Nov. 30, 1965 W. H. LEWIS 3,220,323

PAVEMENT FINISHING APPARATUS

Filed April 2, 1962 4 Sheets-Sheet 1

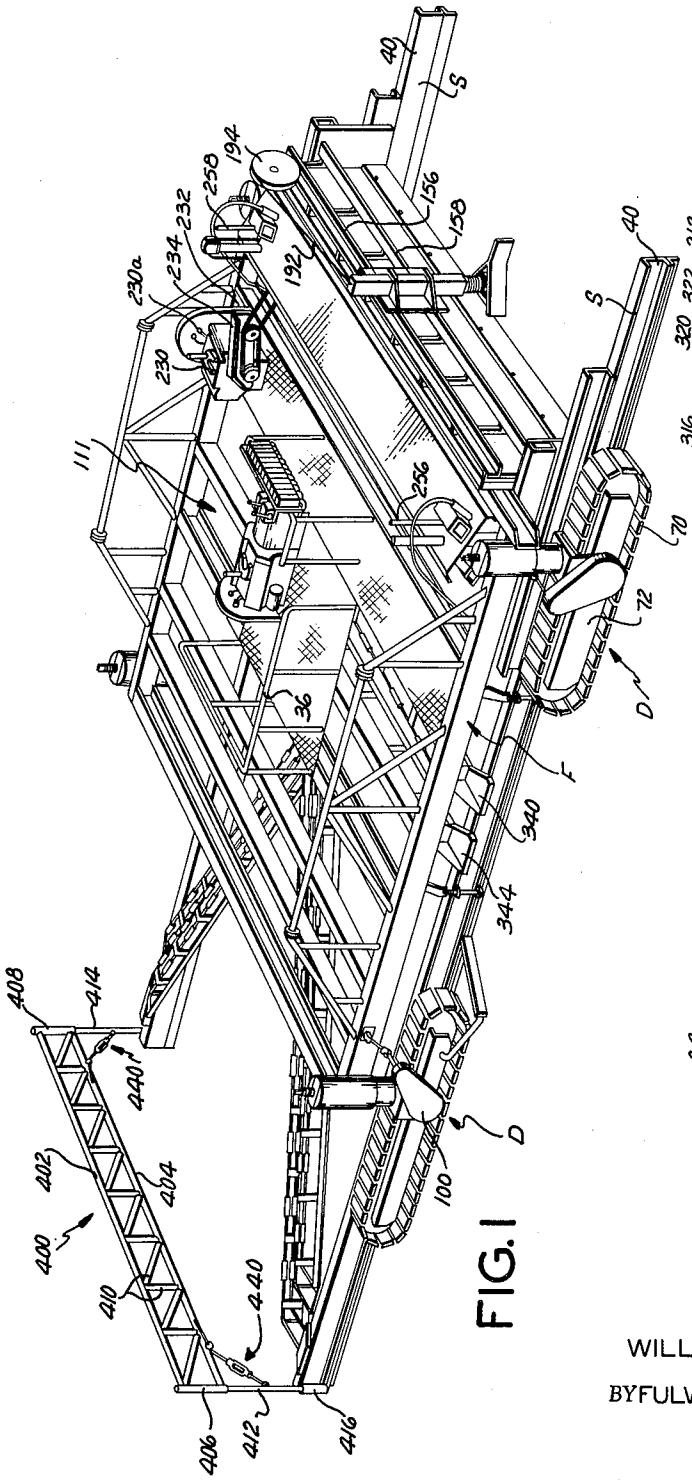

FIG. 1

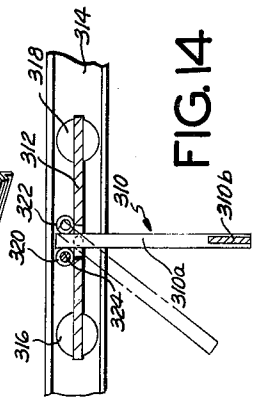

FIG. 14

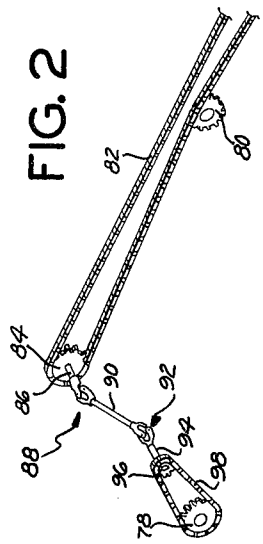

FIG. 2

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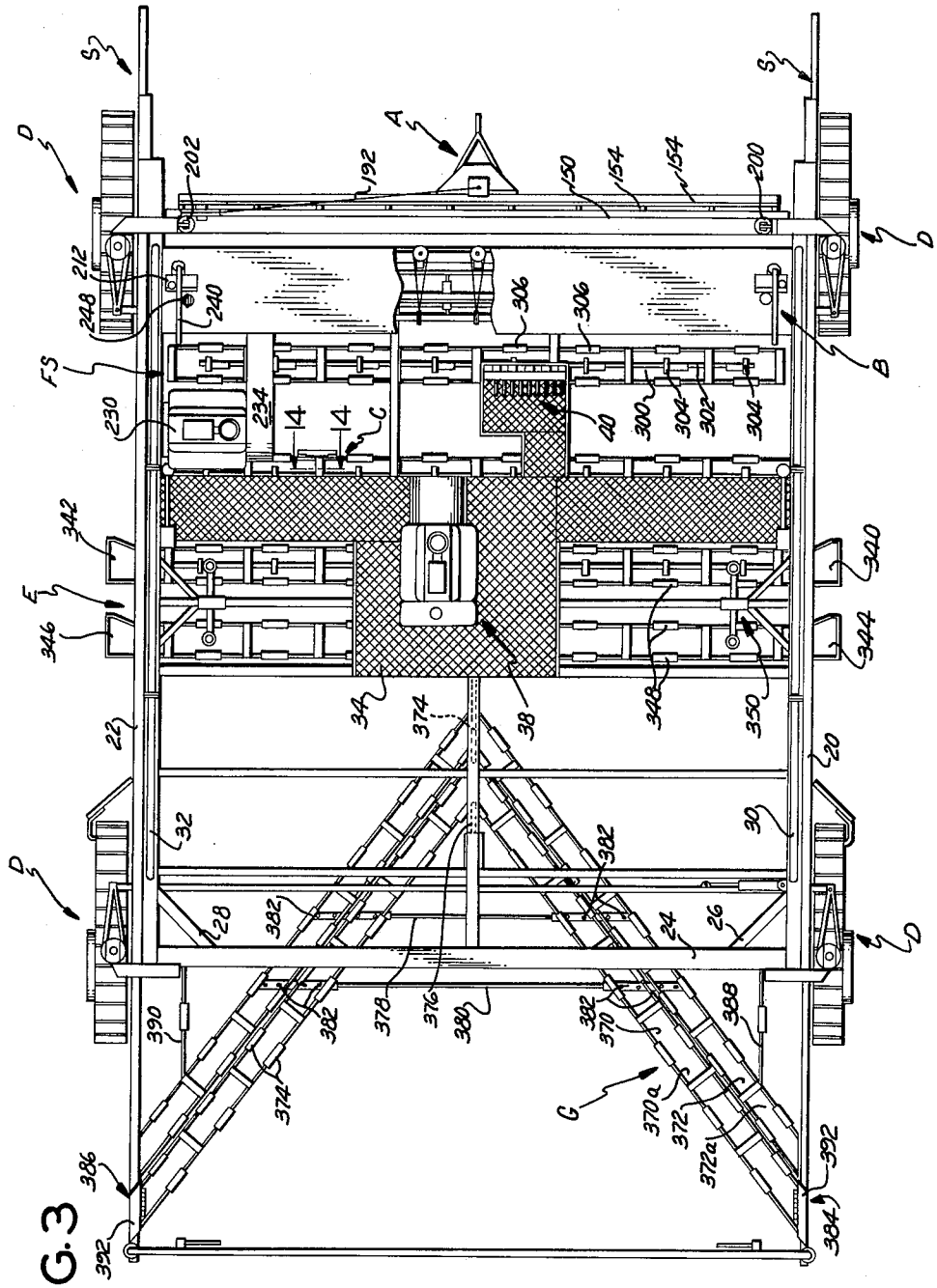

