

July 21, 1964

N. F. CLAYBORNE ET AL
METHOD AND APPARATUS FOR DETERMINING TRACK
AND ROAD SURFACES AND THE LIKE

3,141,418

Filed Jan. 4, 1960

14 Sheets-Sheet 1

FIG. 1

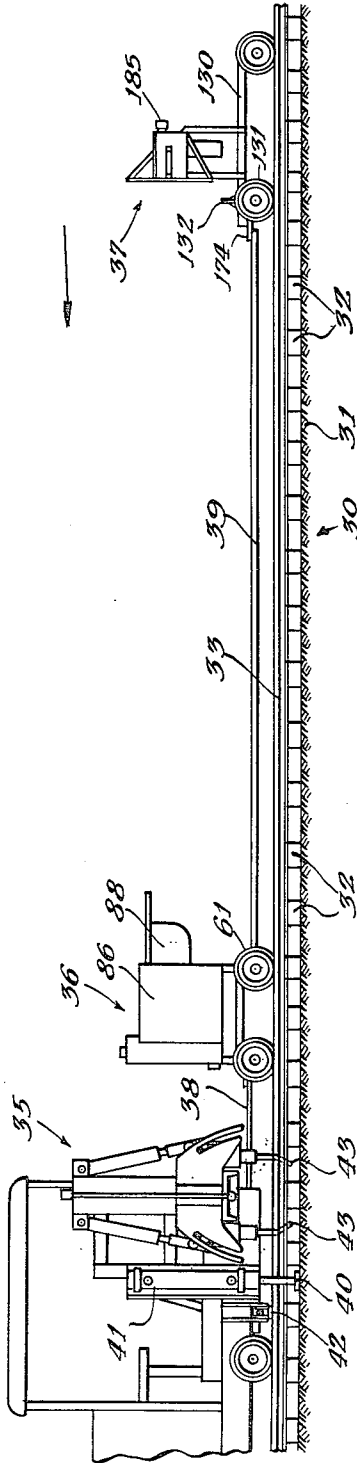
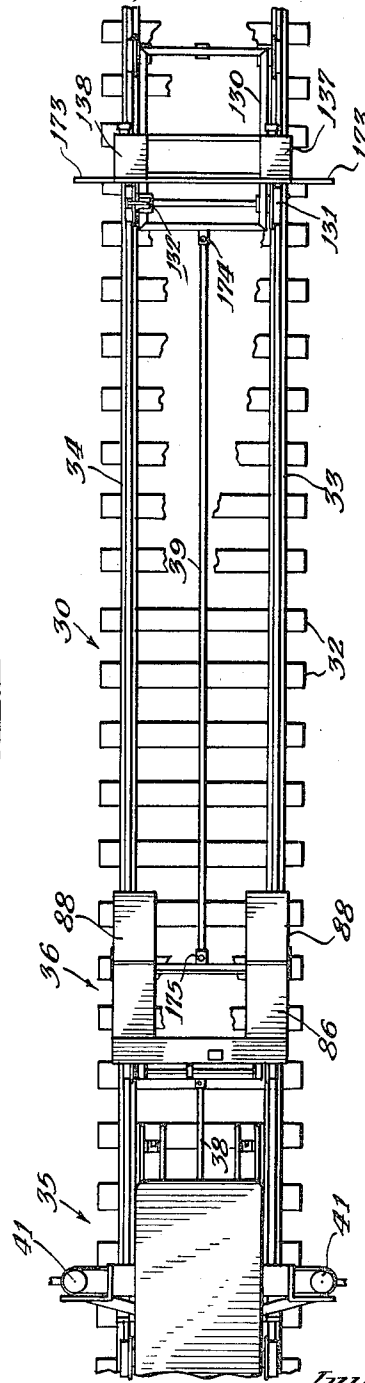


FIG. 2



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FIG. 3

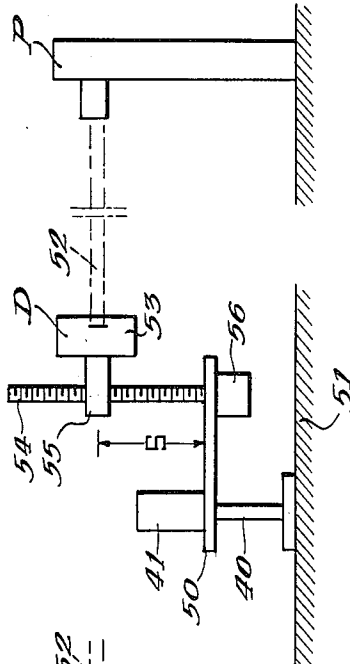


FIG. 4

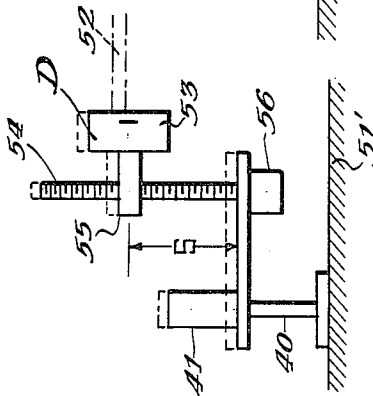


FIG. 5

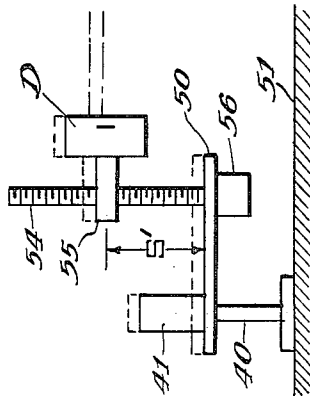
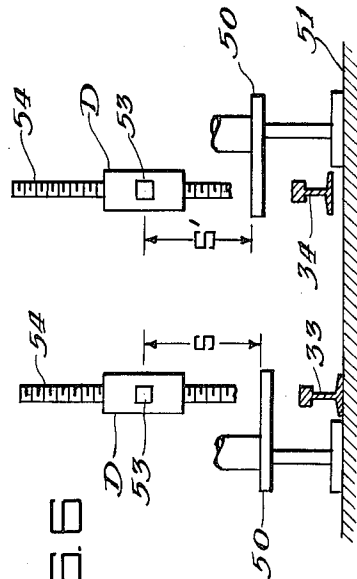


