrom and through bearings 78 and 79. Sprockets 80 and 81 on the outer ends of the shafts 76 and 77 drive chains 82 and 84, which extend over sprockets 85 and 86 associated with the right hand and left hand rear wheels 13 of the vehicle. It will be noted that the drive arrangement between the power source 54 and the rear wheels 13 provides a large speed reduction so that the vehicle 11 may be propelled forwardly at a very slow speed such as necessary in the making of a road in accordance with the method herein disclosed. An initial speed reduction is accomplished in the selective transmission 55, this being subsequently multiplied through the belts 62, the gears 64 and 65, the chains 72 and 82 and 84.

The pug mill 67 is swung below the side channels 19 of the vehicle 11 and includes a body or shell 90 which may be readily formed from sheet steel bent to provide an essentially flat bottom 91 and side walls 92 which meet the bottom portion through curved portions 93. The forward end of the shell 90 may be laterally flared, as shown at 94 in Fig. 2. By means of downwardly extending brackets 95, 96 and 97 the shaft 66 is rotatably supported at one side of the shell and a second shaft 98 is supported at the opposite side of the shell, this shaft 98 having a gear 100 at its rearward end which meshes with the gear 65 so as to rotate in unison therewith but in an opposite direction. Along the length of each shaft 66 and 98 mixing members 102 are mounted, these members having radially extending arms 103 with paddles 104 mounted at the extremities thereof. Means are provided for delivering divided materials into the forward end of the pug

mill 67, such means being in the form of a replaceable steel blade 105 which is secured to and projects forwardly from a lip 106 of the shell. The blade 105 is essentially straight and horizontal, with the exception of the end portions 108 thereof which are curved upwardly. The cutting plane 110, Fig. 1, of the blade 105 is adjusted relative to the surface 111 on which the front wheels 12 roll by raising or lowering the forward end of the vehicle frame through rotation of the screw 22 in the manner previously described.

The vehicle 11 may be provided with a reservoir 112 for containing a binder material consisting of an asphalt oil or tar substance such as employed in roadwork. The spray means 113, which may consist of a horizontal perforated pipe, is connected to the reservoir 112 through piping 113a having a control valve 114 therein.

A use of the invention may be as follows:

If a road is to be refinished without the addition of new materials other than the tar or oil binder, the surface of such road is first scarified and hardened or disked so that the materials previously forming the surface structure of the road are broken up into relatively fine form. These divided road materials are then preferably formed by the use of scrapers into several longitudinal ridges or windrows extending lengthwise with respect to the road. If the road is eighteen feet in width, the divided materials are formed into two windrows, one on each side of the road. The machine shown in the drawings is then propelled along a path of movement coinciding with a windrow and in such position that the windrow, as indicated by dotted lines 116 in Fig. 1, extends between the forward wheels 12 and in the line of forward movement of the pug mill 67. The blade 105 being adjusted to proper depth will cut under the windrow as it is moved forwardly, thereby directing the divided materials into the forward end of the pug mill 67 where it is engaged, mixed and moved rearwardly by the action of the mixing members 102. The spraying means 113 is preferably situated so that it will spray the divided materials with oil or tar substance as they enter or just after they enter the forward end of the pug mill. It will be recognized that if a heavy tar is employed it may be desirable to use heat to fluidify the same before it is sprayed onto the divided materials.

An improved feature of my pug mill resides in its ability to very thoroughly knead and mix the divided materials by forcing these materials and rolling and churning them in pressural contact. This I accomplish by decreasing the angularity of the blades 104 toward the rearward end of the pug mill. For example, the blades indicated at 104a at the forward end of the pug mill are turned into diagonal positions of approximately 45° relative to their circular lines of movement about the shafts 66 and 98. As clearly shown in Figs. 1 and 2, the angles of the blades 104 are gradually decreased relative to the planes in which they move so that the driving or propelling effect thereof is reduced toward the rearward end of the pug mill. As will be noted, the blades indicated at 104b are swung to angles of approximately 20° relative to their planes of movement. This variation in the angles of the blades or paddles 104 causes the movement of the divided materials, as shown at 120, to be retarded toward the rearward end of the pug mill 67 so that the height of the mass of divided materials builds up to considerable depth at a point 121 near the rearward end of the pug mill. The

