

Oct. 31, 1944.

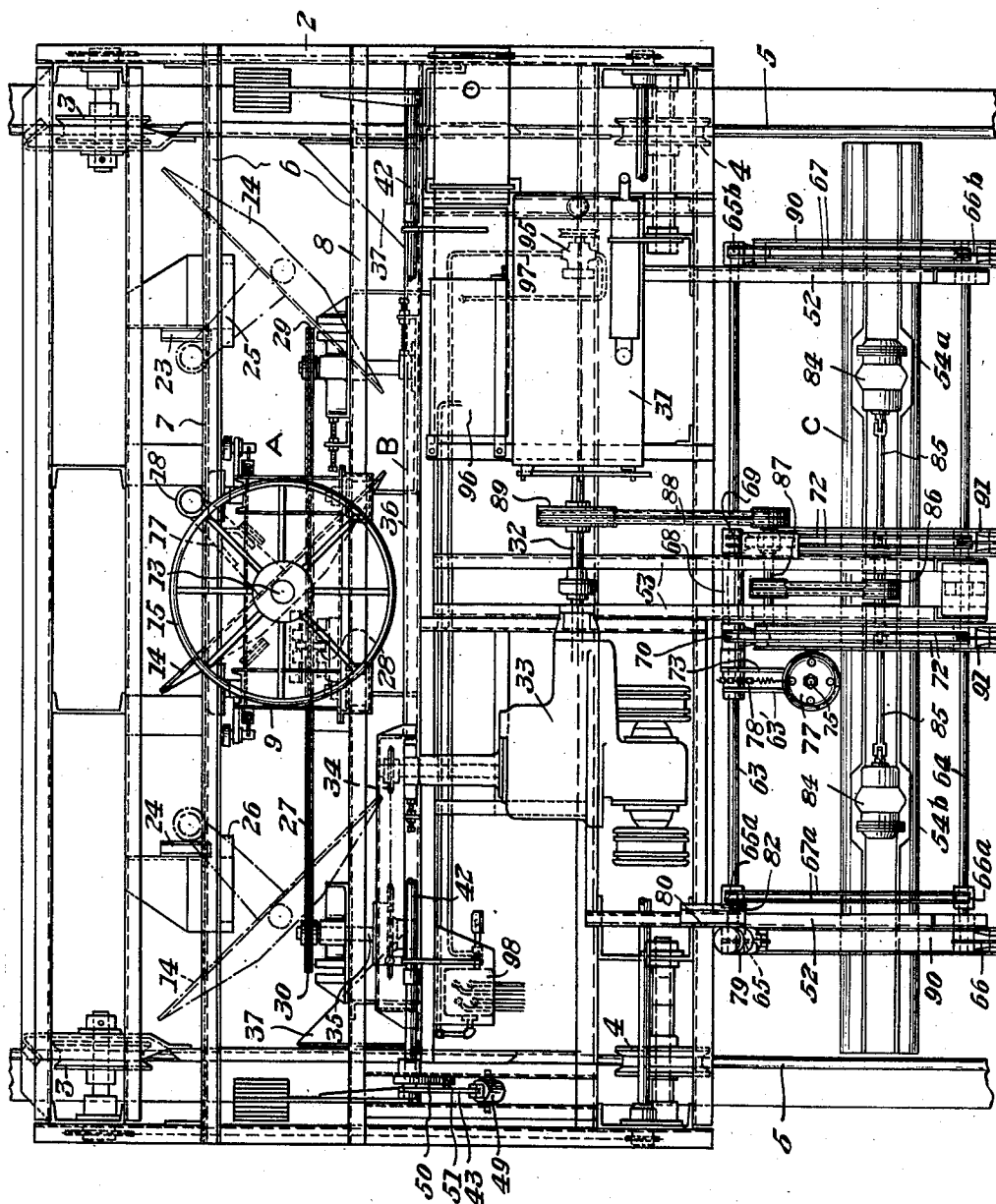
J. E. BUSHNELL

2,361,377

PAVING

Filed Sept. 23, 1941

7 Sheets-Sheet 1



INVENTOR
James E. Bushnell
by Christy Parmelee and Strickland
his attorneys

Oct. 31, 1944.