FIG. 6



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FIG. 7

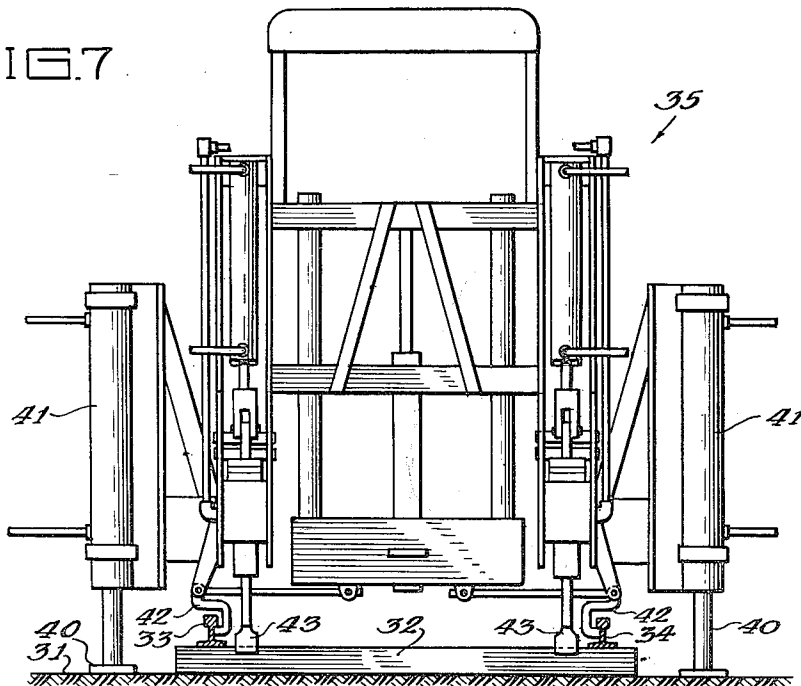
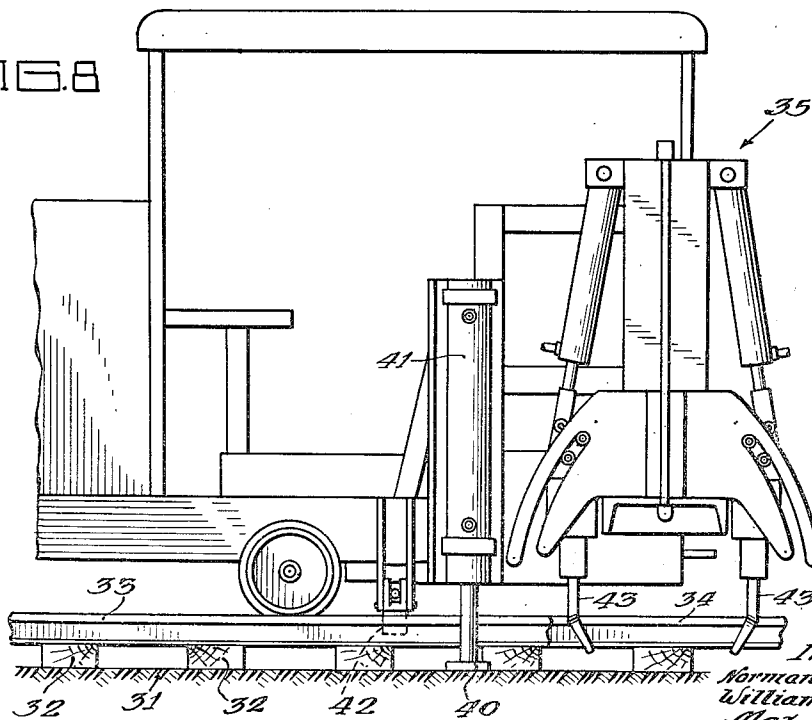


FIG. 8



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FIG. 10

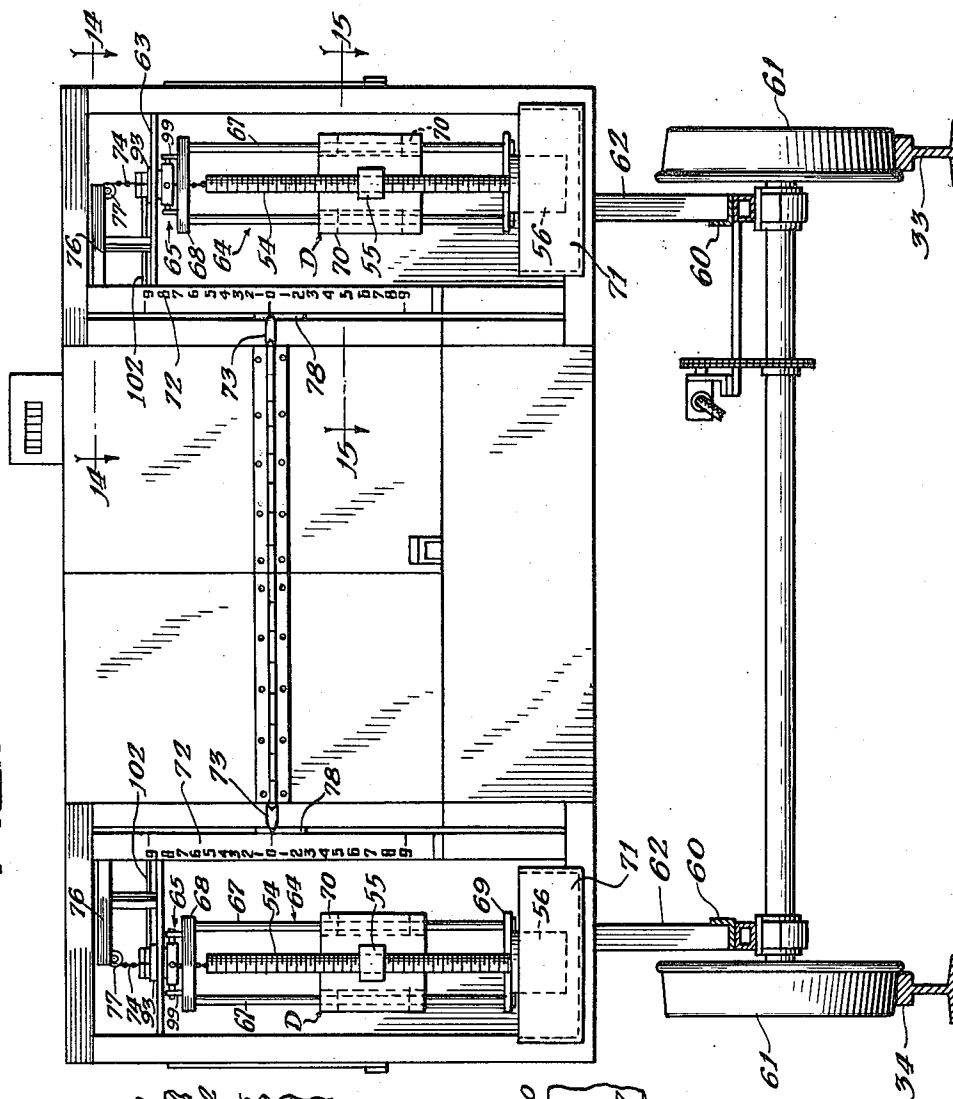


FIG. 11

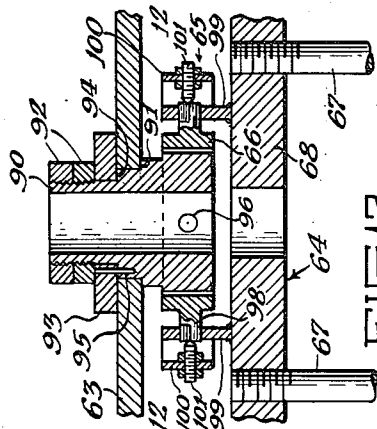
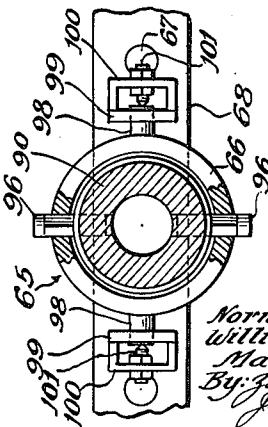