rearward movement of the materials is also resisted by the use of a lateral wall 122 which extends downwardly at the rearward end of the pug mill and protects the gear mechanism through which the shafts 66 and 98 are driven. As shown at 123 the thoroughly mixed road material formed of divided materials and the impregnating substance are delivered to the road surface, where they may be thereafter levelled off by use of scrapers and rolled to a desired finish.

The foregoing method may be varied by the addition of aggregate materials to the divided materials formed by the breaking up or scarification of the previous surface structure of a road; for instance, to the divided materials, sand, gravel or crushed rock may be added to improve the properties of the road-forming composition delivered from the pug mill of the machine. As a further alternative the entire surface structure of a road may be formed from new materials which are placed along the path which the road is to follow and are picked up and mixed with a binder by the machine, to be subsequently delivered from the machine in condition to be spread out to form a road structure.

The process is simply illustrated in the perspective diagram of Fig. 6 in which a layer of divided materials 130 is formed along a path 131 as by the use of a scarifier 132 to break up existing road materials or by the addition of new road materials. Oil or tar substance of suitable character is then applied to the divided materials. For this purpose an oiler 133 is illustrated which may be moved along a head of a continuous mixer 67 which is adapted to deliver a composition 68 suitable for formation into a surface structure of a road by being subsequently spread thereover through the use of a scraper or leveller 134. The thickness of the road structure may be varied as desired by varying the volume of divided materials for a given width of road and by controlling the speed of the vehicle 11 to accommodate the volume of materials continuously delivered by the blade 105 into the forward end of the pug mill 67.

The features of my invention are readily embodied in an apparatus which is moved by a separate tractive vehicle, or in one having a caterpillar drive. These details may be changed to suit conditions or preferences.

Although I have herein shown and described my invention in simple and practical form, it is recognized that certain parts or elements thereof are representative of other parts, elements, or mechanisms which may be used in substantially the same manner to accomplish substantially the same results; therefore, it is to be understood that the invention is not to be limited to the details disclosed herein but is to be accorded the full scope of the following claims.

I claim as my invention:

1. A road making machine of the character described, including: a vehicle; means for propelling said vehicle; a mixing mill carried by said vehicle, said mill comprising a shell forming a channel having inlet and outlet openings at its opposite ends and a mixing member rotatable on a longitudinal axis in said channel, said mixing member having spirally disposed blades radially projecting relative to said axis, the angles of spiral of said blades being decreased at a position toward the rearward end of said mixing member; and means for operating said mill, there being means for delivering road materials

from the road to said mill, said mill delivering the mixed materials to the road surface.

2. A road making machine of the character described, including: a vehicle; means for propelling said vehicle; a mixing mill carried by said vehicle, said mill comprising a shell forming a channel having inlet and outlet openings at its opposite ends and a mixing member rotatable on a longitudinal axis in said channel, said mixing member having spirally disposed blades radially projecting relative to said axis, the angles of spiral of said blades being gradually decreased from maximum to minimum respectively from the forward end to the rearward end of said mixing member, said mill having a wall adjacent said outlet opening for holding back the movement of material at the rearward end of said mill; and means for operating said mill, there being means for delivering road materials from the road to said mill, said mill delivering the mixed materials to the road surface.

3. A pug mill of the character described, comprising: a shell forming a channel having inlet and outlet openings at its opposite axial ends; and a mixing member rotatable on a longitudinal axis in said channel, said mixing member having spirally disposed blades radially projecting relative to said axis, the angles of spiral of said blades being decreased near the rearward end of said mixing member so as to produce a relatively rapid rearward feeding action in the forward part of said mixing member and the accumulation of a relatively large body of material in the rearward part of said mixing member.