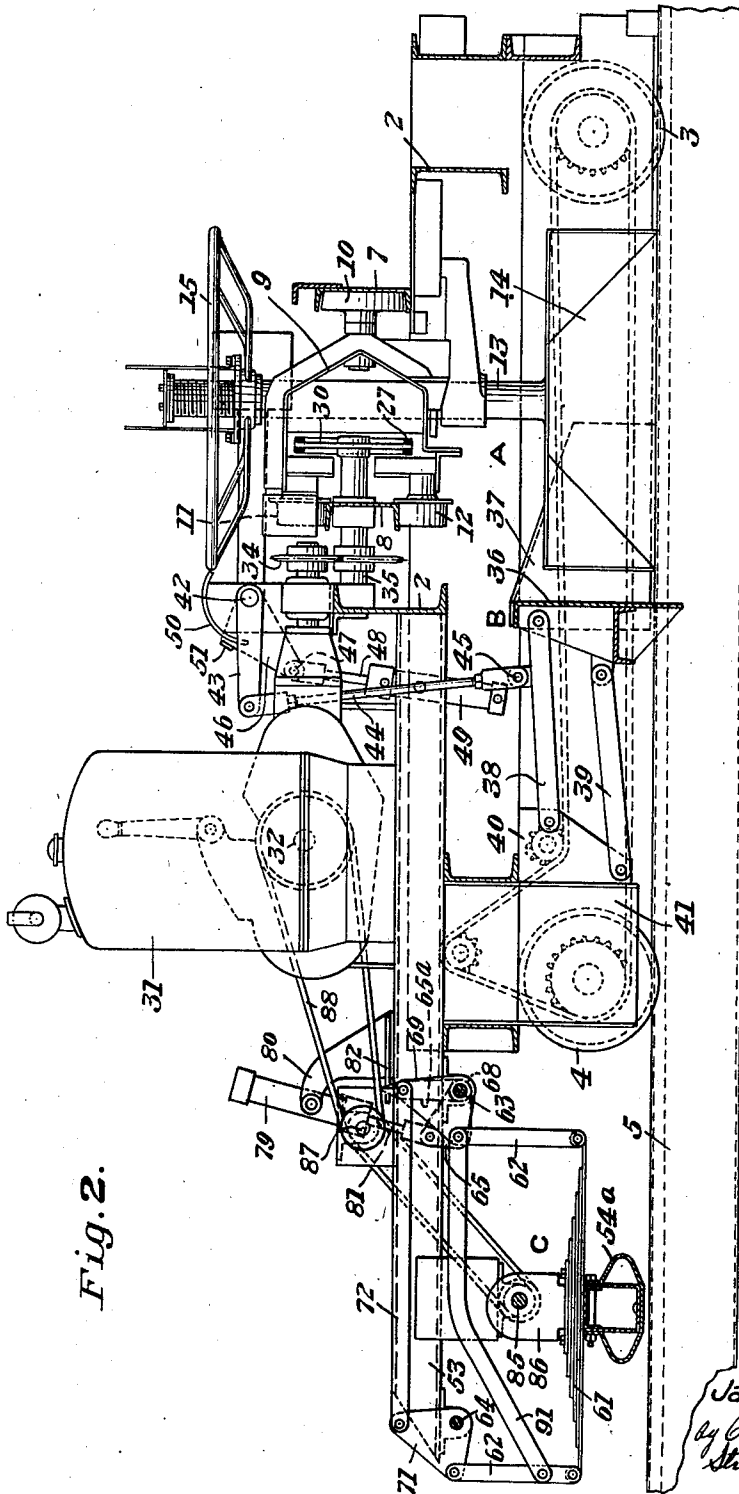
J. E. BUSHNELL

2,361,377

PAVING

Filed Sept. 23, 1941

7 Sheets-Sheet 2



INVENTOR

James E. Bushnell
by Christy, Parmelee and
Strickland
his attorney

Oct. 31, 1944.

J. E. BUSHNELL

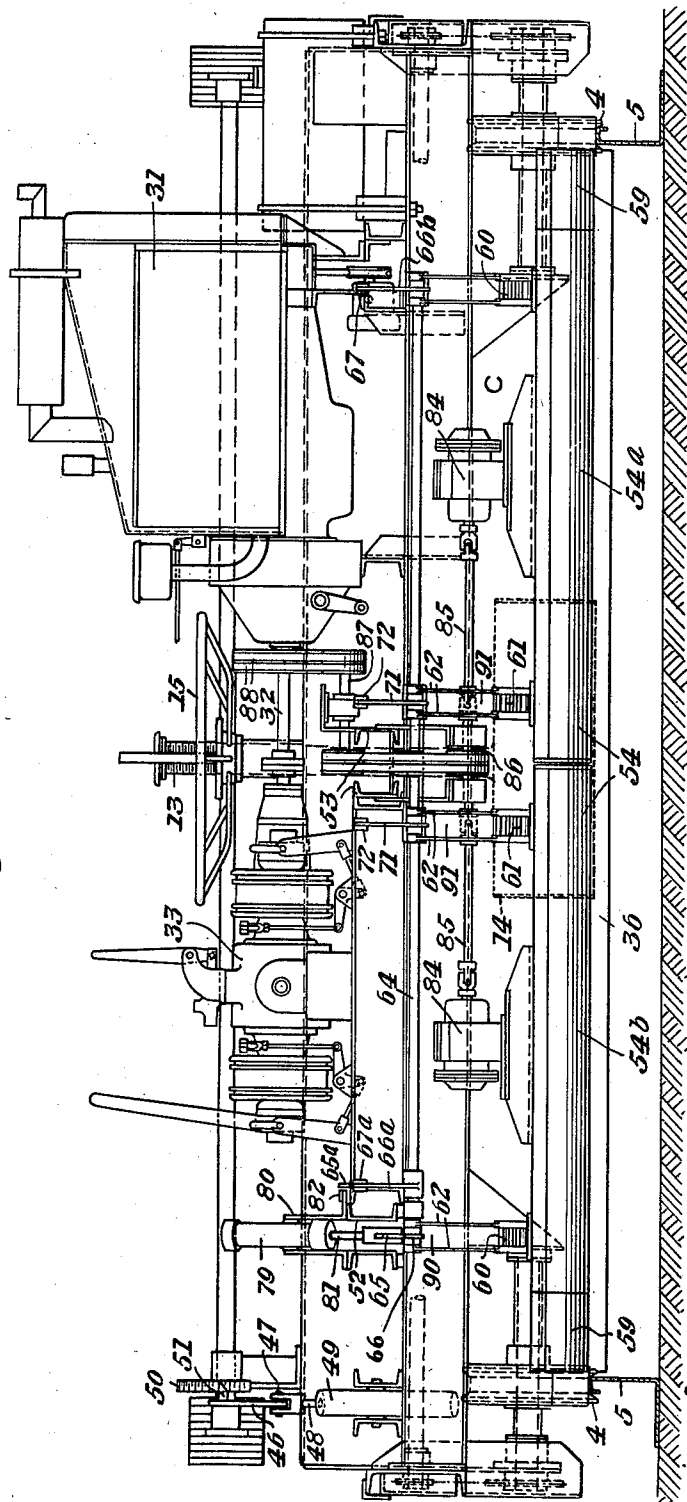
2,361,377

PAVING

Filed Sept. 23, 1941

7 Sheets-Sheet 3

Fig. 3.



INVENTOR

James E. Bushnell
by Christy, Karmel
and Strickland
his attorneys

Oct. 31, 1944.

J. E. BUSHNELL

2,361,377

PAVING

Filed Sept. 23, 1941

7 Sheets-Sheet 4

Fig. 4.