FIG. 12



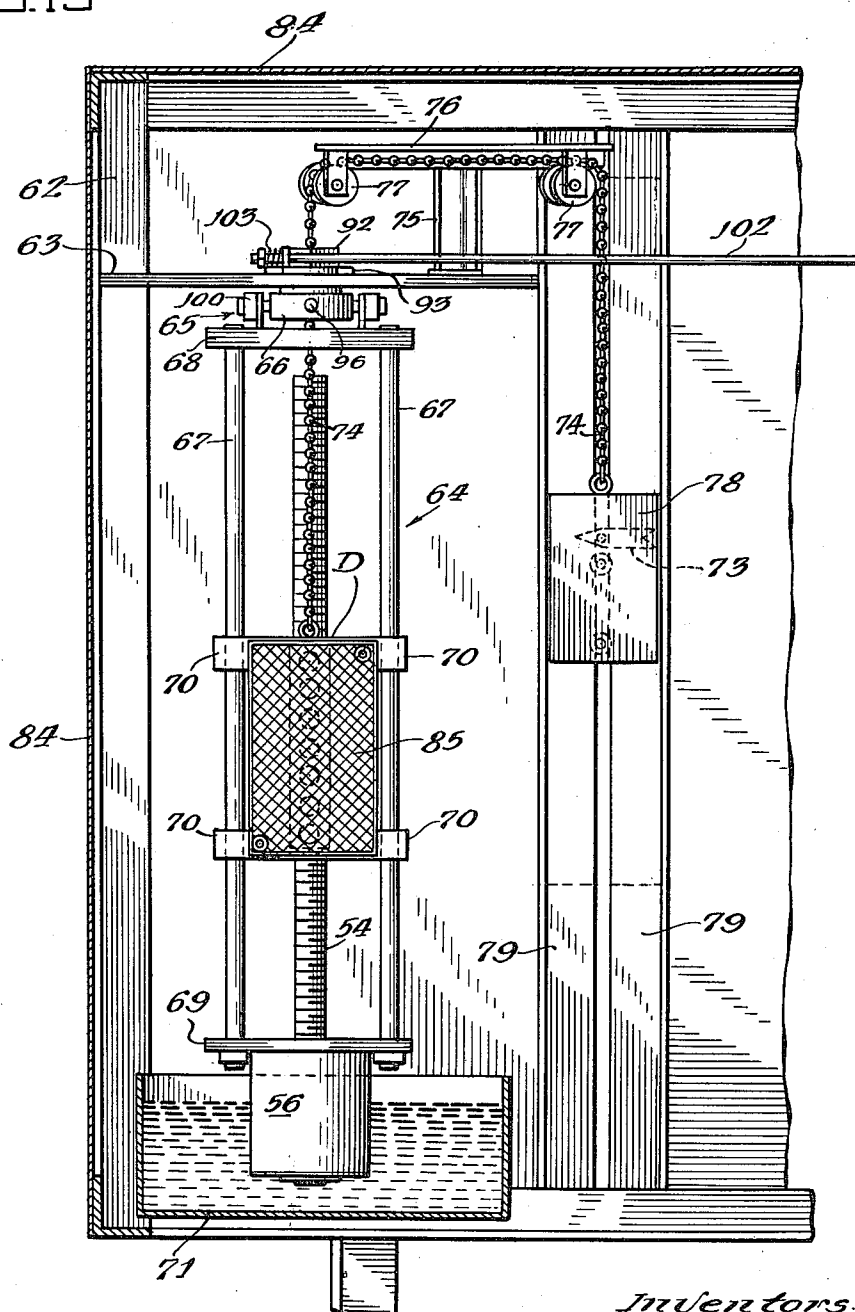
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FIG. 13



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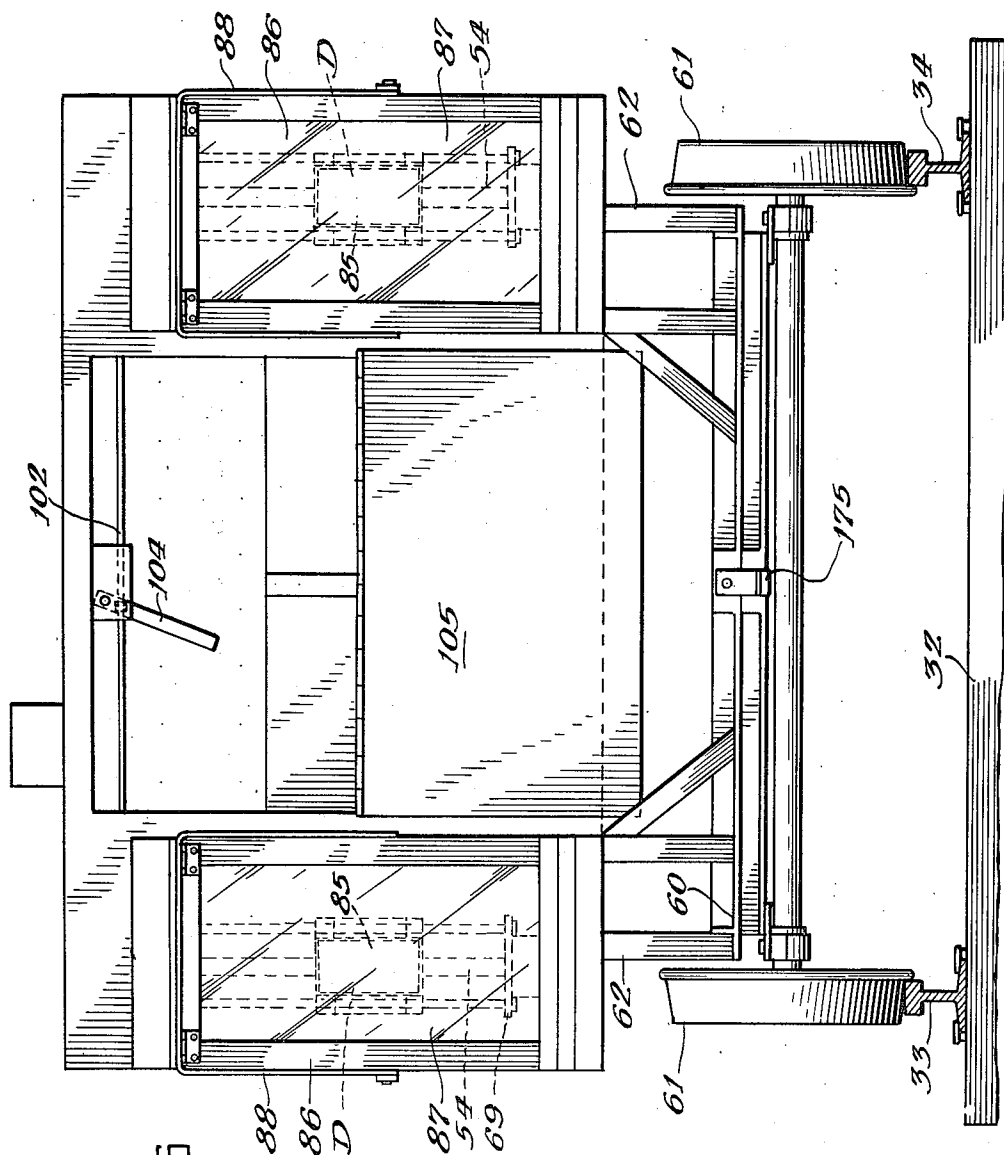


FIG. 16

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A schematic diagram of a pressure-responsive valve assembly. The assembly includes a main body 41 with a vertical stem and a base. A piston 118 is located within a chamber 119, which is connected to a pressure source 112 via a passage 114. The piston 118 is biased by a spring 116. A drain passage 120 leads from the chamber 119 to the base of the assembly. The assembly is controlled by a solenoid 54, which is connected to a control circuit 122. The control circuit 122 includes a battery 123 and a switch 121. The solenoid 54 is connected to the main body 41 via a cable 52. The main body 41 has a flange 110 and a seal 111. The assembly is shown in a cross-sectional view.