4. A pug mill of the character described, comprising: a shell forming a channel having inlet and outlet openings at its opposite axial ends; and a mixing member rotatable on a longitudinal axis in said channel, said mixing member having spirally disposed blades radially projecting relative to said axis, the angles of spiral of said blades being gradually decreased from maximum to minimum respectively from the forward end to the rearward end of said mixing member.

5. A road making machine of the character described, including: a vehicle; means for propelling said vehicle; a mixing mill carried by said vehicle, said mill comprising a shell forming a channel having inlet and outlet openings at its opposite ends and a plurality of mixing members in side-by-side position and rotatable on longitudinal axes in said channel, each of said mixing members having spirally disposed blades radially projecting relative to said axes, the angles of spiral of said blades being gradually decreased from maximum to minimum respectively from the forward end to the rearward end of said mixing member; and means for operating said mill, there being means for delivering road materials from the road to said mill, said mill delivering the mixed materials to the road surface.

6. A road making machine of the character described, including: a wheeled-frame; means for propelling said machine; a mixing mill carried by said frame, said mill comprising a shell forming a channel having inlet and outlet openings at its opposite ends and a mixing member rotatable on a longitudinal axis in said channel, said mixing member having spirally disposed blades radially projecting relative to said axis, the angles of spiral of said blades being consistently decreased from the forward end to the rearward end of said mixing member so as to produce a relatively rapid rearward feeding action in the forward part of said mixing mill and the

accumulation of a relatively large body of material in the rearward part of said mill; and means for operating said mill, there being means for delivering road materials from the road to said mill, said mill delivering the mixed materials to the road surface.

7. A road making machine of the character described, including: a wheeled-frame; means for propelling said machine; a mixing mill carried by said frame, said mill comprising a shell forming a channel having inlet and outlet openings at its opposite ends and a plurality of mixing members in side-by-side position and rotatable on longitudinal axes in said channel, each of said mixing members having spirally disposed blades radially projecting relative to said axes, the angles of spiral of said blades being gradually decreased from maximum to minimum respectively from the forward end to the rearward end of said mixing member, there being a transverse wall adjacent said outlet opening for retarding the movement of materials in the rearward end of said mill to assist in the accumulation of a relatively large mass of materials in the rearward end of said mill; and means for operating said mill, there being means for delivering road materials from the road to said mill, said mill delivering the mixed materials to the road surface.

8. A road making machine of the character described, including: a wheeled-frame; means for propelling said machine; a mixing mill carried by said frame, said mill comprising a shell forming a channel having inlet and outlet openings at its opposite ends and a mixing member rotatable on a longitudinal axis in said channel, said mixing member having spirally disposed blades radially projecting relative to said axis, the angles of spiral of said blades being consistently decreased from the forward end to the rearward end of said mixing member so as to produce a relatively rapid and spread-out movement of material in the forward part of said mill and a slow movement of the material and a consequent accumulation of a large body of material near the rearward end of said mill; means for feeding a binder to the material as it moves in spread-out condition in the forward part of said mill; and means for operating said mill, there being means for delivering road materials from the road to said mill, said mill delivering the mixed materials to the road surface.

9. A pug mill of the character described, comprising: a shell forming a channel having inlet and outlet openings at its opposite axial ends; a mixing member rotatable on a longitudinal axis in said channel, said mixing member having spirally disposed blades radially projecting relative to said axis, the angles of spiral of said blades being gradually decreased from maximum to minimum respectively from the forward end to the rearward end of said mixing member so as to produce a relatively rapid and spread-out movement of material in the forward part of said mill and a slow movement of the material and a consequent accumulation of a large body of material near the rearward end of said mill; and means for feeding a binder to the material as it moves in spread-out condition in the forward part of said mill.

10. A pug mill of the character described, comprising: a shell forming a channel having inlet and outlet openings at its opposite axial ends; and a mixing member rotatable on a longitudinal axis in said channel, said mixing member having spirally disposed blades radially projecting rela-

tive to said axis, the angles of spiral of said blades being gradually decreased from maximum to minimum respectively from the forward end to the rearward end of said mixing member, there being a transverse wall adjacent said outlet opening for retarding the movement of materials in the rearward end of said shell to cause the accumulation of a relatively large body of material in the rearward part of said shell.