FIG. 3

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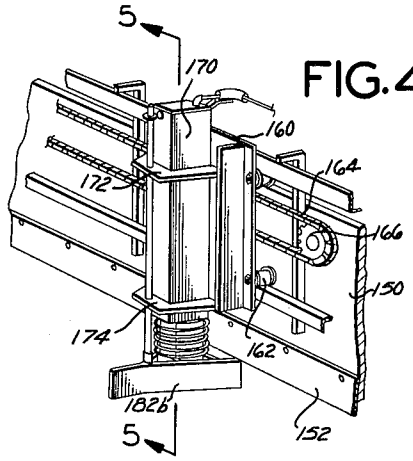

FIG. 4

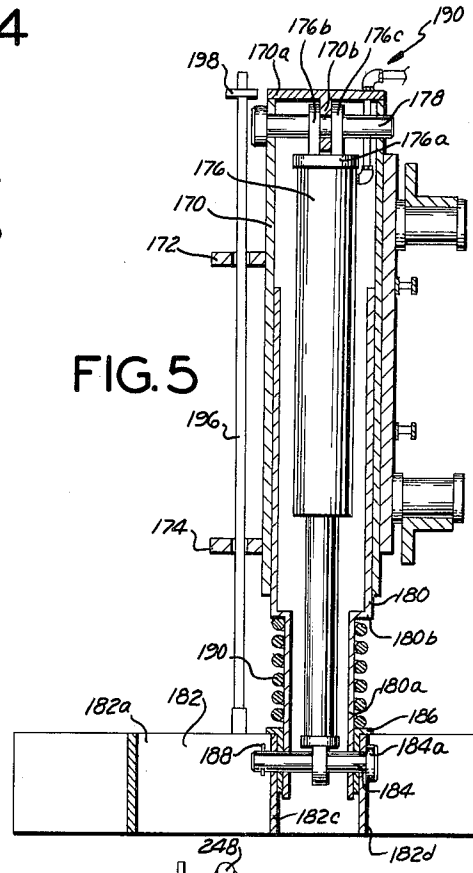

FIG. 5

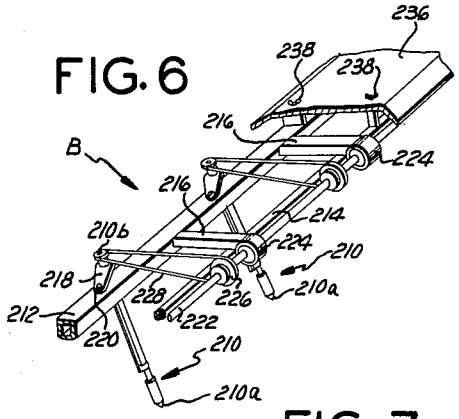

FIG. 6

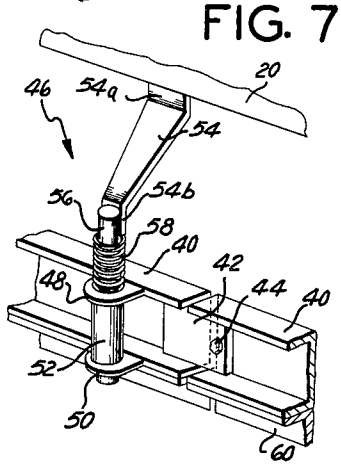

FIG. 7

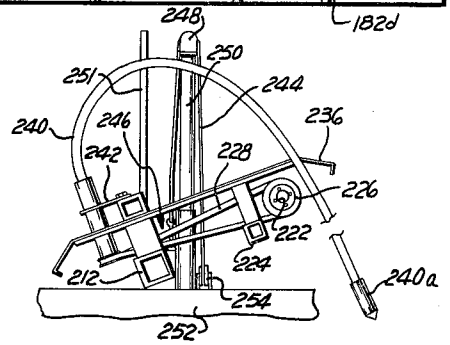

FIG. 8

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FIG. 9

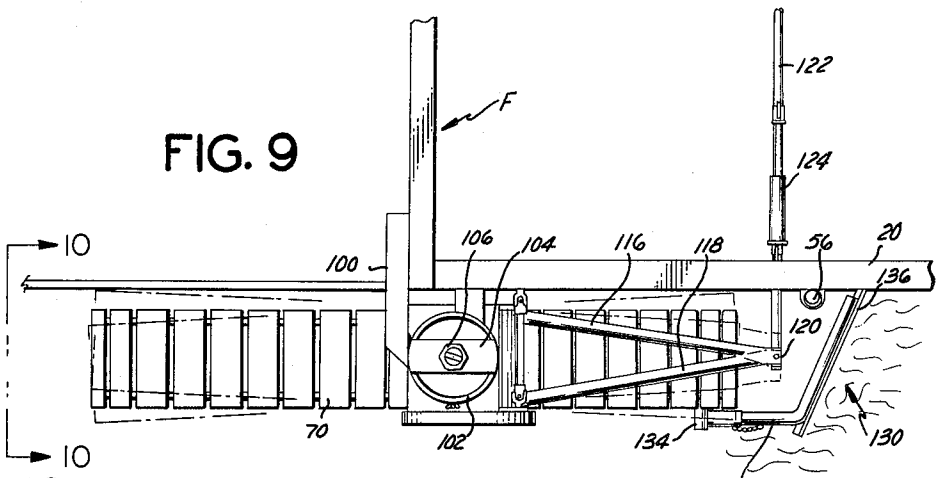


FIG. 10

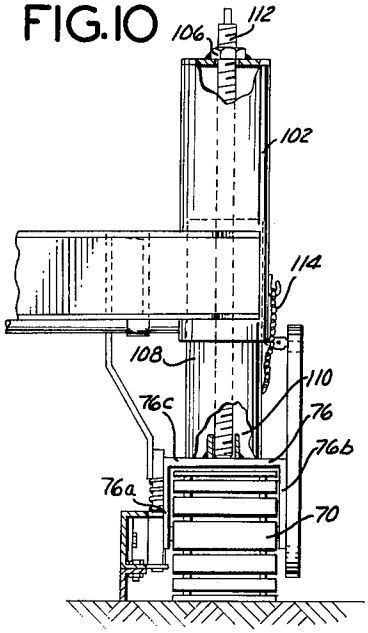


FIG. 11

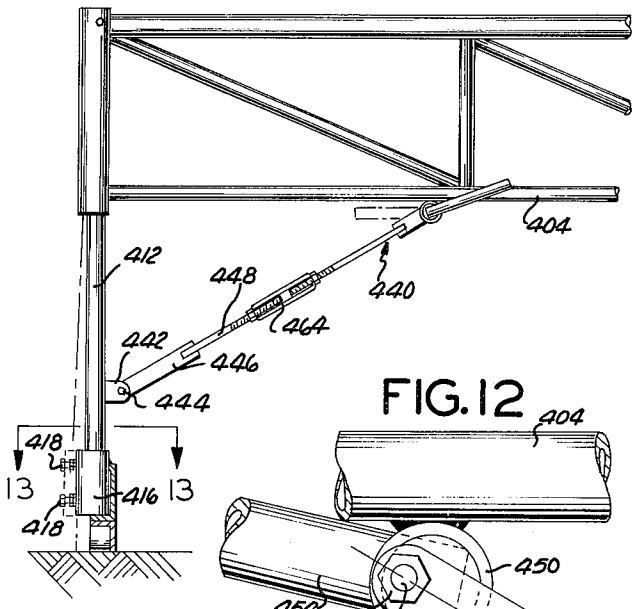
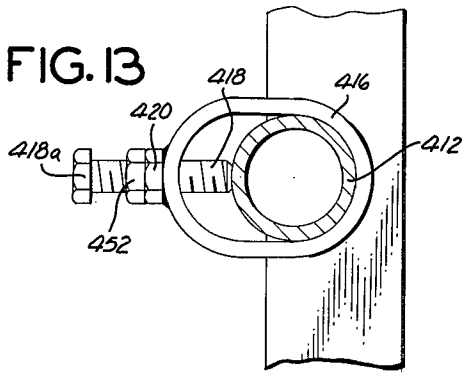