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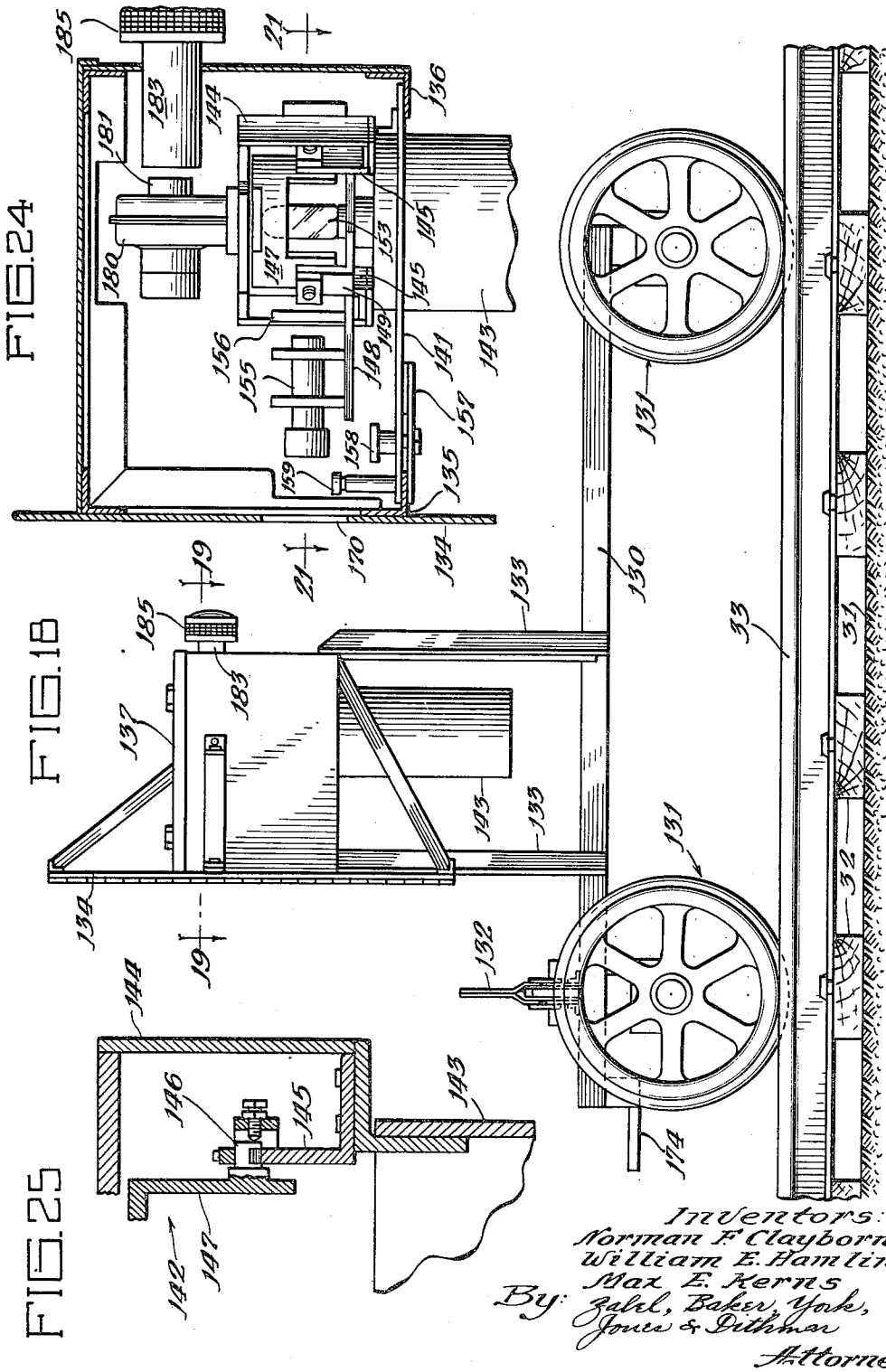
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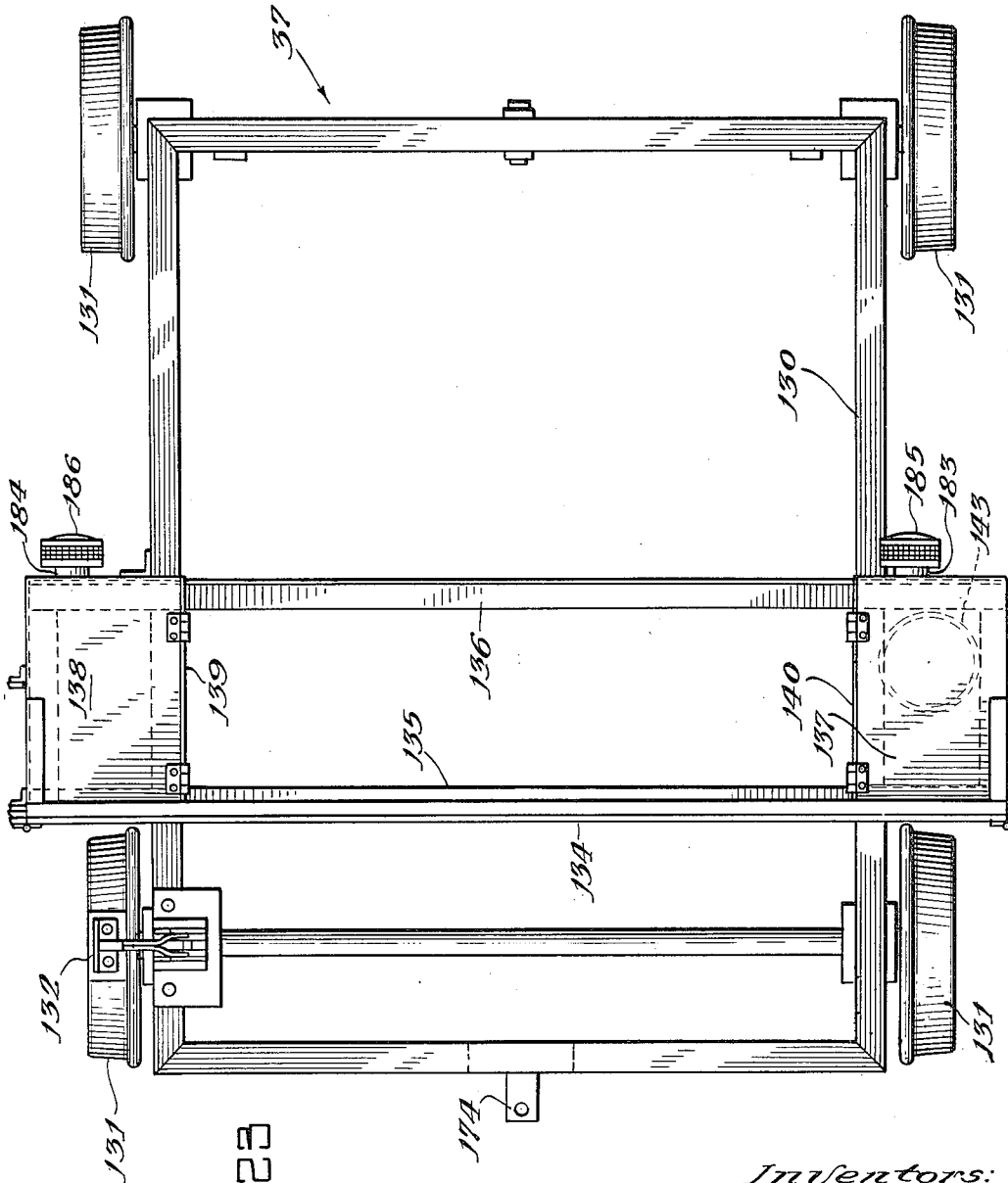