11. A road making machine of the character described, including: a wheeled-frame; means for propelling said machine; a mixing mill carried by said frame, said mill comprising a shell forming a channel having inlet and outlet openings at its opposite ends and a mixing member rotatable on a longitudinal axis in said channel, said mixing member having spirally disposed blades radially projecting relative to said axis for mixing and moving road materials from said inlet opening to said outlet opening, said mill having a wall adjacent said outlet opening for holding back the movement of material at the rearward end of said mill; and means for operating said mill, there being means for delivering road materials from the road to said mill, said mill delivering the mixed materials to the road surface.

12. A road making machine of the character described, including: a wheeled-frame; means for propelling said machine over a road surface; means for raising and lowering said frame relative to the plane of the road; a mixing mill carried by said frame having an inlet member forwardly directed to the travel of said machine for delivering divided materials from said road surface to said mill; guide means for guiding said machine over said road surface; a pick-up blade secured to said mixing mill so as to be raised and lowered in accordance with the raising and lowering of said frame; and means positioned contiguous to said guide means for adjusting the position of said pick-up blade.

13. A road making machine of the character described, including: a wheeled-frame; means for propelling said machine over a road surface; means for raising and lowering the forward end of said frame relative to the plane of the road; a mixing mill carried by said frame, said mixing mill having a horizontal blade portion directed forwardly therefrom adapted to be raised and lowered in accordance with the raising and lowering of the forward end of said frame so as to deliver divided materials from said road surface to said mixing mill, the adjustment of said blade portion being under direct control of the operator of said machine.

14. A road making machine of the character described, including: a wheeled-frame; means for propelling said machine over a road surface; means for adjusting the position of the forward end of said frame relative to the plane of the road; walls providing a mixing mill on said frame; a blade member on the forward end of said mixing mill for delivering divided materials from said road surface to said mill; and means responsive

to the adjustment of said frame for moving said blade member to different positions relative to the plane of said road.

15. A road making machine of the character described, including: a wheeled-frame; means for propelling said machine over a road surface; means for adjusting the position of the forward end of said frame relative to the plane of the road; walls providing a mixing mill on said frame; a blade member on the forward end of said mixing mill for delivering divided materials from said road surface to said mill; and means responsive to the adjustment of said frame for moving said blade member to different positions relative to the plane of said road, the adjustment of said frame being under direct control of the machine operator.

16. A road making machine of the character described, including: a wheeled-frame; means for propelling said machine over a road surface; a mixing mill carried by said frame; a blade member on the forward end of said mixing mill for delivering divided materials from said road surface to said mill; means for raising and lowering the forward end of said frame so as to move said blade member to different positions relative to the plane of the road; and means for operating said mill, said mill mixing said materials and delivering the mixed materials to the road surface.

17. A road making machine of the character described, including: a wheeled-frame; means for propelling said machine over a road surface; a mixing mill carried by said frame; a blade member on the forward end of said mill for delivering divided materials from said road surface to said mill; means for raising and lowering the forward end of said mill so as to move said blade member to different positions relative to the plane of the road; and means for mixing said materials and delivering said materials to the road surface.

18. A road making machine of the character described, including: a wheeled-frame; means for propelling said machine over a road surface; means for raising and lowering said frame relative to the plane of the road; a mixing mill carried by said frame; a pick-up blade on the forward end of said mill for delivering divided materials from said road surface to said mill; means for moving said pick-up blade to different positions relative to the plane of the road; a mixing member rotatable on a longitudinal axis in said mill, said mixing member having spirally disposed blades radially projecting relative to said axis for mixing and moving said road materials from the forward end of said mill to the rearward end thereof, there being a wall for holding back the movement of material at the rearward end of said mill; and means for operating said mixing member and delivering the mixed materials to the road surface.

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