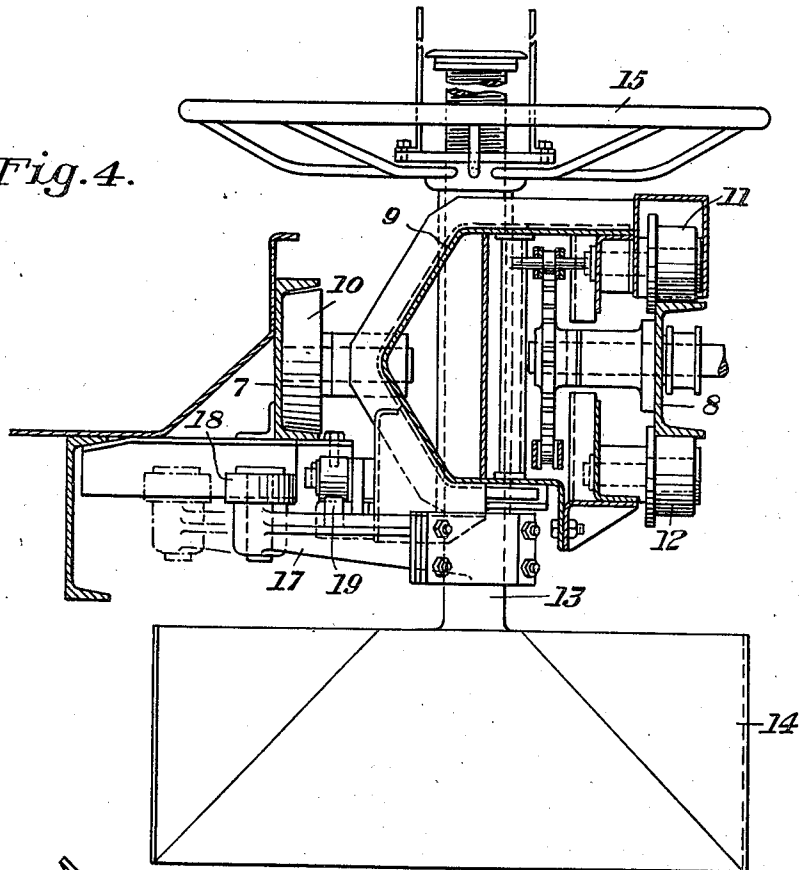
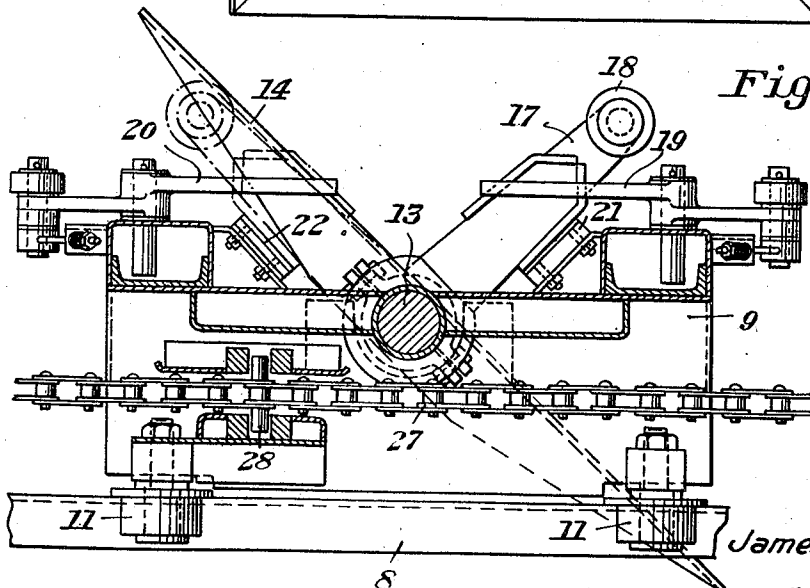


Fig. 5.



INVENTOR

James E. Bushnell

by Christy, Parmelee and Strickland
his attorneys

Oct. 31, 1944.

J. E. BUSHNELL

2,361,377

PAVING

Filed Sept. 23, 1941

7 Sheets-Sheet 5

Fig. 6.

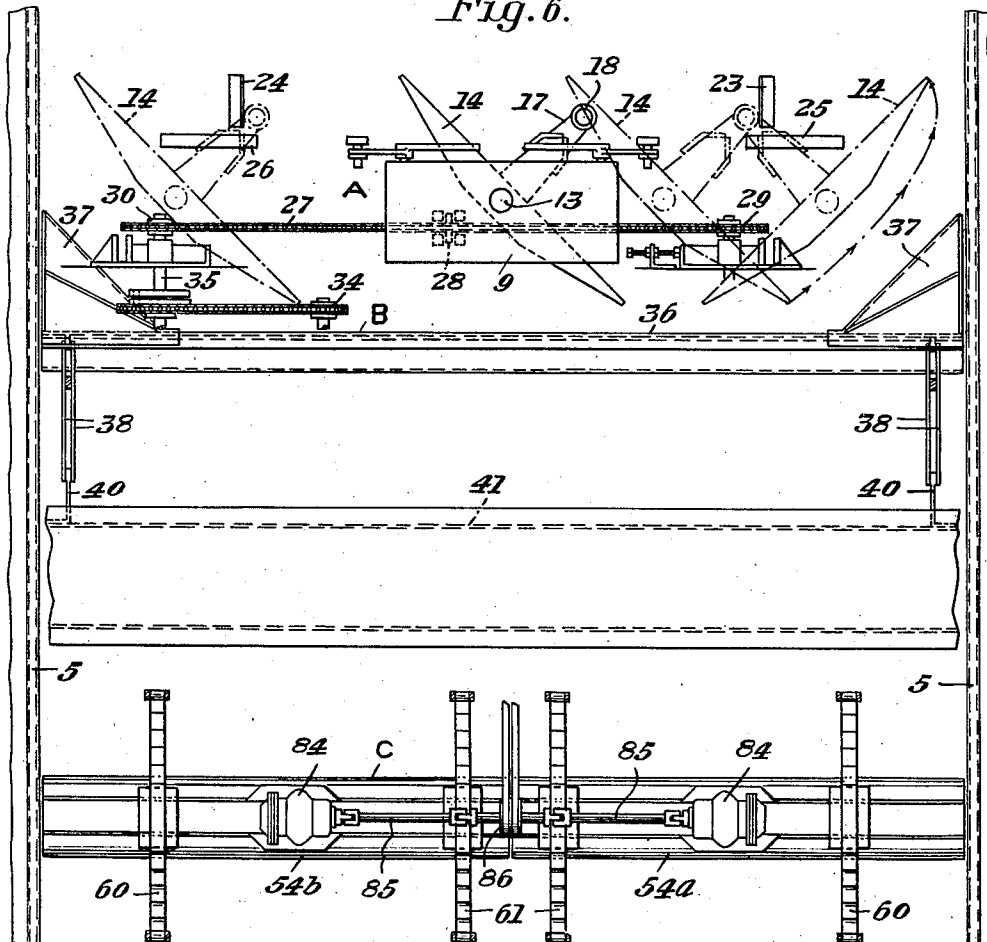


Fig. 7.

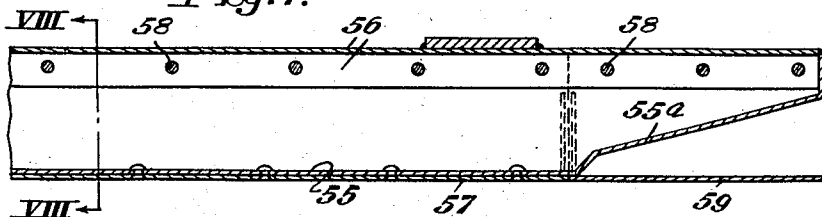
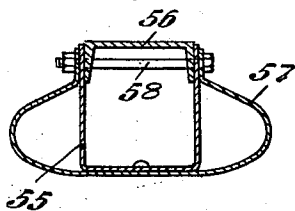


Fig. 8.



INVENTOR

James E. Bushnell

by Christy, Parmelee and Strickland
his attorneys

Oct. 31, 1944.