FIG. 23

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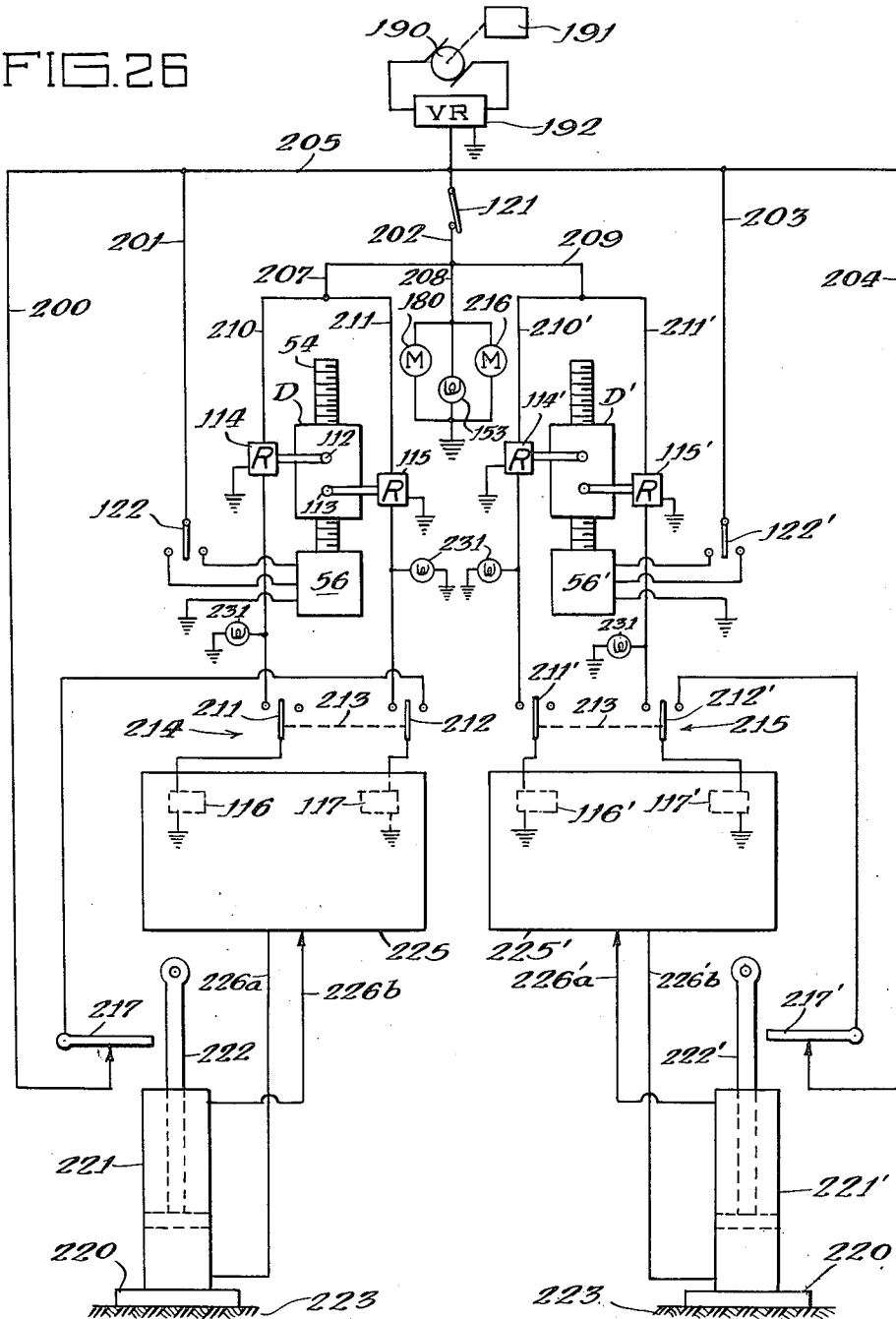
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FIG. 26



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METHOD AND APPARATUS FOR DETERMINING TRACK AND ROAD SURFACES AND THE LIKE

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Filed Jan. 4, 1960, Ser. No. 325

21 Claims. (Cl. 104-7)

This invention relates to an improved method and apparatus for determining surfaces in connection with the operation of surface construction equipment or surfacing devices.

It is an object of our invention to provide an improved method and apparatus for determining a surface by the use of a reference plane which is horizontal to a high degree of accuracy.

The invention is described in connection with track surfacing, but is also adaptable to road building and to certain other types of construction.

In track surfacing, the usual practice is to elevate each rail to a true grade line. Thus, two separate grade lines are established, one for each rail. This practice requires frequent checking of cross level to assure that there is no warping of the surface determined by the two grade lines which are not necessarily coplanar.

According to the present invention, the two rails of a section of track are raised into coincidence with a transverse element of a grade plane, which plane is determined by the distance between it and the horizontal reference plane at three different points. The characteristics of the grade plane are its gradient, or longitudinal slope, and its inclination, or transverse slope which corresponds to superelevation.

By the practice of our invention, a much truer track can be obtained because both rails are simultaneously surfaced with respect to a single grade plane rather than with respect to two separate grade lines which are not necessarily coplanar. As applied to surfacing equipment, such as a jack tamper, the improvement in surface is more pronounced because the usual jack tamper is capable of elevating both rails simultaneously to an equal extent, or one rail while the other rail is stationary, but no means are provided to elevate both rails simultaneously to different extents. As a result, the usual machine corrected track consists of track in which only one rail is corrected with respect to the grade line, while the second rail is more or less spot corrected with respect to the first rail, thus providing bumpy and uneven track as far as the second rail is concerned.

In applying the practice of our invention to other applications, it will be understood that the surface to be determined may be obtained by scraping, rolling, abrasion or by deposition of pavement, rather than by elevating and tamping, but the surface to be established is determined by the same principles as those pointed out herein in connection with track surfacing.

A further object of our invention is to provide an improved method of determining a surface in connection with the operation of surface correcting or surface constructing machinery.

Another object is to provide improved apparatus for determining a surface which is to be established, either by correction or by construction.

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Still another object is to provide an improved method and apparatus for determining a surface, such as a road surface or a track surface, with respect to its characteristics of smoothness, gradient, and inclination.

In accordance with our invention two separate pieces of apparatus are provided, one being reference means and the other being the self-aligning receiver. The reference means is the device which establishes a horizontal reference plane in the form of a horizontal band of light, and it includes a projector with a slot objective. The self-aligning receiver means comprises the jack element of the surfacing apparatus controlled thereby, in combination with detector means for sensing the light beam.

The detector and the projector in themselves may preferably constitute the two elements of a split lens assembly type of aligning device such as that shown in the copending application of Norman F. Clayborne, one of the applicant's herein, Serial No. 817,105 filed June 1, 1959 now patent 3,012,469 issued December 12, 1961.

This type of aligning device provides a directionally responsive signal which can be utilized to actuate a self-aligning receiver, as pointed out in said application.

The receiver assembly also includes suitable control means for regulating the extension of the jack so that the surfacing device, or the surfacing tools thereof, may be maintained in a proper position during the surfacing operation such that the surface element established thereby will coincide with the desired grade plane.

Another object of our invention is to provide reference means which includes a band projector in combination with means for orienting the projector in such a manner that the light projected thereby will be horizontal to a high degree of accuracy.