FIG. 12

FIG. 13



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United States Patent Office 3,220,323 Patented Nov. 30, 1965

3,220,323

PAVEMENT FINISHING APPARATUS

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Filed Apr. 2, 1962, Ser. No. 184,425
4 Claims. (Cl. 94—46)

The present invention relates generally to pavement finishing apparatus, but more particularly to an improved finisher having slip-forms.

It is common practice, in the making of roadways, airport runways, and other relatively large or long concrete surfaces, to lay one or more strips or sections of concrete. Heretofore, the usual practice has been to install a pair of spaced stationary side forms for defining the width of the concrete section. With this arrangement, the concrete was poured between the stationary side forms and the finishing apparatus then "worked" the concrete to remove air pockets or unwanted accumulation of aggregate material, and to provide the desired surface texture. The stationary side forms supported the concrete until it set.

A pavement finisher for use with stationary side forms as above-explained, is shown and described in my copending patent application Serial No. 673,450 filed July 22, 1957, for Pavement Finisher and now abandoned.

It is an object of the present invention to provide a concrete finisher having movable slip-forms.

Another object of this invention is to provide a pavement finisher as characterized above wherein the slip-forms are provided with suitable wear members which can be quickly and easily replaced as required.

Another object of the present invention is to provide a pavement finisher having slip-forms and which is driven by caterpillar-type endless tracks.

Another object of the present invention is to provide paving apparatus as characterized above which is capable of performing a plurality of different operations on concrete.

Another object of the present invention is to provide a pavement finisher as characterized above which is operated by suitable automatic drive means for simultaneously performing a plurality of different finishing operations.

Another object of the present invention is to provide a pavement finisher which is extremely flexible in that substantially all of the various functions afforded thereby can be independently adjusted according to prevailing conditions.

Another object of this invention is to provide a slip-form pavement finisher which includes means for suitably agitating the concrete to break up any accumulation of aggregate materials.

Another object of the present invention is to provide pavement finishing means as characterized above which includes means for shoveling concrete transversely of the direction of movement of the apparatus for providing the desired shape to the concrete being laid, as for instance along areas of super elevation.

Another object of the present invention is to provide in a pavement finisher as characterized above finishing screeds having vibrating action for effecting a smooth surface to a section of concrete.

Another object of the present invention is to provide a slip-form pavement finisher as characterized above having means for varying the relative position of the rear portions of the side forms to facilitate moving the finisher in a reverse direction for laying a new section of concrete in contiguous arrangement with previously laid concrete.

Another object of this invention is to provide a pavement finisher as characterized above which is relatively

simple and inexpensive to manufacture, but which is rugged and dependable in operation.

The novel features which I consider characteristic of my invention are set forth with particularity in the appended claims. The device itself, however, both as to its organization and mode of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIGURE 1 is a perspective view of a pavement finisher according to the present invention;

FIGURE 2 is a fragmentary perspective view of a portion of the drive means for the subject apparatus;

FIGURE 3 is a top plan view of the finisher of FIGURE 1;

FIGURE 4 is a fragmentary perspective view of the forward shovel of the subject apparatus;

FIGURE 5 is a vertical sectional view of the forward shovel actuating means taken substantially along line 5—5 of FIGURE 4;

FIGURE 6 is a fragmentary perspective view of a portion of the drive mechanism for the vibrators of the subject apparatus;

FIGURE 7 is a fragmentary perspective view of the mounting means for the apparatus;

FIGURE 8 is a fragmentary side elevational view of the vibrator mechanism;

FIGURE 9 is a fragmentary top plan view of one of the caterpillar type drive mechanisms of the subject apparatus;

FIGURE 10 is a rear elevational view taken substantially along line 10—10 of FIGURE 9;

FIGURE 11 is a fragmentary front elevational view of the adjustment means for the rear portion of the slip-forms:

FIGURE 12 is a fragmentary rear elevational view of a small portion of the adjustment means of FIGURE 11;

FIGURE 13 is a sectional view taken substantially along line 13—13 of FIGURE 11; and

FIGURE 14 is a fragmentary sectional view of an intermediate shovel taken substantially along line 14—14 of FIGURE 3.

Like reference characters indicate corresponding parts throughout the several views of the drawings.

General arrangement

Referring to FIGURES 1 and 3 of the drawings wherein is shown a preferred form of pavement finisher in accordance with the present invention, it is noted that the subject apparatus comprises a plurality of different operating devices.

Generally, the subject finisher comprises a square or rectangular frame F which carries suitable motive power means M and appropriate controls therefor. Also attached to frame F are suitable drive mechanisms D for propelling the apparatus along the surface to be covered with concrete. Depending from the frame F is a pair of spaced slip-forms S which are dragged over the surface to be paved, and which define the width of the section of concrete being laid.

Proceeding from the forward end of the apparatus to the rearward end thereof, it is seen that there is provided a forward shovel A for moving the concrete transversely of the direction of movement of the apparatus. An agitator section B is provided in back of the forward shovel A for properly agitating the concrete to remove air pockets and accumulated aggregate. A forward screed FS is positioned behind the agitator section for suitably leveling the surface of the concrete as will hereinafter be explained.

An intermediate shovel C is also provided, followed by a pair of finishing screeds E and a pair of V-shaped floats G for further smoothing the surface of the concrete.

Frame F

The frame F is formed of side channel members **20** and **22** which are held in spaced parallel relation by transverse members including a forward channel member (not-shown) and a rearward channel member **24**. Included in frame F are various other transverse support members and corner support members as shown at **26** and **28** all of which cooperate to provide a sturdy rectangular frame on which is mounted most of the components and sub-assemblies to be hereinafter described. For providing additional rigidity and strength to frame F, strengthening frames **30** and **32** may be provided on the side members **20** and **22** respectively.

On top of frame F is mounted a "cat-walk" in the form of steel mesh **34** providing a place for one or more operators to walk and control the subject finishing apparatus. Suitable hand rail means as shown at **36** in FIGURE 1 may be provided as deemed necessary.

Motive power means in the form of an internal combustion engine **38** is also mounted on frame F for providing the necessary power for operating all of the various components to be hereinafter described. As part of the motive power means for the subject apparatus, there is provided a hydraulic pump driven by engine **38** for providing the necessary fluid pressure for operation of hydraulic actuators to be hereinafter identified. A plurality of control valves **40** are also mounted on the frame F for suitable manipulation by the operators of the apparatus in controlling the flow of fluid pressure to such actuators.