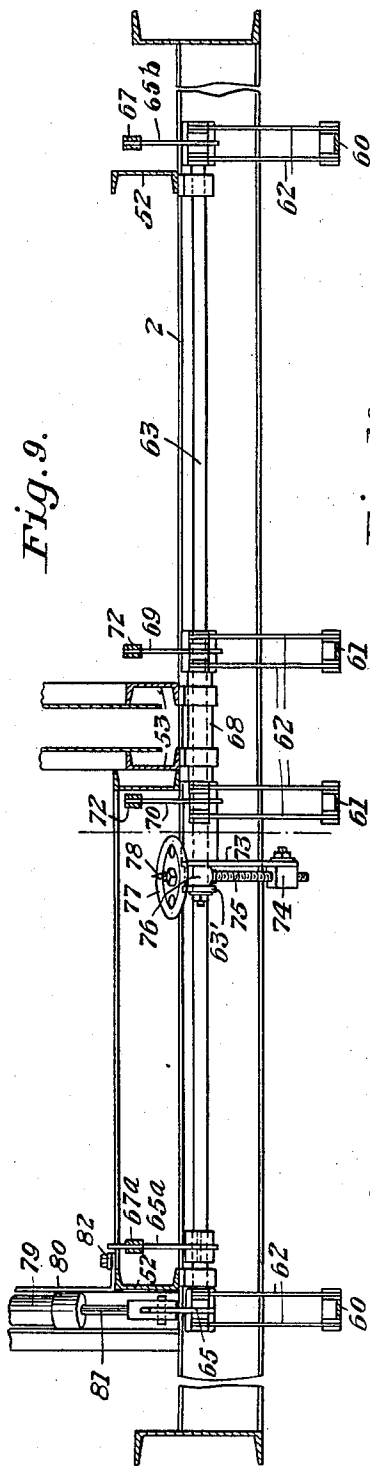
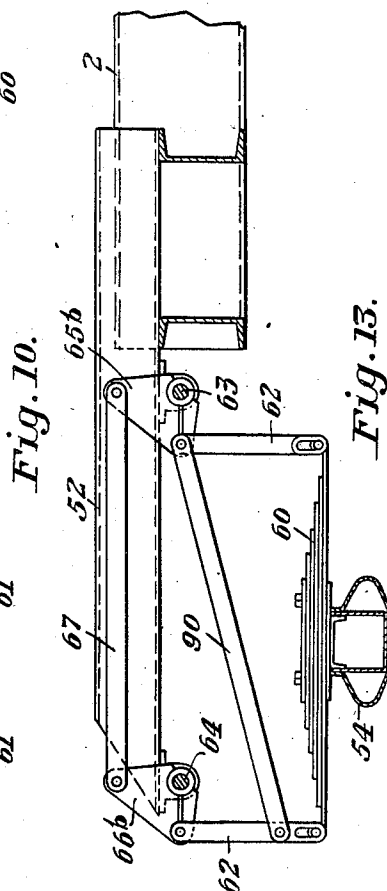
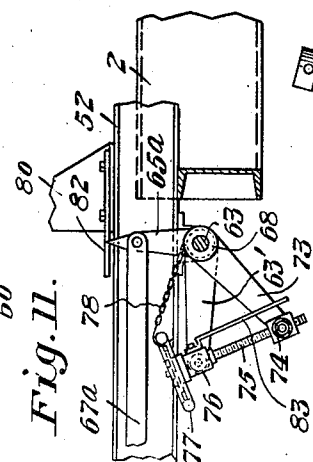
J. E. BUSHNELL

2,361,377

PAVING

Filed Sept. 23, 1941

7 Sheets-Sheet 6



Oct. 31, 1944.

J. E. BUSHNELL

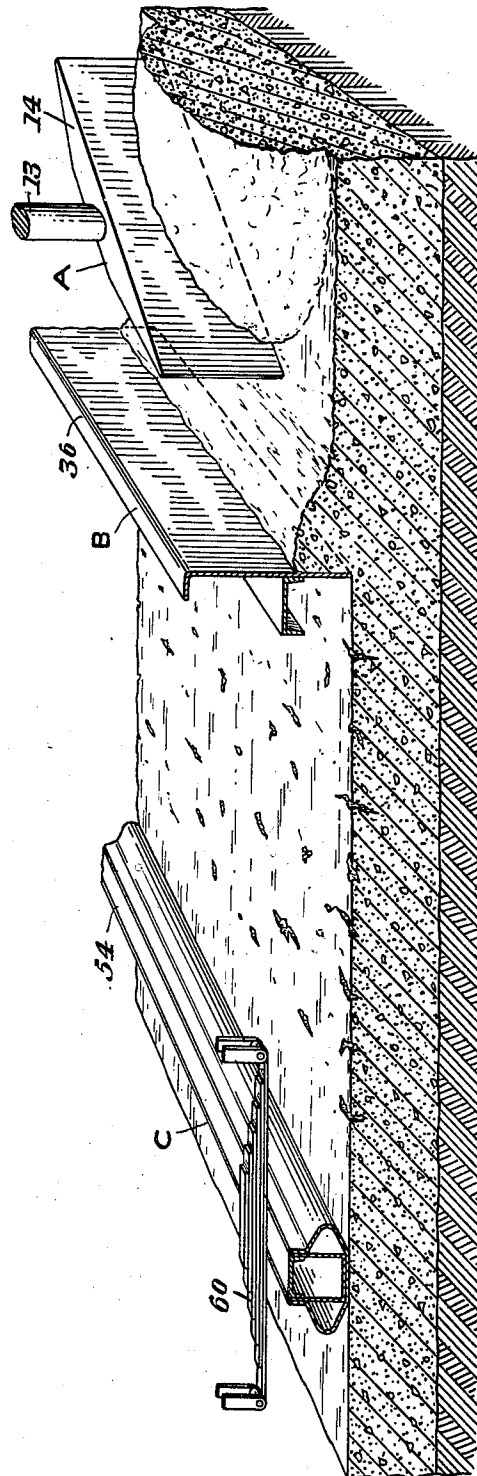
2,361,377

PAVING

Filed Sept. 23, 1941

7 Sheets-Sheet 7

Fig. 14.



INVENTOR

James E. Bushnell

By *Christy, Parmelee and
Strickland*
his attorneys

UNITED STATES PATENT OFFICE

2,361,377

PAVING

James E. Bushnell, Aspinwall, Pa., assignor to
Blaw-Knox Company, Blawnox, Pa., a corpora-
tion of New Jersey

Application September 23, 1941, Serial No. 411,969

10 Claims. (Cl. 94—45)

This invention pertains to the art of paving, particularly road paving. The invention is for an improvement in paving methods and apparatus as disclosed in application Serial No. 324,755, filed March 19, 1940, of Edward L. Harrington, and Serial No. 353,860, filed August 23, 1940, of Charles A. Long, the latter application having issued as Patent No. 2,334,717, dated November 23, 1943.