A further object is to provide a self-aligning receiver which can either be mounted on or closely associated with the surfacing device which is controlled thereby, the control means of which is so designed that it can be readily connected to the jack of the surfacing device so that the jack can function as an integral part of the self-aligning receiver.

Still another object of our invention is to provide improved apparatus for surfacing track to any desired gradient and superelevation.

A further object is to provide an improved method and apparatus whereby both rails of a track may be elevated independently and simultaneously so as to coincide with a transverse element of the desired grade plane.

Another object is to provide in connection with a track surfacing device a self-aligning receiver which provides for completely automatic operation, in combination with manually operable control means for retracting the jack.

Still another object of our invention is to provide in connection with a self-aligning receiver, reference means in which the projector is shiftably mounted so that the horizontal reference plane can be located with respect to either rail of the track. Thus, the superelevation can always be determined with respect to the inner rail.

A further object is to provide an improved method of surface determination in which the characteristics of the surface to be established are determined by a horizontal reference plane, and in which the elevation of the horizontal reference plane is determined by the elevation of a previously established surface of similar characteristics.

A still further object is to provide in a device of the type described, improved method and means for eliminating the effect of ambient light.

Other objects, features and advantages will become apparent as the description proceeds.

With reference now to the drawings in which like reference numerals designate like parts:

FIG. 1 is a side elevation of a preferred embodiment of our invention illustrating the operation thereof as applied to track surfacing;

FIG. 2 is a plan view of FIG. 1;

FIGS. 3 to 6 are diagrams illustrating the principle of operation of our invention;

FIG. 7 is a rear view of a tamper jack;

FIG. 8 is a side elevation thereof;

FIG. 9 is a side elevation of the receiver cart;

FIG. 10 is a front elevation of FIG. 9;

FIG. 11 is an enlarged vertical transverse section taken along line 11—11 of FIG. 9 showing the mounting for the swinging frame;

FIG. 12 is a plan section taken along line 12—12 of FIG. 11;

FIG. 13 is a vertical transverse section taken along line 13—13 of FIG. 9 showing the swinging frame;

FIG. 14 is a plan section taken along line 14—14 of FIG. 10;

FIG. 15 is a plan section taken along line 15—15 of FIG. 10;

FIG. 16 is a rear elevation of FIG. 9;

FIG. 17 is a diagram illustrating the operation of the detector;

FIG. 17a is a diagram illustrating a modification;

FIG. 18 is a side elevation of the projector cart;

FIG. 19 is a plan section taken along line 19—19 of FIG. 18 showing the projector and its associated parts;

FIG. 20 is a vertical transverse section taken along line 20—20 of FIG. 19;

FIG. 21 is a plan section of the projector showing the gimbals taken along line 21—21 of FIG. 24;

FIG. 22 is a rear view of the projector cart;

FIG. 23 is a plan view thereof;

FIG. 24 is a vertical longitudinal section taken along line 24—24 of FIG. 19 showing the projector in side elevation;

FIG. 25 is a vertical section taken along line 25—25 of FIG. 19 showing a detail of the gimbals;

FIG. 26 is an electrical wiring diagram of the complete device; and

FIG. 27 is a diagram illustrating the operation of the hydraulically actuated valve shown in FIG. 26.

In FIGS. 1 and 2 is shown a section of railway track 30 which comprises the usual ballast 31, ties 32 and rails 33 and 34. The preferred embodiment of our invention shown herein comprises three separate units mounted on the track 30 for movement from right to left, these units comprise a jack tamper 35, a receiver cart 36, and a projector cart 37. Suitable coupling means 38 are provided for coupling the receiver cart 36 to the self propelled jack tamper 35, and suitable coupling means, such as a rod 39 is provided to couple the projector cart 37 to the receiver cart, and to maintain a fixed distance between the two.

As the assembly moves from right to left, the track beneath the jack tamper 35 is corrected as will hereinafter be described, with the result that the projector cart 37 is always supported on corrected track so that it can function as a reference means to control the operation of the receiver and the jack tamper 35.

The jack tamper is a standard commercial piece of equipment which is used in track surfacing operations, and which serves initially to establish the track surface which surface is subsequently set permanently by a production tamper, with or without the use of additional ballast.

The jack tamper includes means for clamping the rails

so that they and the ties to which they are secured may be elevated to the desired grade and maintained in this position while tamping tools pack the ballast underneath the ties.

The essential parts of the device are shown in FIGS. 7 and 8, and include the jacks 40, the rail clamps 42 and the tamper tools 43. The jacks 40 are operated by hydraulic actuating cylinders 41, and the tamper tools 43 are forced downwardly into the ballast by hydraulic actuating cylinders 44. In addition, vibrators 45 are provided for the tamp tools, which may be in the nature of an air hammer type of motor, or an eccentric type vibrator. The rail clamps 42 are in the form of bell cranks which may be operated by suitable means not shown herein.

According to our invention, the operation of the jacks 40 is controlled by an aligning device of the general type shown in the aforesaid copending application, and which aligning device comprises a projector P and a detector D. The latter may either be mounted on and form a part of the jack tamper 35, as illustrated in the diagrams of FIGS. 3 to 6 or it may be separately mounted on a receiver cart 36 as pointed out in connection with FIGS. 1 and 2.

In either event, the combination of the jacks 40 and the detector D provides a self-aligning receiver, the operation of which is illustrated by the diagrams of FIGS. 3 to 6. Referring to FIG. 3, the reference numeral 50 represents the framework of the jack tamper 35 which is suitably supported by the jacks 40 on a surface 51 which corresponds to the ballast 31 of FIGS. 1 and 2. The projector P is suitably mounted a fixed distance above the surface 51, and projects a beam 52 in the form of a transverse band toward the detector D. The detector D is adjustably mounted on or with respect to the frame 50, and it includes a target 53 which tends to align itself with the light beam 52 as pointed out in the aforesaid copending application, the target 53 corresponding to the opaque spacer of the split lens assembly as will be pointed out hereinafter.

The output of the detector D controls the flow of hydraulic fluid into and out of the jack 40 in order to produce the self-aligning characteristic above referred to. Thus, in comparing FIG. 4 with FIG. 3, if it be assumed that the surface 51' is lower than the surface 51, the jack 40 will cause the frame 50 to be elevated from the solid line position of FIG. 4 into the dotted line position, wherein the target 53 is aligned with the light beam 52. In both of these FIGURES 3 and 4, it will be observed that the distance S between the center of the target 53 and the upper surface of the frame 50 is constant.

In situations wherein it is desired to establish an upgrade, the self-aligning characteristics of the device may be utilized to accomplish this result, merely by decreasing the distance S, as indicated by S' in FIG. 5. For instance, in establishing an upgrade, it is necessary to lift the rails 33 and 34 above the roadbed or surface 51, and then to tamp the ballast in position. Thus, this operation involves the elevating of the frame 50 from the solid line position of FIG. 5 into the dotted line position, and this is automatically accomplished by lowering the detector D by a corresponding amount.

The adjustable mounting of the detector D with respect to the frame 50 as shown herein comprises a vertically oriented lead screw 54 which is suitably journaled in and supported on or with respect to the frame 50. The detector D is mounted on the lead screw by means of a nut 55, and suitable guides not show herein, so that rotation of the lead screw will serve to regulate the distance S. The lead screw 54 may be rotated either manually, or by reversible driving means, such as a reversing motor 56.

Thus any desired upgrade or downgrade can be established merely by lowering or raising, respectively, the detector D by a corresponding amount, and this may be mechanically accomplished by energizing the motor 56 in one direction or the other.