Slip-forms S

The slip-forms S are formed of a plurality of sections of U-shaped channel members **40** as shown most clearly in FIGURE 7 of the drawings. The channel members **40** are contiguously arranged and are held in such position by connectors **42** each of which is fastened to one of the channel members **40** by a bolt **44**. The connection as afforded by connector **42** is loose so as to permit relative movement between the channel members **40** during operation of the paving apparatus. This enables the side forms, as will hereinafter become more apparent, to generally conform to the changes in contour of the surface being provided with concrete.

At predetermined spaced intervals along either side of frame F are mounting means **46** whereby frame F is partially supported on the slip-forms. At such intervals, the channel members **40** are provided with a pair of outwardly extending tabs **48** and **50** having aligned openings. A section of pipe **52** is suitably welded to tabs **48** and **50** concentrically of the aligned openings therein.

A depending bracket **54** having a slight S shape has its upper end portion **54***a* welded to side channel member **20** of frame F. The opposite end portion **54***b* of bracket member **54** is welded to a section of pipe or rod **56** which extends downwardly through the aligned openings in the tabs **48** and **50** and through the pipe **52** therebetween. A helical compression spring **58** is interposed between the upper tab **48** and the lower end portion **54***b* of bracket **54** to provide means for resiliently supporting frame F and its associated components.

Attached to the underside of each channel member **40** is an L-shaped wear member **60** as by suitable fastening means such as bolts or the like. To permit wear members **60** to be readily and easily replaced, such fastening means should be of the type which can be conveniently disassembled in the field.

Wear plates **60** together with the channel members **40** provide slip-forms which offer a vertical surface against which the concrete can form so as to provide the desired vertical side walls for the section of concrete being laid. Such slip-forms, of course, are part of the pavement finisher and are carried thereby across the ground surface being provided with concrete. The wear members **60** are in scraping or sliding contact with the ground surface throughout the operation of the apparatus and hence are subject to considerable wear.

It is thus seen that the slip-forms S rest on the ground surface and are dragged therealong by appropriate drive means to be hereinafter described, while the frame F and all associated equipment are partially supported by such slip-forms and resilient mounting means **46**. Thus, the heavy frame and other equipment provide sufficient weight for firmly holding the slip-forms in contact with the ground surface.

Drive means D

Although any appropriate number of drive mechanisms may be employed in the instant pavement finishing apparatus, the preferred embodiment shown in the drawings comprises two drive mechanisms D on each side of the apparatus. Each such drive means comprises an endless caterpillar-type track **70** which is suitably mounted on substantially centrally located drive gears and forward and rearward idler gears, no one of which gears is shown in the drawings. The endless track **70** is mounted on or formed integrally with one or more endless chains which cooperate with the drive gears and idler gears so as to be driven over the ground surface. Such gear members, however, are suitably mounted on a support member **72** in a manner common to devices or machines which presently employ caterpillar-type drive means.

The substantially centrally located drive gears are keyed to a drive shaft **74** which is rotatably mounted in an inverted U-shaped yolk **76**. Yolk **76** is formed with a pair of depending side members **76***a* and **76***b* which are joined together by an intermediate horizontal member **76***c*. Shaft **74** is suitably journaled in the depending side members **76***a* and **76***b* and carries a gear member **78** adjacent the side member **76***b*.

As shown most clearly in FIGURE 2 of the drawings, gear member **78** is driven by a drive gear **80** which is mounted adjacent the inner side wall of one of the side channel members of frame F. Drive gear **80** is suitably keyed to a drive shaft (not shown) which is rotated by internal combustion engine **38**.

The power transmission means of FIGURE 2 is used for driving the rearward drive mechanism D as shown in FIGURE 1. Accordingly, the shaft to which gear member **80** is keyed extends transversely of the apparatus and terminates adjacent the inner surface of channel member **20** of frame F. An elongated endless chain **82** is driven by gear member **80** and cooperates with a gear member **84** suitably journaled in channel member **20** near the rearward end portion thereof and also with a like gear member (not shown) near the forward end portion of said channel member **20**. Whereas the gear member **84** drives the caterpillar-type drive mechanism near the rear end portion of channel member **20** the above-mentioned corresponding gear member is part of the drive means for the drive mechanism D located near the forward end portion of channel member **20**.

As shown in FIGURES 1 and 2, gear member **84** is keyed to a shaft **86** which carries one-half of a universal joint **88**. The other half of universal joint **88** is connected to an intermediate shaft **90**.

In order to provide another horizontal shaft parallel to the shaft **86**, an additional universal joint **92** is utilized for connecting intermediate shaft **90** to a horizontal shaft **94**. Keyed to shaft **94** is a gear member **96** which cooperates with an endless chain **98** to transmit power to gear member **78**.

In FIGURE 1, the gear members **78** and **96** and drive chain **98** are covered by a shroud or protective shield **100**.

It is thus seen that power from internal combustion engine **38** is transmitted to gear member **80** located adjacent channel member **20** of frame F and to a similar

gear member adjacent the inner surface of channel member 22 on the opposite side of frame F. The gear member 80 drives endless chain 82 so as to simultaneously actuate the two drive mechanisms D on the right-hand side of frame F. In similar fashion, the drive mechanisms on the left-hand side of frame F are simultaneously driven by internal combustion engine 38.

Referring specifically to the drive means shown in FIGURE 2, it is seen that the chain 82 causes gear member 84 to drive the shafts 86, 90 and 94 so as to drive gear member 78 through gear member 96 and chain 98. In this manner, the drive shaft journaled between the side members of yolk 76 is rotated so as to rotate the drive gears for the caterpillar-type track.

It is thus seen that the four caterpillar-type drive mechanisms D are simultaneously actuated to propel the pavement finisher. By suitable manipulation of the controls near the engine 38, an operator can cause the apparatus to move forward or in a reverse direction as desired.

Each drive mechanism D is suitably fixed with respect to frame F such that the relationship therebetween can be varied by suitable adjustment means. This enables the operators of the apparatus to control the amount of weight supported by the drive mechanisms and the amount of weight of the apparatus supported by the above-described slip-forms. In this manner, the desired sliding action of the slip-forms over the ground surface can be provided.

The adjustable connection between the drive mechanisms D and the frame F is shown most clearly in FIGURES 1, 9 and 10 of the drawings. Attached to frame F as by welding or the like, is a U-shaped channel member 100. Channel member 100 extends outwardly from the side of frame F and has welded to the extended end portion thereof a section of cylindrical pipe 102. Across the upper end portion of pipe section 102 is a strap 104 which is welded to pipe section 102. Strap 104 is provided with a through opening over which is coaxially positioned a fastening nut 106. Nut 106 is welded to strap 104 as shown in FIGURE 10.

Telescopically fitted within the lower end portion of pipe section 102 is a cylindrical hollow pipe 108. The lower end portion of pipe 108 is attached to the intermediate member 76c of yolk 76 as by welding or the like. A retainer 110 in the form of a smaller pipe section is also welded to yolk 76 concentrically of and within pipe 108 as shown most clearly in FIGURE 10. An adjustment screw 112 the upper end portion of which is square or hexagonally shaped to be gripped by a wrench, is inserted within the telescopically connected pipe sections 102 and 108. Screw 112 is threaded into nut 106 and has its lower end portion positioned within retainer 110. As will be readily apparent to those persons skilled in the art, this arrangement permits an operator to turn adjustment screw 112 relative to nut 106 to thereby vary the relative position of the particular drive mechanism D with respect to frame F. To prevent separation of the telescopically connected members 102 and 108 in the event the pavement finisher is lifted, there is provided a loose fitting chain 114 the opposite ends of which are individually connected to said members 102 and 108.

For steering each of the drive mechanisms D there is provided a pair of steering arms 116 and 118 joined together as at 120. The opposite end of each of the arms 116 and 118 is suitably anchored to yolk 76 as by being welded to intermediate portion 76c thereof.