Generally, the Harrington application above referred to discloses a method and apparatus wherein there is a frame movable along the form rails that are placed at each side of sub-grade over which the concrete is spread. The concrete or other paving material is dumped in heaps on the sub-grade, and as the frame advances along the rails, a spreader which moves transversely to and fro across the roadway sweeps or spreads the heaped material to a predetermined depth between the forms. This spreader preferably is in the form of a blade or paddle; and adjacent each limit of its travel the blade sweeps around the base of the pile of material being pushed by the spreader so that when the spreader moves in the opposite direction the pile will be swept or spread in the opposite direction. Moreover the oblique inclination of the spreader is such as to impart a forward component to the material.

The frame also has a transverse screed which is set at any elevation to which concrete is to be graded, and if the concrete is deposited in two layers, the screed is first set for the upper surface of the lower layer and reset for the surface of the upper layer when the machine makes a second pass to determine approximately the final level of the surface to be paved, and this screed is so positioned with reference to the spreader that the spreader gathers in some of the excess material in front of the screed and moves it forwardly and laterally, thereby tending to keep the accumulation in front of the screed substantially constant. In the device as illustrated in the Harrington patent the screed has a vertical front face and a substantially horizontal bottom face, and it is given a vibrating or tamping motion while being moved forward. It therefore not only moves surplus concrete ahead of it, but also compacts the concrete which is moving forward as well as packs and smooths that beneath it, all at a single operation, leaving behind it a troweled surface.

This device has given commercially satisfactory results, but I have found that those results can be improved by separating the striking-off member from the tamping or vibrating member so that there is a definite interval between the two. The

reason why my improvements give better results is that they permit more effectual escape of air from the spread concrete before the upper surface thereof is sealed by surface working. This will be explained more fully in the description to follow.

In accordance with the present invention, the spreader of the Harrington application as specifically improved by Long may be employed. This is followed by an adjustably fixed strike-off blade in the same relation to the spreader as the strike-off of Harrington, but it presents only a scraping edge which leaves the surface of a relatively dry mix pitted and full of crevices or fissures. This strike-off in turn is followed at a short distance by an adjustable vibrating or tamping conditioning member. The step of longitudinal scraping is thus interposed as a distinct and separate step between the spreading operation and conditioning or vibrating member, thus serving to remove and thrust forward to the spreader excess material and leave the top surface of the spread concrete, torn by transverse fissures, open at the top.

The vibrator or tamper which follows at a short interval, agitates the concrete beneath it, and this agitation or vibration spreads forward in the denser concrete near the bottom of the slab causing the concrete above to coalesce at the bottom of the fissures and thus to close the fissures from the bottom upward, permitting air and excess water to escape at the top surface before the latter is sealed by the troweling action of the conditioning member.

The invention further contemplates certain improvements in the construction of machines of this character to facilitate their application to their intended purpose, as will hereinafter more fully appear.

My invention may be fully understood by reference to the accompanying drawings which illustrate a present preferred embodiment of my invention and in which:

Figure 1 is a top plan view of the spreading machine;

Figure 2 is a side elevation, partly in section, of the machine shown in Figure 1;

Figure 3 is a rear end elevation of the machine;

Figure 4 is a detail view showing the transversely movable spreader assembly;

Figure 5 is a section on a horizontal plane of Figure 4;

Figure 6 is a more or less schematic view showing a plan view of the spreader, scraper and vibratory conditioner in the relative positions in which they cooperate, with the movement of the

spreader being outlined in several dotted line positions;

Figure 7 is a fragmentary view illustrating a longitudinal section through one end of the conditioner or tamper;

Figure 8 is a transverse section through the conditioner or tamper in the plane of line VIII—VIII of Fig. 7.

Figure 9 is a detail view showing a part of the suspension for the vibratory member or tamper, the view being a section on a vertical plane of Figure 1;

Figure 10 is a detail view partly in section and partly in elevation of the suspension for the vibratory member;

Figure 11 is a detail sectional view showing the adjusting mechanism for adjusting the inner ends of the conditioner or tamper relatively to the outer ones;

Figure 12 is a detail view showing the jack for elevating the conditioner or vibrating tamper;

Figure 13 is a detail view showing the indicator for indicating the relative height of the inner portion of the conditioner relatively to the outer; and

Figure 14 is a diagrammatic view illustrating the method of paving as accomplished by this invention.

Referring to the drawings, the machine in its general organization corresponds closely to the machine shown in the Harrington and Long applications above referred to and for various details in the construction of this machine such applications should be resorted to.

Generally the machine comprises a main supporting frame 2 having forward supporting wheels 3 and rear supporting wheels 4. These wheels are adapted to run on the form rails 5 that are commonly used at each side of the sub-grade which is to be paved. The wheels may be power driven as disclosed in the Harrington application so that the forward travel of the machine may be correlated to the spreading and paving operations which the machine performs.

The frame provides a support for the spreading unit designated generally as A, a scraping unit generally designated as B, and a vibratory finisher generally designated as C.

Referring first to the spreader unit A, the main frame of the machine is provided with a transverse runway designated 6 in Figure 1. Along one edge of the runway is a channel 7 (see Figure 2) and along the other edge is a channel 8. A carriage or trolley designated 9 is provided with rollers 10 that travel in the channel 7 and with rollers 11 and 12 which are guided on the channel 8, the various rollers providing a support to enable the carriage to travel back and forth along the runway. The carriage 9 supports a vertical post 13 on the lower edge of which is a spreader 14, the spreader being generally in the form disclosed in the said Harrington application. The post 13 is adjustable by means of a handwheel 15 (see Figure 4). The post is mounted in the carriage so that it may rotate about its own axis and it has secured thereto a laterally projecting arm 17 (see Figures 4 and 5) having a roller 18 at the free end thereof. This lever 17 cooperates with latching dogs 19 and 20 as fully explained in the said Long application. When the arm 17 is in the full line position shown in Figure 5, it is held against stop 21 by the latch member 19 and when it is swung to the dotted line position it is held against the stop 22 by the latch 20. The roller 18 on the arm 17 is posi-

tioned to cooperate with fixed abutments 23 and 24 (see Figure 1) on the frame of the machine while the latches 19 and 20 are operated by engagement with cams 25 and 26.

The arrangement is such that when the carriage is moving along the runway between the ends of the runway, the spreader is held at an angle to the direction of travel of the carriage so that as it spreads the material it also tends to thrust the material forwardly and the spreader is held at the proper angle by the latches 19 and 20, depending upon the direction of travel of the carriage. As the carriage reaches one limit of its travel, one of the cams 25 or 26 releases its respective latch 19 or 20 so that the post which carries the spreader is free to turn. Then the roller 18 on the end of the arm 17 engages one of the abutments 23 or 24. This causes the spreader to rotate around the pile of material which it has been pushing. This is fully and clearly described in the said Harrington and Long applications, and the movement of the spreader at one limit of its travel is indicated in Figure 6.