By utilizing two such detectors, D and D', as shown in FIG. 6, the elevation of each rail 33 and 34 may be independently determined for purposes of establishing superelevation. In FIG. 6 it will be understood that a constant distance is maintained between the frame 50 and the respective rails 33 and 34 by means of the rail clamps 42, shown in FIG. 7.

Thus, by adjustably mounting the detector D with respect to the frame 50 of the jack tamper 40, it is possible to establish any desired combination of track surfacing and grade, and by providing a separate detector for each rail, it is possible to provide any desired combination of surfacing, grade, and either cross level track or superelevation.

Referring now to FIGS. 9 to 17 in which the construction of the receiver cart 36 is shown, the reference numeral 60 designates the cart chassis which is supported by flanged wheels 61. An upright supporting structure 62 is mounted on the chassis 60 and includes at either side, support plates 63, as shown in FIGS. 9 and 10. The mechanism can be enclosed by suitable panels 84, as shown in FIG. 13, but which are omitted in certain of the other figures in order to illustrate the underlying mechanism.

As shown in FIGS. 9 and 10, two detectors D are provided, one above each of rails 33 and 34, and since the construction of both sides of the device is substantially identical, only one side will be described herein, and the same reference numerals applied to the identical parts of both sides.

The detector D is slidably mounted in a frame 64 in order to provide the desired vertical adjustability previously referred to.

The frame 64 is suspended from the support plate for rotation about a vertical axis and also for free swinging movement. As shown in FIGS. 11, 12 and 13, the frame 64 is suspended in gimbals 65 so that it will hang like a pendulum and thus maintain a vertical orientation irrespective of track conditions.

The frame as shown in FIG. 13 comprises a pair of guide rods 67, a top yoke 68, and a bottom yoke 69. The detector D is provided with brackets 70 which engage the guide rods 67, and with a nut 55 which cooperates with the lead screw 54 to provide the desired adjustment of elevation. The reversible motor 56 for driving the lead screw is mounted on the underside of the bottom yoke 69, and the lead screw is journaled in the motor bearings. The motor 56 and the lead screw 54 are suitably offset from the plane of the guide rods 67 to counterbalance the weight of the detector D so as to insure vertical orientation of the lead screw 54. The motor 56 is a waterproof submersible type, and it is suspended in an oil pot 71, the motor and oil pot serving as means to dampen the oscillations of the swinging frame 64.

Means are provided to indicate the position or setting of the detector D. As shown in FIGS. 10 and 14, a scale 72 is mounted on the forwardly facing surface of the upright supporting structure 62, and a slidably mounted pointer 73 cooperates therewith. The pointer 73 is connected to the detector by means of a chain 74. As shown in FIG. 13 a post 75 projects upwardly from the support plate 63 and carries at its upper end a transverse pulley support 76 for supporting two pulleys 77 around which the chain 74 is directed. A counterweight 78 is connected to the pointer end of the chain 74 to maintain the chain taut and relieve the load on the motor 56, the counterweight being guided between two angles 79 which form a part of the supporting structure 62.

Means are provided to prevent, insofar as possible, ambient light from actuating the detector D. As shown in FIGS. 9, 13 and 15, a honeycomb 85 is mounted on the rear surface of the detector D and provides a plurality of horizontally aligned passages which are designed to be oriented parallel with the rays of the light beam 52. Thus all non-parallel rays of ambient light will be blocked off,

and the inner surfaces of the honeycomb are coated with a suitable non-reflecting and light absorbent paint. Furthermore, the detector is mounted at the forward end of a casing or tunnel 86, the inner surface of which may similarly be coated, and suitable baffles along the side walls of the casing 86 may additionally be provided if desired. Thus ambient light may effectively be excluded from the detector. The rear end of the casing 86 is closed with a transparent panel 87 which cooperates with the metal panels 84 to enclose the chambers in which the detectors are located almost completely thus keeping dust and dirt away from the operating mechanism.

The rear surfaces of the casings 86 may be provided with adjustable sunshades 88 to further facilitate the exclusion of ambient light, as shown in FIGS. 9 and 16.

FIGS. 11 and 12 illustrate the manner in which the frame 64 is mounted for free swinging movement in the gimbals 65, and FIGS. 11, 14 and 15 illustrate the manner in which the swinging frame is mounted for rotation about a vertical axis.

As shown in FIG. 11, a threaded sleeve 90 is rotatably mounted in the support plate 63, the sleeve being provided with a first shoulder 91 which engages the under surface of the support plate 63. Jam nuts 92 cooperate with the upper threaded end to maintain the sleeve in position.

A control lever 93, shown in FIGS. 11 and 14, overlies the support plate 63 and engages at one end the threaded sleeve 90, being confined between the nuts 92 and a second shoulder 94. The control lever 93 is keyed to the threaded sleeve at 95 so that actuation of the control lever 93 from the solid to the dotted line position as shown in FIG. 14 will cause corresponding angular displacement of the detector D and its honeycomb 85, as illustrated in FIG. 15.

The threaded sleeve 90 is hollow so as to accommodate the chain 74, as illustrated in FIG. 13, but nevertheless the lower portion of the threaded sleeve 90 is of substantial thickness so as to afford proper support for two oppositely disposed pivot pins 96 which are received and anchored in suitable bores formed in the lower portion of the threaded sleeve 90.

As shown in FIG. 12, the pivot pins 96 are provided with upwardly facing knife edges which pass through and support the ring 66 of the gimbals 65.

The gimbals 65 also include pivot pins 98 which are received in suitable apertures formed in bearing lugs 99 which extend upwardly from the top surface of the top yoke 68. Brackets 100 are carried by bearing lugs 99, and set screws 101 are set in the brackets as shown in FIGS. 11 and 12 so as to maintain the swinging frame 64 centered with respect to the ring 66. This arrangement also permits the use of sufficient clearance between the bearing lugs 99 and the ring 66 so as to permit assembly.

Since both detectors are actuated from the same light source, which is always located at a fixed distance, such as 25 feet, from the vertical plane of the detectors, it is necessary that the two detectors be longitudinally oriented along non-parallel lines which intersect at the effective light source. In other words, the converging orientation of two detectors can be considered as a focusing of both detectors on a single source. The angular displacement of the detectors about a vertical axis is provided so that the detectors can be focussed on the projector P when it is in either one of two alternative positions. As will be pointed out hereinafter, the projector is located above either one of the two rails, and where the track section has a radius, the projector P should be located over the inner rail. Therefore, it is necessary to shift the position of the projector P from one rail to the other from time to time, and the angular displacement provided by the control levers 93 permits the detectors to be focused accordingly.

The control levers 93 are actuated by a transverse control rod 102 shown in FIGS. 14 and 16, which connects both control levers 93 and permits them to be moved in

unison. A suitable resilient connection 103 can be provided between each control lever 93 and the control rod 102 to absorb any shock incident to operation. A manual lever 104, as shown in FIG. 16 is provided at a central point at the rear of the receiver cart 36, for operating the parts 102 and 93. The space in which the manual lever 104 is located may be closed by a hinged panel 105.

Thus, whenever the position of the projector P is changed, the manual lever 104 is thrown into its other position so that the detectors will remain focussed on the projector.

The detector D, as shown in FIGS. 15 and 17, includes a split lens assembly 110 which includes an opaque spacer 111, the dimensions of which correspond to the target 53 of FIGS. 3 to 6. Located behind each half of the split lens assembly, and at or along the focus of each half at a point adjacent the shadow cast by the opaque spacer 111 are two photoresponsive devices, one being an elevating cell 112 and the other being a lowering cell 113. Each cell is connected to an amplifier relay 114 and 115, respectively, which energize solenoids 116 and 117 respectively of a four-way valve 118.