A steering rod 122 extends transversely of the frame F of the pavement finisher and has its opposite ends connected to the steering arms of the oppositely disposed drive mechanisms D as will now be described.

A steering shaft 122 is provided for each of the forward and rearward pairs of drive mechanisms D. Each such drive rod is suitably journaled with respect to frame F for reciprocatory movement. The opposite ends of steering rod 122 are connected to the juncture of the respective steering arms. A hydraulic cylinder 124 is connected between side member 20 of frame F and the steering rod 122 so as to effect reciprocatory movement thereof in accordance with the steering action to be effected. Hydraulic actuator 124 is, of course, connected by suitable flexible conduits to the hydraulic pump which is actuated by internal combustion engine 38 as above-described. Thus as actuator 124 causes steering rod 122 to move upwardly as shown in FIGURE 9, the steering arms 116 and 118 cause the drive mechanism D to be rotated about pipe section 102 in a counterclockwise direction. Conversely, of course, as actuator 124 moves rod 122 downwardly the drive mechanism D is rotated in a clockwise direction.

Mounted in front of each of the rear drive mechanisms D is a deflector 130 for deflecting out of the path of the respective drive mechanism any concrete which, in the course of the finishing operations to be described, is caused to be forced beyond the above-described slip-forms. Such deflector, as shown in FIGURE 9, comprises a suitably angled rod 132 which is rotatably mounted on support member 72 of such drive mechanism by means of a suitable fitting 134. A deflector blade 136 is welded to rod 132 as shown in said FIGURE 9, said blade thereby being disposed at an angle with respect to the direction of travel of the apparatus and extending from adjacent the side form to a point beyond the path of the respective drive mechanism. As shown most clearly in FIGURE 3 of the drawings, each of the rear drive mechanisms D is provided with a deflector 130.

Forward shovel A

Referring to FIGURES 1, 3, 4 and 5 of the drawings, it is seen that the forward shovel A is movably mounted on a strike-off plate 150, the latter of which is fastened by any desired means to frame F. As shown most clearly in FIGURES 1 and 4 of the drawings, plate 150 may be provided with a strike-off member 152 along its lower edge. Such member may be fastened to plate 150 in any desired manner as by means of fastening bolts or the like. Since strike-off member 152 is subject to considerable wear it is desirable that it be removably fixed to strike-off plate 150 to permit of quick and easy replacement.

On the forward face of strike-off plate 150 are positioned a plurality of spaced mounting brackets 154 which carry in spaced relation a pair of horizontally disposed L-shaped channel members 156 and 158. Mounting brackets 154 may be welded to the face of strike-off plate 150 and channel members 156 and 158 may, in turn, be welded to such mounting brackets.

A mounting plate 160 (see FIGURE 4) is positioned relative to strike-off plate 150 for rectilinear movement thereon. Fastened to plate 160 as by mounting bolts or the like, are four rollers 162 which are spaced for cooperation with angle members 156 and 158 as shown most clearly in FIGURE 4. Two such rollers 162 are attached to plate 160 for engagement with upper angle member 156 while the other rollers are mounted thereon for cooperation with the lower angle member 158. Each of such roller members 162 is formed with a pair of spaced annular end flanges to permit such roller to straddle the respective angle member to securely mount the shovel A on the strike-off plate 150 while permitting relative rectilinear movement with respect thereto.

For effecting such rectilinear movement of forward shovel A, there is provided an endless chain 164 which cooperates with a pair of gear members (only one of which is shown at 166) disposed at opposite ends of plate 150. Mounting plate 160 is suitably secured to one of the horizontally disposed sections of chain 164 so that shovel A is caused to move in response to rotation of the gear member 166 under the influence of internal combustion engine 38.

Connected relative to mounting plate 160 is an actuator housing 170 for the forward shovel A. Housing 170 is substantially square in cross section and is carried by a pair of horizontally disposed mounting members 172

and 174. These mounting members are connected to frame 160 as by welding or the like to provide a unitary structure therewith.

Positioned within housing 170 is a hydraulic actuator 176 the upper end portion of which is provided with a cover 176*a* having a pair of upstanding tabs 176*b* and 176*c* which are spaced to receive a depending tab 170*b* of a cover 170*a* of the housing. A pin 178 is positioned in suitably aligned openings in opposite side walls of housing 170 and in tabs 176*b*, 170*b* and 176*c* as shown most clearly in FIGURE 5 of the drawings.

Telescopically fitted within the lower end portion of housing 170 is a tubular member 180 having a substantially square cross-sectional configuration. Member 180 is provided with a reduced lower end portion 180*a* affording a shoulder 180*b*.

A shovel member 182 is connected to the reduced lower end portion 180*a* of telescopic member 180 and comprises a pair of angularly disposed side members 182*a* and 182*b* which are connected together to form a generally V or Y-shaped shovel. A pair of transverse structural members 182*c* and 182*d* are provided between the shovel members 182*a* and 182*b*.

Interconnecting the reduced lower end portion of telescopic member 180*a* and the lower end portion of the ram or piston of the hydraulic actuator 176 is a pin 184. Such pin also extends through suitable openings formed in transverse members 182*c* and 182*d* and a spring retainer 186 which is interposed between such members and the lower end portion 180*a* of member 180. Pin 184 is formed with an enlarged end portion or head 184*a*, there being a cotter pin or key 188 insertable into a transverse opening in the other end of pin 184 to retain the parts in assembled relation as shown in FIGURE 5. A compression spring 190 is interposed between shoulder 180*b* of telescopic member 180 and the upper flanged end portion of spring retainer 186. For reasons which will hereinafter become more apparent, the aligned openings in members 182*c*, 182*d*, retainer 186, lower end portion 180*a* of member 180 and the lower end portion of hydraulic actuator 176 are made oversize so that shovel member 182 is pivotal within substantially any vertical plane. This arrangement affords a resilient mounting for shovel member 182 so that it can perform its intended functions, compression spring 190, of course, tending to position shovel member 182 in a horizontal plane and affording such resilient mounting.

Suitable hydraulic tubing or conduit means identified generally with the numeral 190 is provided between the cover 170*a* of housing 170 and the hydraulic actuator 176 to conduct hydraulic fluid to the latter for actuation which will be hereinafter described. As shown most clearly in FIGURE 3 of the drawings, flexible hydraulic conduit 192 is connected with conduit means 190 to bring hydraulic fluid from the aforementioned pump which is driven by internal combustion engine 38. Flexible conduit 192 is wound on a spool or drum 194 which is spring biased to maintain a minimum but constant tension on such conduit. With this arrangement, as forward shovel A moves back and forth on strike-off plate 150, the flexible conduit 192 is extended or retracted accordingly.

Mounted on shovel member 182 is a gauge rod 196 which extends through suitable openings in horizontal mounting plates 172 and 174. The upper end of rod 196 may be provided with an indicator 198 if desired. It will be noted that this arrangement affords indication of the vertical position of shovel member 182 with respect to housing member 170, this being desirable in view of the fact that shovel member 182 is hidden from the operator's view by strike-off plate 150.

Hydraulic actuators as shown at 200 and 202 in FIGURE 3 are operable from hydraulic control panel 40 to independently adjust the vertical position of the opposite ends of strike-off plate 150. As will be readily apparent to those persons skilled in the art, this feature is particularly desirable in making banked turns in a section of concrete. Thus, it may be desirable to adjust one side of the strike-off plate 150 higher than the other.