In the operation of the machine the carriage is alternately moved to and fro along the runway as the machine travels forwardly. The spreader engages the piles of material that are dumped on the sub-grade in the path of travel of the machine. It works or sweeps the material back and forth between the form rails 5. At each side of the frame the spreader moves around the pile of material spreading the material into the space adjacent the rails 5 so that the material is evenly spread over the full width of the area to be paved. Because of the oblique inclination of the spreader a forward component of movement is imparted to the excess material.

The spreading unit A, therefore, serves to initially distribute the concrete or other paving material over the area to be paved as the whole machine travels forwardly. The action of the spreader is to push the material back and forth so that all voids will be filled and the spreader is set at an elevation such that the depth of the paving material when spread will be slightly greater than the final depth which is desired in the finished roadway.

The carriage which carries the spreader is caused to move back and forth by means of a driving chain 27 which is parallel with the runway and which, as shown in Figure 5, has a transverse pin 28 that operates in a vertical slide on the carriage. The shaft 27 passes around the sprockets 29 and 30 at opposite sides of the longitudinal center of the machine. When the pin 28 is in the top reach of the chain the carriage is propelled in one direction and when the pin 28 has passed around the sprockets and is in the bottom reach of the chain the carriage travels in the other direction. This is fully explained in said Long application.

The frame of the machine is shown as having an internal combustion engine 31 thereon. This engine drives a shaft 32 which in turn is connected with a transmission 33 that drives a sprocket 34 which in turn drives the shaft 35 to which the sprocket 30 is keyed.

The scraper or strike-off unit B comprises a vertical plate 36 extending crosswise of the full width of the frame and which may have forwardly extending side portions 37 at each end thereof or other means to prevent material from spilling over the side rails. The scraper 36 is suitably reinforced on the back thereof as best shown in Figure 2. It is supported against the

thrust of the material being scraped by means of links 38 and 39 (see Figure 2) at each end of the strike-off, these links being pivotally attached at their rear ends to a bracket 40 on a rigid stanchion 41 extending downwardly from the main frame of the machine. Provision is made for raising and lowering the strike-off. This may be a mechanism such as that shown in the Harrington application above referred to or it may be a mechanism such as that shown in the drawings and particularly Figure 2 wherein there is supported above the frame of the machine a transverse shaft 42 having rearwardly extending arms 43 attached thereto adjacent each end of the shaft. Adjustable links 44 at the outer ends of the arms 43 are pivotally connected at 45 with the link 38. By rotating the shaft 42 the links 44 will be raised and lowered at each side of the machine in unison to lift or lower the strike-off 36. For rotating the shaft 42 there is shown a crank 46 which is keyed to the shaft and which is pivotally connected at 47 to the piston rod 48 of the hydraulic jack 49. By moving the piston of this hydraulic jack up or down the strike-off 36 may be raised or lowered. To indicate the elevation of the strike-off there is a segment at 50 which is suitably calibrated and a pointer 51 on the crank 46 moves over this segment. Except for the fact that a hydraulic jack is illustrated in place of a screw jack, the construction of the mechanism for raising and lowering the strike-off is generally similar to that disclosed in the previous applications referred to. The strike-off 36 differs from the strike-off of the construction shown in the previous application in the fact that it is an adjustably fixed plate or scraper which has only a narrow bottom edge so that its function is entirely that of a scraper or screed and it does not and is not intended to smooth or tamp, but to leave the upper surface unsealed. Under normal conditions of operation the strike-off is adjusted to an elevation where its lower edge will be in a plane slightly below the lower edge of the spreader 14 so that there will always be an excess of material to be scraped away. It is important that the strike-off 36 be positioned parallel with and relatively close to the path of travel of the spreader so that as material accumulates in front of the strike-off the spreader will scrape away the excess accumulation, spread it over the sub-grade and thrust it forwardly, and thereby keep the amount of material in front of the strike-off substantially constant. This is of importance first, because it automatically feeds the excess material forwardly to a position where it will ultimately spread into the road, and second, because it prevents the accumulated material from building up to a point where it offers too much resistance to the forward travel of the machine.

For supporting the vibratory conditioning unit C a plurality of structural members 52 and 53 extend rearwardly from the main frame of the machine, the members 52 being adjacent the sides of the frame and the members 53 being relatively close to the center of the frame. Where the vibratory tamper is sufficiently heavy this extension may be provided with wheels (not shown) to support it on the side rails 5. The vibratory member is suspended from the rearwardly extending structure thus formed.

The conditioner or tamper itself, which is designated generally as 54, may be a continuous member, but preferably it is divided at the center as clearly shown in Figure 3 to form two sections

54a and 54b. The purpose of dividing this element is to enable the inner ends to be elevated relatively to the outer ends so as to provide for the forming of the crown of the paved area where this is desired. Each of the members 54a and 54b is similarly constructed and comprises a U-shaped beam having a pan 55 made of bent metal plate forming the bottom and sides of the beam, there being an inverted channel 56 at the top of the enclosure (see Figures 7 and 8). The end portion of the pan or beam of the outer portion of each section of the conditioner is preferably tapered as shown in Figure 7. Encasing the pan 55 throughout the greater portion of the length of each section is a jacket 57 which is formed of metal plate and which is secured in place by a series of through-bolts 58. The contour of the conditioning element is generally similar to that shown in McCrery Patent No. 2,042,156 but the construction is substantially stronger and lighter.

Separate jacket members 59 are provided for the tapered end portions 55a of the pan which portions 59 are also held in place by means of through-bolts 58. One or both of the end sections 59 may be removed so that the member may operate with both of the jacket sections 59 in place, or with only one of them in place, or with neither of them in place. This enables a conditioning unit of fixed length to be adjusted to operate on various widths of paving. The taper at 55a of course provides clearance when the end jacket section 59 is not in use.

Extending transversely of each section of the conditioning member are two leaf springs 60 and 61, the springs 60 being closest to the sides of the machine and the springs 61 being closest to the center. Attached to each end of each spring is a suspension link 62. Mounted in bearings on the underside of the frame members 52 and 53 is a rock shaft 63. Parallel with the rock shaft 63 is a second rock shaft 64. Secured to the rock shaft 63 are three cranks, one designated 65 being at the extreme left-hand end of shaft 63 as viewed in Figure 1, crank 65a being just to the right of shaft 65, and crank 65b being at the extreme right-hand end of the shaft. Fixed on the rock shaft 64 are three cranks positioned in line with the three cranks above referred to, these being 66, 66a and 66b, respectively. The vertical link 62 on the front end of the spring 60 at the left side of the machine is pivotally connected at its upper end to crank 65 (see Fig. 12). The link 62 at the rear end of the spring is connected to the crank 66, crank 66 being a simple horizontally extending arm or lever (see Fig. 1). A link 62 on the crank 65b suspends the forward end of the right-hand spring 60, and link 62 on the crank 66b suspends the rear end of the same spring. A link 67 (see Fig. 10) connects cranks 65b and 66b. A similar link 67a connects cranks 65a and 66a (see Figs. 9 and 11). The links 67 and 67a serve to transmit motion from rock shaft 63 to rock shaft 64, and the four links 62 as described provide the suspension for the extreme outer ends of the vibratory conditioner. The inner ends of the conditioner are suspended in a generally similar fashion but through a means which enables the height of the inner ends to be adjusted relative to the outer ends but which, at the same time, allows the unit as a whole to be raised and lowered without changing this adjustment.