Agitator section B

Immediately behind strike-off plate 150 and extending transversely of the apparatus is the agitator section B. As shown most clearly in FIGURE 6, this section comprises a plurality of rotatable agitators 210 which are provided with depending lower end portions 210*a* in the nature of eccentrics. The agitators 210 are mounted with respect to a square channel member 212 which is firmly mounted with respect to the aforedescribed frame F. Additional support members in the form of a channel member 214 parallel to member 212 and a plurality of spaced support members 216 are provided for further supporting the agitator structure.

Each of the agitators 210 is adjustably connected to channel member 212 by a pivotal finger 218. One end of each finger 218 is secured to channel member 212 by adjustable fastening means such as bolt 220. The upper end portion of the respective agitator 210 is supported by the finger 218 and carries a pulley 210*b*.

A drive shaft 222 mounted in suitable bearings 224 is rotatably positioned with respect to frame member 214. Drive shaft 222 carries pulleys 226, one for each of the agitator mechanisms 210 employed in the agitator section B. A belt 228 drivingly interconnects each pulley 226 and the pulley 210*b* on the upper end portion of the respective agitator 210. Drive shaft 222 is connected to an auxiliary engine 230, having separate control means 230*a*, by appropriate pulleys and V-belt power transmission means, as shown at 232 in FIGURE 1. Such power transmission means, of course, is operable to rotate drive shaft 222 at the desired rate of speed. A protective covering 234 is provided over the power transmission means 232 for obvious reasons of safety.

As shown in FIGURE 6 of the drawings, an elongated cover 236 is provided over the drive means for the actuators 210, there being finger-operated fastening means 238 for quick and easy removal of cover 236 for purposes of repairing the agitator equipment.

Agitators 210 are rotated at a relatively high rate, and this together with the eccentric action of the lower end portion 210*a* effects agitation of the concrete so as to break up any accumulation of aggregate and to disperse unwanted air pockets. Such agitators, of course, are spaced along the entire transverse dimension of the pavement finishing apparatus.

At opposite ends of the agitator section B, are outside agitators which are constructed somewhat differently due to the special problems encountered adjacent the aforedescribed slip-forms. That is, it has been found desirable to effect agitation of the concrete immediately adjacent the slip-forms. To accomplish this, it is necessary to have the end agitators freely positionable so that they can be placed wherever desired.

As shown in FIGURE 8 of the drawings, the end agitators as shown at 240 extend upwardly through a suitable opening in the cover plate 236 and are then bent downwardly toward the rear of the pavement finisher. The end portion 240*a* of such agitator 240 can then be positioned in the concrete at the desired place.

The agitator 240 is mounted with respect to channel member 212 by a bracket 242 similar to bracket 218 shown in FIGURE 6. The bracket 242 is adjustable for varying the tension on the respective drive belt 228 which extends from the drive shaft 222 to the respective agitator.

Hydraulically operated adjustment means is provided for varying the vertical position of the agitator section B. Such means comprises an hydraulic actuator at the right-hand end of the agitator section. Such actuator directly moves that end of the section and, by means of a line 244 also moves the other end thereof. Line 244 has

one of its ends fastened to the aforedescribed frame composed of channel members **212**, **214** and **216** as shown at **246** in FIGURE 8. Line **244** also extends over a pulley **248** in the upper end portion of a post or stanchion **250** secured to a member **252**, the latter of which is anchored relative to the aforedescribed frame F. Line **244** also cooperates with a pulley **254** rotatably positioned on member **252** and extends the length of member **252**. At the right-hand end of member **252**, line **244** is wound on a suitable pulley fastened relative to member **252** and the end portion thereof is fixed to the agitator frame comprised of members **212**, **214** and **216**. As will be realized by those persons skilled in the art, this arrangement results in the left-hand end portion of the agitator section B moving upward or downward with the right-hand end portion thereof as the latter moves under the influence of the afore-mentioned hydraulic actuator. That is, as the right-hand end portion of the agitator section moves, the line **244** is moved a corresponding amount with respect to stationary member **252**. Such movement of line **244** causes the end portion **246** thereof to raise the left-hand end portion of the agitator section. Thus, a single hydraulic actuator is used for simultaneously moving the agitator section B in a vertical plane. Suitable gauges in the form of sections of pipe **256** and **258** at either end of the agitator section are provided as shown in FIGURE 1. Such pipe sections are firmly anchored to stationary member **252** and extend upwardly through appropriate openings formed in cover member **236**. Thus vertical movement of agitator section B changes the amount of such pipe sections exposed above the cover **236**.

Forward screed FS

The forward screed FS is positioned immediately behind agitator section B. It is constructed on the order of the screeds described in my copending application Serial No. 673,450. Briefly, such screed FS is formed of an alongated pan **300** on which is suitably positioned a vibratory shaft **302**. On shaft **302** is mounted a plurality of eccentrically arranged weights such that as shaft **302** is rotated, the weights **304** vibrate the screed FS. The vibratory shaft **302** is driven by the internal combustion engine **38**, there being suitable power transmission means interposed between such engine and such shaft.

The forward screed also comprises a frame work which, as explained in the aforementioned copending application, includes a plurality of turnbuckles **306** arranged on the opposite elongated sides of the screed. Such turnbuckles **306** are manually operable to vary the shape or contour of the forward screed FS.

Hydraulic actuators are positioned at each end of screed FS to facilitate individual positioning of the end portions thereof in accordance with the surface of the concrete to be provided.

Variable drive means (not shown) is provided in the power transmission means between the engine **38** and the shaft **302** to facilitate variation of the vibratory action afforded the forward screed.

Intermediate shovel C

The intermediate shovel C is similar to that shown and described in the aforementioned copending application Serial No. 673,450. Briefly, as shown in FIGURE 14, it comprises a depending shovel member **310** which is mounted on a platform **312**, the latter of which is movable relative to a pair of opposed U-shaped channel members one of which is shown at **314**. Such channel members are adjustably mounted relative to the aforedescribed frame F and extend transversely of the direction of movement of the apparatus.

The platform **312** carries four wheels, two on either side thereof. As shown in FIGURE 14 two of the wheels **316** and **318** are positioned within channel member **314**, while the other wheels (not shown) are positioned within the channel member which is in opposed relation to the member **314**. In this manner, the platform **312** and the shovel **310** are permitted to move back and forth, transversely of the concrete being laid.

The shovel member **310** comprises a pair of side members **310***a*, and a blade **310***b* connected between the lower end portions of the side members. The upper end portions of the side members are pivotally mounted on platform **312** whereby the blade **310***b* depends into the concrete being worked. A pair of pin-receiving tubular members **320** and **322** are positioned on platform **312** on opposite sides of the upper end portions of shovel **310**. Such tubular members are formed to receive a pin **324** for preventing or limiting the amount of pivotal movement of shovel **310**. That is, with pin **324** in tubular member **320** as shown in FIGURE 14, shovel **310** is permitted to move from its solid line position to its broken line position as shown therein. However, shovel **310** cannot pivot to the right as shown in FIGURE 14 due to the limit stop function of pin **324**. Such arrangement permits shovel **310** to move concrete to the left, as shown in FIGURE 14, but prevents movement of concrete to the right. Thus shovel **310** is operable to move concrete in only one direction. In the event it is necessary to reverse the action of shovel **310**, it is merely necessary to remove pin **324** from within tubular member **320** and insert the same within tubular member **322**.

As shown and described in the aforementioned copending application, the entire shovel mechanism C is moved back and forth by a chain drive connected with engine **38**. However, such drive means might take substantially any desired form which is capable of affording rectilinear reverse movement to the entire shovel mechanism.

Finishing screeds E

The finishing screeds E are also fully described and shown in the aforementioned copending application.

Briefly, such screeds are adjustable with respect to the afore-described frame F so as to be positionable in accordance with the desired pavement surface to be provided. Such screeds are oscillatory and may or may not be provided with vibratory means as desired.

As shown most clearly in FIGURES 1 and 3, each finishing screed is provided with a pair of shoes as shown at **340** and **342** on the forward finishing screed and as shown at **344** and **346** on the rearward screed. Such shoes are hingedly positioned on the ends of the screeds and rest on top of the afore-described slip-forms S. As fully explained in the afore-mentioned copending application, there is also provided means for firmly fastening such shoes in horizontal alignment with the respective screeds, if such arrangement is desired. Generally, however, such shoes **340**, **342**, **344** and **346** are permitted to pivot with respect to the screeds to which they are attached so as to provide the desired pavement surface irrespective of flexing or relative movement of the various sections of the slip-forms.

Finishing screeds E are also formed with turnbuckles **348** which facilitate adjustment of such screeds according to the desired shape or contour of the surface to be provided. As shown at **350**, the finishing screeds are tied together so as to have reverse oscillatory motion as fully explained in the aforementioned application. Reference should be had to the aforementioned co-pending application Serial No. 673,450 for a complete understanding of all the details of construction and operation of the finishing screeds.

V-shaped floats G

The floats G are shown at **370** and **372** and comprise pans **370***a* and **372***a* respectively. In addition, such floats are V-shaped as shown most clearly in FIGURE 3 of the drawings and comprise turnbuckles as shown at **374** which, as above-described with respect to the screeds, are operable to vary the shape or contour of the floats.

Floats **370** and **372** are individually supported at their forward end portions by support members **374** and **376**

which depend from the afore-described frame F. Such support members afford a flexible connection between the frame and the respective floats whereby the latter are free to move with respect to the former. A pair of adjustable braces 378 and 380 is provided across the floats. Such braces are suitably secured to both sides of each of the floats by suitable fastening means as shown at 382. By properly adjusting braces 378 and 380, the angle of disposition of the floats with respect to the concrete surface can be varied. This, of course, has a marked effect on the texture and smoothness of the resulting surface of the concrete.

The rearward end portions of float 370 are supported on the adjacent end portions of the side forms S as shown at 384 and 386. The rearward end portion of float 372, on the other hand, is supported by suitable adjustable brackets 388 and 390 which extend from the transverse channel member 24 of the afore-described frame F. Thus by suitable manipulation of brackets 388 and 390 the rearward or trailing ends of the float 372 can be varied as desired. In this manner, the floats provide a smooth finish to the pavement due to the floating action theerof as the apparatus is propelled over the concrete section.

To close the end of float 370, there is provided a leveling block or shoe 392 at each rearward end portion thereof. The blocks 392 are hingedly fixed to the respective ends of float 370 and when in their operating positions as shown in FIGURES 3 and 1 rest on the slip-forms S.

The purpose of the shoes or blocks 392 is to permit of separation of the rearward end portions of the slip-forms as will hereinafter be described. That is, such shoes afford extensions for the rearward end portions of the float 370, which extensions can be quickly and easily removed from the side forms when the latter are to be separated. It is a simple matter, of course, to return the shoes 392 into engagement with the top of the slip-forms after the latter have been returned to their operating positions.

Across the rear of the apparatus is a frame 400 which, if desired, may be used to support burlap in the event it is desired to provide a burlap finish to the pavement being laid. Such frame 400 comprises a pair of horizontal tubular members 402 and 404 which are held in spaced relation by a pair of tubular end members 406 and 408 and a plurality of intermediate support members 410.

A pair of supporting rods or pipes 412 and 414 are inserted into the pipe members 406 and 408 respectively. The lower end portion of pipes 412 and 414 are received by tubular members fastened to the rearward end portions of the respective slip-forms S. One of such tubular members is shown at 416 in FIGURES 1, 11 and 13.

Each of such tubular members is welded to the respective slip-form and is provided with a pair of fastening bolts 418 which threadedly engage a nut 420 welded to the side of section 416. Each bolt 418 also extends through a suitable opening in the side wall of pipe section 416. A lock nut 422 is provided on the shank of bolt 418 for firmly retaining the latter in adjusted position as will hereinafter be described. Each bolt 418, of course, is formed with a head 418*a* for receiving a wrench to facilitate such adjustment.

Due to the afore-described arrangement, as shown most clearly in FIGURES 11 and 13 of the drawings, the depending supporting pipes 412 and 414 of frame 400 are inserted into the respective pipe sections, and the bolts 418 are tightened thereagainst to firmly retain the frame 400 in the proper position on the apparatus.

As shown most clearly in FIGURE 11 of the drawings, there is a manually operable expansion mechanism 440 on each side of frame 400. Each expansion mechanism 440 comprises a tab 442 welded to the respective depending pipe from frame 400. Connected to each tab 442 as by a bolt 444 is a connecting link 446 which carries a threaded stud 448.

Welded to the underside of each end portion of horizontal member 404 of frame 400 is a cylindrical pipe section 450 the axis of which is disposed normal to the axis of pipe member 404. Positioned within pipe section 450 is a cylindrical member 452 for rotation therewithin by a handle 454.

Connected to cylindrical member 452 but at a point removed from the axis of rotation thereof, is a connecting link 456. A bolt 458 having a nut 460 may be provided for this purpose. A threaded stud 462 is secured to lever 456 as by welding or the like. A turnbuckle 464, as shown in FIGURE 11, is positioned on studs 448 and 462 to effect adjustment of the expansion mechanism 440 as will hereinafter be described.

By suitable manipulation of handle 454, the post 412 can be moved from its solid line position shown in FIGURE 11 to the broken line position shown therein. This is accomplished by moving the handle from its position as shown in solid lines in FIGURE 11 to its position as shown in broken lines therein. The cylindrical plug 452 acts as an eccentric so as to move post 412 outwardly.

Such movement of post 412 forces the rearward end portion of the respective slip-form to a new position. This is particularly desirable when a section of concrete is to be laid in a contiguous manner with respect to a previously laid section of concrete. That is, in commencing a days work, it is frequently necessary to continue a section of concrete which was interrupted at the end of the previous days work. The previously laid concrete, of course, has set by this time and it is desirable to add a new section as an extension thereof.

To commence such operation, the expansion mechanisms 440 on either side of frame 400 are manipulated so as to further separate the rear end portions of the slip-forms. Then, the entire apparatus is moved rearwardly until the apparatus is positioned properly for laying the new concrete at the very terminous of the previously laid section of concrete. Then, of course, the adjustment means 440 on either side of the frame 400 are reversely actuated so as to return the slip-forms to their proper operating positions.

Operation of apparatus

The above-described pavement finisher operates generally as follows.

The subject apparatus is self-propelled by the motive power means M. Thus, with such means in operation, the entire apparatus can be caused to move in a forward direction along the surface to be covered with concrete. During such movement of the apparatus, fluid concrete is poured between the forward end portions of the slip-forms S, immediately forward of the shovel A. Such pouring apparatus may take substantially any desired form and may include a strike-off member for generally leveling the fluid concrete between the slip-forms.

The forward shovel A is caused to move back and forth laterally of the direction of movement of the apparatus. Such movement of shovel A is effected by the motive power means M through suitable power transmission means including the endless chain 164. Shovel A, of course, is movably supported on rollers 162 in engagement with the angle members 156 and 158 mounted on the front of the strike-off member 150.

The position of shovel blade 182 can be readily adjusted by varying the fluid pressure applied to actuator 176. That is, as pressure is applied to such actuator, the piston (not shown) within the cylinder is moved downwardly so as to cause shovel blade 182 to move in the downward direction. Application of pressure in the reverse direction, of course, causes shovel blade 182 to be raised. The application of fluid pressure to actuator 176 is controlled from the control panel 40 as shown in FIGURE 3. The gauge rod 196 accords a visual indication

to the operator of the height of the shovel blade **182** at any given moment. Also, as shovel A is caused to move on strike-off member **150**, the fluid pressure line **192** is wound or unwound on reel **194** accordingly.