Surrounding the center of the shaft 63 (see Figure 9) is a tube 68 which is journaled in bearings on the underside of the central mem-

bers 53. The sleeve 68 has a crank 69 keyed thereto at the right-hand end and a similar crank 70 keyed thereto at the left-hand end. The cranks 69 and 70 are similar to the crank 65b (see Figure 10) but are secured to the sleeve 68 instead of to the shaft 63. Links 62 on the forward ends of the springs 61 connect with these cranks. Loose on the rear shaft 64 in line with the cranks 69 and 70 are cranks 71. Horizontal links 72 connect the cranks 71 with the cranks 69 and 70. The links 62 at the rear ends of the springs 61 are connected at their upper ends to the cranks 71. Figure 2 shows the above-described center suspension for the right-hand conditioning member 54a.

Keyed to the shaft 63 is a crank or arm 63'. Attached to the end of the sleeve 68 is an arm 73 (see Figure 11). On the free end of the arm 73 is a swiveled nut 74 through which passes a screw shaft 75. This shaft also passes through a swivel block 76 on the end of the arm 63' and it is provided at its outer end with a hand-wheel 77. This screw adjustment provides an adjustable link between the arms 73 and 63' whereby the angular relation of the cranks 69 and 70 relative to the cranks 65 may be varied.

By reason of this arrangement when the shaft 63 is rotated the shaft 64 will be correspondingly rotated and motion will be transmitted to all of the cranks and through these cranks to the links 62 to thereby raise or lower the conditioning member. However, by increasing or decreasing the length of the adjustable link between the cranks 72 and 63', the links which support the springs 61 may be changed with reference to the links that support the springs 60 to thus change the elevation of the inner ends of the conditioning member with reference to the outer ends. A chain 78 hooked over the hand-wheel 77 serves to hold the hand-wheel from accidental rotation.

For operating the conditioning member to raise or lower it any suitable mechanism may be employed for rotating the shaft 63. The construction shown in the drawings comprises a hydraulic cylinder 79 at the left-hand side of the frame of the machine as viewed in Figures 1 and 3, and which cylinder is also clearly shown in Figure 2. This cylinder is pivotally supported on a rigid bracket 80 on the frame of the machine. A piston rod 81 operated by the cylinder is connected to the crank 65 at the left-hand end of the shaft 63 as best shown in Figure 12. Through the control of fluid pressure to the cylinder 79 the piston rod 81 may be moved up and down to rock the shaft 63, and thus raise or lower the conditioning member. The crank 65a, as shown in Figures 11 and 13, terminates in a pointer which moves along a calibrated plate 82 on the frame of the machine to indicate the height of the conditioning member. There may also be a calibrated strip 83 on swivel block 76 projecting over the swivel nut 74 to indicate the elevation of the inner ends of the conditioning member relative to the outer ends.

On each of the vibratory conditioning members is a vibrating unit in the form of a rotating unbalanced weight 94 generally similar to the vibrator shown in McCrery Patent No. 2,042,156. These vibrators are both driven through universally coupled shafts 85 from a pulley 86. The pulley 86 in turn is connected by belts to a shaft 87. The shaft 87 in turn is driven through belts 88 from a pulley 89 on the engine shaft. To prevent the links 62 from swinging in a vertical arc diagonals 90 extend from a point

intermediate the ends of the rearmost links at each end of the conditioner to the upper ends of the links 62 at the forward ends of the springs 60 as shown in Figure 10. At the inner ends of the vibrator sections there are diagonals 81 similarly arranged but which, as shown in Figure 2, are curved so as to clear the shaft 85.

For operating the fluid pressure jacks 49 and 79 any suitable source of fluid pressure may be used. In Figure 1 of the drawings a pump 95 is mounted directly under the engine and is driven from the engine. Oil is circulated by the pump from a reservoir 96, through pipe 97, to a control valve 98 conveniently located. The valve is a standard valve which forms no part of the present invention. It has two pipes leading therefrom for each jack to be controlled, one pipe being to supply oil to one side of the piston of the hydraulic jack, and the other to provide oil to the other side of the piston. By operation of the valve the piston of either jack may be selectively moved a predetermined distance, and by closing the valve maintained in position to which it has been moved by the fluid trapped on opposite sides of the piston. All of this is fully understood by those skilled in the art and forms no part of the present invention per se.

In the operation of the machine which is diagrammatically illustrated in Figure 14, and in performing the method of the present invention, the paving material, such as concrete, is dumped on the sub-grade between the side rails 5 in advance of the machine. The machine travels along the rails toward the right as viewed in Figure 2. As the machine moves along the spreader 14 engages the piles of material and spreads them out over the sub-grade to a depth greater than the ultimate desired thickness of the road, the spreader sweeping the material to and fro and thrusting it forward, the operation of the spreader serving to completely fill the space to be paved and working the material into the space close to the inner faces of the side rails 5. The strike-off 36 engages the excess depth of material and scrapes it forward, leaving the concrete surface behind it fissured, because of the engagement of the edge of the scraper with the larger fragments of stone or aggregate in the concrete. As before explained, the material that accumulates in front of the strike-off is kept substantially constant by reason of the fact that it is engaged by the spreader and thrust forwardly and spread out over the sub-grade. The surface left by the strike-off, particularly where the concrete is a relatively stiff, dry mix such as is commonly used in a high speed paving operation, is pitted and contains crevices of various sizes, the surface of the concrete behind the spreader being generally rough and fissured. (See Figure 14.)