It should be particularly noted that shovel blade **182** is pivotally mounted on the reduced lower end portion **180***a* of member **180** by means of pin **184**. Such connection is intended to be relatively loose so as to permit blade **182** to readily move from one pivotal position to another. A compression spring **190** tends to maintain blade **182** in a horizontal central position, and also acts as biasing means against which the sidewise motion of the shovel A acts in tilting shovel blade **182** about pivot pin **184**. With this arrangement, shovel A is enabled to sweep back and forth spreading out the fluid concrete.

Immediately behind shovel A is the strike-off member **150**, the strike-off edge **152** thereof engaging the fluid concrete and leveling the same to a predetermined depth. As above-explained, the depth to which such strike-off member **152** levels the concrete, can be controlled by suitable actuation of hydraulic actuators **200** and **202** from the control panel **40**. In this regard, it should be noted that in forming structures having super elevations, as for instance in making banked curves in roadways, the strike-off plate can be adjusted so that one end thereof is higher than the other.

Following the strike-off blade **150** is the agitator section B described above. The lower end portion **210***a* of each agitator **210** is positioned within the fluid concrete and by virtue of the afore-described eccentric action of such lower end portions, the concrete is suitably agitated so as to disperse any accumulation of aggregate materials and any air pockets which might tend to weaken the resulting concrete structure. Such agitators, of course, are operated from the auxiliary engine **230** through the transmission means **232** which drives the rotatable shaft **222**. The individual agitators **210**, of course, are driven by shaft **222** through the respective pulley **226**, belt **228** and pulleys **210***b*.

The end agitators as shown most clearly in FIGURE 8 of the drawings, should be properly positioned in close proximity to the side forms S to insure proper agitation in this region. As above-explained, such end agitators have elongated flexible cables to facilitate placement of the lower end portions thereof in the desired locations.

The entire agitator section B can be raised and lowered as desired to control the depth of the lower end portions of the agitators **210** within the fluid concrete. Such operation is effected by suitable actuation of the hydraulic actuator at one end of the agitator section. Such actuator moves the adjacent end portion of the agitator section up or down, as desired, and by means of the cable **244** which cooperates with pulleys **248** and **254**, the other end of the section is moved accordingly. Thus, by use of the single hydraulic actuator the entire agitator section B is positioned as desired.

The gauge **251** shown in FIGURE 8 affords a visual indication for the operator as to the vertical position of the agitator section.

Immediately behind the agitator section B is the forward screed FS. As above-explained, screed FS is driven by motive power means M. This results in the pan **300** of screed FS vibrating along the surface of the fluid concrete. Such action, of course, results from the rapid rotation of the eccentric weights on the shaft **32** as fully explained in my copending patent application Serial No. 673,450.

Behind the forward screed FS is the intermediate shovel C which is caused to move laterally of the direction of movement of the apparatus. As above-explained, such shovel moves within opposed channel members one of which is shown at **314** in FIGURE 14. Such action results from the motive power means M through suitable transmission means.

Of particular importance in the operation of intermediate shovel C is the fact that by suitable positioning of stop pin **324**, the shovel blade **310** can be caused to move concrete in only one lateral direction. Thus, such shovel can be caused to move concrete toward the high side of a super elevation. For instance, in the laying of concrete along a banked turn of a roadway, there is a tendency for the concrete to flow down toward the lowest point of the banked turn. To compensate for this the intermediate shovel C can be used to push the concrete from the lowest point toward the highest point of the turn.

Immediately behind the intermediate shovel C are the finishing screeds E. With the shoes **340**, **342**, **344** and **346** resting on the adjacent slip-forms, the finishing screeds E provide a smooth finish to the entire pavement. As fully explained in my copending application Serial No. **673,450**, such finishing screeds may be provided with a vibratory action as by means of suitably eccentrically arranged weights. In any event, such finishing screeds E have an oscillatory motion so as to effect "working" of the surface of the concrete so as to cause the heavier aggregate to sink beneath the surface of the concrete pavement. In this regard, the desired effect is obtained in that the lighter and hence smaller particles of cement and aggregate are "worked" to the surface to provide a flat smooth texture for the surface of the resulting pavement.

As above-explained with respect to both the forward screed FS and the finishing screeds E, they may be suitably adjusted by means of the turnbuckles to provide the desired contour or "crown" for the resulting pavement.

To the rear of the finishing screeds E are the V-shaped floats G which are dragged across the surface of the concrete for further providing a flat smooth finish. Such floats are also adjustable by means of turnbuckles to effect the desired shape and contour for the resulting pavement.

The shoes **392** at the opposite ends of the rear float should be positioned on top of the adjacent slip-forms S so as to complete the surfacing of the pavement at the ends thereof. The V-shaped floats can be adjusted vertically by means of the support members **374** and **376** as above explained.

If desired, sections of wet burlap material can be suspended from the frame **400** at the rear of the apparatus to provide a burlap finish to the pavement.

It should be particularly noted that throughout the afore-described operation of the subject apparatus, the slip-forms S are dragged along the surface to be covered with concrete. They provide the side structures for providing the vertical sides for the resulting pavement. Such arrangement eliminates the need for stationary forms which heretofore have necessitated considerable time and effort in the formation of relatively long sections of concrete. Such slip-forms, as above-explained, are made in various sections **40**, as shown in FIGURE 7, which are movable with respect to each other so as to conform to the variations in the surface of the ground.

The drive mechanisms B are driven from the source of motive power M by transmission means as shown in FIGURE 2. This arrangement causes the endless tracks **70** of the four drive mechanisms to operate so as to move the entire apparatus as desired.

Throughout the operation of the afore-described apparatus, the deflectors **130** on the outside of the slip-forms S remove any fluid concrete from the path of the rear drive mechanisms.

It is thus seen that the present invention provides pavement finishing apparatus having slip-forms. Further, Such invention or apparatus is capable of performing a plurality of functions in a very quick and efficient manner. Such functions can be effectuated by a minimum number of operating personnel.

This, of course, results in an appreciable saving in the construction of large sections of concrete pavement.

Although I have shown and described certain specific embodiments of my invention I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessi-

tated by the prior art and by the spirit of the appended claims.

I claim:

1. A pavement finisher, comprising:

a frame;

means for propelling said frame over a surface to be paved;

a pair of slip-forms mounted on said frame for defining the margins of said pavement, each of said slip-forms being defined by a plurality of contiguously arranged slip-form elements, said slip-form elements being loosely connected so as to permit relative movement therebetween in a vertical plane;

and mounting means interposed between said frame and said slip-forms, said mounting means including vertically-acting resilient means that constantly bias said slip-forms downwardly against the ground surface, with the loose interconnection of said slip-form elements enabling the latter to generally conform to changes in contour of said ground surface.

2. A pavement finisher as set forth in claim 1 wherein the lower portion of each of said slip-form elements is provided with a readily replaceable wear member that engages the ground.

3. A pavement finisher as set forth in claim 1 wherein said slip-forms include vertically-aligned, horizontal shoulders and said slip-form elements are loosely connected by connector plates disposed between the shoulders of contiguous slip-form elements, one end of each said connector plate being bolted to a slip-form element.

4. A pavement finisher as set forth in claim 3 wherein said slip-forms include vertically-aligned, horizontal shoulders and said slip-form elements are loosely connected by connector plates disposed between the shoulders of contiguous slip-form elements, one end of each said connector plate being bolted to a slip-form element.

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