As the spreader moves along, the conditioner which has been adjusted to the proper height smooths down the rough surface and the vibratory action causes the concrete to settle. The vibrations which are of high frequency and relatively small amplitude are transmitted not only to the concrete directly under the conditioner but they also travel laterally so that the concrete is vibrated well in advance of the conditioner and before the conditioner actually engages the surface to be smoothed, and the crevices will have been closed. This is indicated in Figure 14 where the crevices immediately in front of the conditioner are closed. By vibrating the concrete in

this manner the walls of the crevices flow together from the bottom toward the top so that the air or water in the crevices is expelled and not trapped as is the case where there is trowelling action immediately over the crevices to seal the surface. The vibrating and conditioning follows so closely or immediately after the operation of striking off the excess that the walls of the crevices when they come together are thoroughly bonded. Even though the weather is hot and the rate of evaporation is high, this bonding occurs before there has been any opportunity for the water to evaporate or to combine sufficiently with the cement to prevent the bonding. The conditioning member is not relied upon for removing excess material from the road surface, its function being that of compacting the concrete in front of it from the bottom upwardly. No substantial amount of material is moved along in front of the vibratory conditioner so that there is no forward overflow of grout or cement to seal the crevices from above and thus prevent the escape of air and surplus water upwardly. As previously explained, the removal of the excess material is effected by the strike-off 36 which is interposed between the spreader and the conditioner. The work of the conditioner follows sufficiently close after the operation of the spreader that the concrete or other paving material is not affected detrimentally by evaporation but is sufficiently far behind the spreading and strike-off units to allow for the escape of air and surplus water. The distance between the substantially parallel strike-off and vibrating member is preferably considerably greater than the thickness of the pavement to be laid.

Normally, as concrete roads are now constructed, this machine is followed by a "finishing machine" which gives a final surface to the conditioned concrete, greater speed of construction being attained by the use of two machines. It is possible, however, when working less rapidly, with certain mixtures of concrete, to use the vibratory tamper member to give the concrete surface its final finish.

While I have illustrated and described one specific machine embodying my invention, it is to be understood that my invention is not limited to the particular embodiment shown, that the machine may be otherwise constructed and within the contemplation of my invention and under the scope of the following claims.

I claim:

1. In a concrete paving machine a car movable above the area to be paved, a transversely extending strike-off blade lying in a vertical plane, and means for adjustably mounting and securing the blade in fixed relation on the car, said blade having a narrow lower working edge, said edge striking off the upper surface of concrete when the car is in its forward motion and pushing the larger projecting aggregates in front of said edge thereby producing fissures extending from the surface of the concrete downwardly, back of said edge, in combination with an elongated high-frequency tamper supported by said car, substantially parallel to said strike-off and spaced behind the strike-off a distance considerably greater than the thickness of the pavement to be laid, whereby when said car is moved forward and the tamper is actuated vibrations pass downwardly and forwardly beneath the tamper through the concrete layer and pass forwardly and upwardly through the layer behind

the strike-off edge, causing closing of the fissures from the bottom upward.

2. In a concrete paving machine comprising a car movable over the area to be paved, a strike-off blade on the car extending transversely thereof and lying in a vertical plane, means for adjustably mounting the blade in fixed relation on the car, said blade having a narrow bottom working edge which through its engagement with the paving material, leaves a surface which is fissured and porous, and an element on the car in spaced relation to the scraper and substantially parallel therewith and which is behind the scraper relative to the operating direction of the car for vibrating the paving material and by such vibration close the fissures and the portions from the bottom toward the top, said element also having a smooth surface to wipe over the paving material and seal the surface thereof.

3. A road paving machine comprising a mobile supporting frame adapted to move along the area to be paved, a spreader at one end of the frame which is movable to and fro across the area to be paved for leveling paving material which is heaped on the area to be paved in the path of travel on the structure, a strike-off having a narrow operating edge on the frame back of the spreader adjusted to determine the approximate level of the paved surface and to push excess material into the path of the spreader whereby the accumulation of material in front of the strike-off is kept within a predetermined maximum and the surface rearwardly of the strike-off is left with fissures and crevices therein and a vibratory member having a wide bottom surface suspended from the frame following the strike-off at a distance substantially greater than the thickness of the material being spread for vibrating the spread material and closing the fissures which are produced by the scraper and thereafter sealing the paved surface.

4. A road paving machine comprising a frame movable along the area to be paved, a spreader on the frame movable to and fro across the area to be paved, a conditioner on the machine rearwardly of the spreader, and a strike-off between the spreader and the conditioner for scraping off the surface of the spread material and leaving it fissured and rough and which is close enough to the spreader so as to push excess material back into the path of the spreader so as to avoid any accumulation in front of the strike-off to prevent the forward movement of the machine and sufficiently far in front of the conditioner so that the disturbance produced in scraping away excess material is not transmitted to the zone in which the conditioner is effective.

5. A road paving machine comprising a mobile frame adapted to travel along the area being paved, an adjustably fixed strike-off having a narrow working edge for determining the approximate level of the paving material, means in front of the strike-off for maintaining a substantially controlled maximum of excess material in front of the strike-off, and means rearwardly of the strike-off spaced therefrom a fixed distance materially greater than the thickness of the pavement slab for vibrating and smoothing the surface over which the strike-off is operated.

6. A road paving machine comprising a mobile frame adapted to travel along the area being paved, an adjustably fixed strike-off having a narrow working edge on the frame for deter-

mining the approximate level of the paving material and leaving the surface thereof fissured and rough, means in front of the strike-off for sweeping the material back and forth in the area to be paved to level the same to a substantially uniform depth and arranged to also control the excess material in front of the strike-off, and means on the frame rearwardly of the strike-off in spaced relation thereto for vibrating and smoothing the surface over which the strike-off has operated.

7. A road paving machine comprising a mobile frame adapted to travel along the area being paved, an adjustably fixed strike-off having a narrow working edge on the frame for determining the approximate level of the paving material leaving the surface thereof fissured and rough, means in front of the strike-off for sweeping the material back and forth in the area to be paved to level the same to a substantially uniform depth and arranged to also control the excess material in front of the strike-off, and means on the frame rearwardly of the strike-off in spaced relation thereto for vibrating and smoothing the surface over which the strike-off has operated, said strike-off, said spreading means and said vibrating means being relatively adjustable in a vertical direction.

8. The method of paving which comprises dragging a strike-off having a narrow edge over a surface on which paving material has been spread to remove excess paving material and to produce a fissured and porous surface on the paving material and thereafter subjecting the

fissured and porous area of the paving material to a vibrating and smoothing action at a distance back of the strike-off greater than the depth of the paving material but sufficiently close to the strike-off so that the crevices will be closed and sealed before there has been any substantial evaporation of water or setting of the concrete.

9. The method of paving which comprises spreading a paving material over the area to be paved, striking off excess depth in the material and leaving the surface thereof fissured and porous and thereafter vibrating and smoothing the surface at a distance back of the strike-off greater than the depth of the paving material and sufficiently close to the strike-off so that the vibration is effective to close the fissures in the surface before there has been any substantial evaporation or sufficient reaction of the water with the cement to preclude the bonding of the sides of the crevices.

10. In the method of paving the steps which comprise spreading paving material over the surface to be paved to a uniform depth greater than the depth ultimately required, drawing a strike-off over the surface to remove the excess depth of material and leaving a surface which contains pits and crevices and thereafter vibrating and finishing the surface before there has been substantial evaporation of water from the cement or before the crevices have become closed at the top with air entrapped therein.

JAMES E. BUSHNELL.