The split lens assembly 110 is preferably a cylindrical lens, and the construction and operation is pointed out in considerable detail in the aforesaid copending application.

When the relative displacement of the elements P and D is such that the light beam 52 overlaps the upper half of the split lens assembly 110, an elevating signal will be produced by the cell 112 which will energize the solenoid 116 and throw the four-way valve 118 into a position in which the hydraulic pressure line 119 is connected to the upper half of the jack actuating cylinder 41, and in which the exhaust line 120 is connected to the lower half of the actuating cylinder 41, thus causing the frame 50 of the jack tamper to be elevated until the beam 52 is exactly aligned with the target 53 or opaque spacer 111. In case of overthrow, the actuation of the four-way valve 118 is reversed. The armature 118a is spring biased into a neutral, valve-off position so that when the detector is deenergized, as by opening of the off-on switch 121, the jack 40 will remain in its regulated position.

As indicated previously, these operations are controlled by adjusting the elevation of the detector D with respect to the frame 50 or its equivalent, and this may be accomplished by operating a double throw control switch 122 which is connected in series with a suitable power source 123 for driving the reversible motor 56 in one direction or the other.

In operation, the switch 122 is thrown in one direction or the other until the pointer 73 indicates either zero for level grade, or the desired amount of upgrade or downgrade in inches per hundred feet. Then the switch 122 is opened so that the detector will remain in its adjusted position of elevation. The detector switch 121 is then closed, and thereafter the jack 40 automatically elevates the frame 50 and its associated structures into the desired position, and maintains them in that position during the tamping operation and until a stable support for the track has been established at that desired elevation. As previously indicated, the arrangement is duplicated, one for each rail, so that the elevation of each rail can be determined independently of the other.

At the conclusion of the tamping operation, suitable manually operated control means are provided for retracting the jack, as will be hereinafter explained.

The projector cart 37 provides means for mounting the projector P on a gimbal supported pendulum so that the reference plane provided by the light beam 52 will be exactly horizontal, and also for mounting the projector in either one of two positions so that the elevation of the reference plane will be fixed with respect to one or other of the two rails 33, 34. As shown in FIGS. 18, 22 and 23, the projector cart 37 comprises a chassis 130 pro-

vided with flanged wheels 131, a spring pressed brake shoe 132 being provided to cause the cart to remain stationary during each surfacing operation. Mounted on the chassis 130 is an upright supporting structure 133 on which a shield 134 is supported.

The supporting structure 133 also includes front and rear transverse rails 135, 136, and mounted at either end of the rails are boxes 137, 138 having hinged side doors 139 and 140, as shown in FIGS. 22 and 23.

A support plate 141 is slidably mounted on the rails 135, 136, as shown in FIGS. 19 and 24. The projector is mounted from the support plate 141 by means of gim-bals 142 shown in FIG. 21.

A cylindrical container 143 is supported at its upper edge by the support plate 141 and forms an integral part thereof. A bridge 144, shown in FIGS. 24 and 25, is secured to the upper edge of the container 143.

Bearing lugs 145 extend upwardly from a portion of the bridge 144 and receive the pivot 146 of the gimbal ring 147 so that the ring will be supported from the support plate 141.

The projector P is mounted on a base plate 148 of somewhat irregular shape as shown in FIG. 21, which base plate includes upwardly extending bearing lugs 149 which receive the pivots 150 on the gimbal ring 147 so that the projector P may be supported from the ring. Suitable set screws may be provided for centering the parts. The pivots are offset 45° from the axis of the projector P so as to avoid interference with the light beam.

The projector P as shown in FIG. 21 includes a light source 153, a condenser lens 154, and a projector lens 155, all mounted on the base plate 148. A slot objective 156 is disposed between the lenses 154 and 155 so that an image of the slot can be projected forwardly in the form of a band for actuating both of the detectors D. The construction and operation of the projector is described in detail in the aforesaid copending application, and the slot objective 156 may be adjustable as pointed out therein.

The whole assembly including the support plate 141 and the projector P may be maintained in the desired position by means of a guide strip 157 which engages the flange of the front rail 135, as shown in FIG. 24. A screw threaded clamping means 158 may be provided for the guide strip 157, and a spring biased plunger detent 159 engages suitable openings formed in the flange of transverse rail 135 so as to lock the projector assembly in a given lateral position.

The projector P, as shown in FIG. 20 is mounted on a pendulum 160 having a weighted end not shown which extends downwardly into oil contained in the container 143 so as to dampen any oscillations which would affect the orientation of the light beam 52. The pendulum's construction includes a stem 162 which depends from the underside of the base plate 148. Recessed plates 163 and 164 are secured to the stem 162 and the pendulum 160 respectively, and embrace a ball 165. The plates 163 and 164 are secured to each other by bolts 166, the ball serving as a universal joint so that suitable adjustment can be made between the axis of the stem 162 and the axis of the pendulum 160. Thus, it is possible to adjust the gimbal mounted projector so that the light beam 52 will be exactly horizontal, thus assuring extreme accuracy of the control function of our invention.

The shield 134 is provided with openings 170 and 171 for each of the two positions of the projector, and it may also be provided with a central opening 172 for use in aligning the beam.

The front surface of the shield 134 may be provided with a suitable light absorbent and non-reflecting coating such as a dull black paint, in order to block out ambient light. The shield 134 may also be provided with hinged side wings 173 which extend its effectiveness during operation, but which may be folded back out of the way at other times.

A coupling lug 174 is provided at the front of the chassis, as shown in FIG. 23, and a similar coupling lug 175 may be provided at the corresponding point on the receiver cart 36 as shown in FIG. 16 whereby the two carts may be coupled together by either the rod 39, or a flexible cable, the rod being preferred. The coupling rod may also include the power cable for the projector and a blower 180, suitable sockets, not shown, provided for this purpose.

The blower 180 is mounted on the bridge 144, as shown in FIGS. 20 and 24, an opening being provided in the bridge so that the stream of air will be directed over the light source 153 for cooling same. The blower is provided with an intake 181.

The purpose of the boxes 137 and 138 is to keep dust and dirt away from the pivots 146 and 150 and otherwise to maintain in a clean condition various lenses, the oil 161, and other parts of the projector assembly. In accordance with this objective, means are provided for filtering the air supplied by the blower 180, which means include a separate conduit 183, 184 for each box 137, 138, and an air filter 185 and 186 for each conduit. The inner end of each conduit is located adjacent to the position occupied by the blower intake 181 when locked in its operative position as determined by the detent 159. Thus, the lamp is cooled by filtered air, and the projector P and its associated parts are maintained free from dust and dirt.

A counterweight 187 is adjustably mounted on the base plate 148 so that elements 160 and 162 may be maintained more nearly in alignment.

The operation of the self-aligning receiver is illustrated by the electrical diagram of FIG. 26. The electrical components may be powered by a suitable generator 190 driven from the engine 191 of the jack tamper, and the power supply includes a suitable voltage regulator 192. The return circuits have been indicated as grounded for the sake of clarity.

Five main circuits are provided, reading from left to right on FIG. 26 as follows:

The jack return circuit 200 for the left side, the left gradient control circuit 201, the aligning circuit 202, the right gradient control circuit 203 and the jack return circuit 204 for the right side, all of which are powered from a common lead 205 leading from the power supply G.

The aligning circuit 202 is provided with an off-on switch 121 which conditions the operation of three branch circuits, the left detector circuit 207, the projector circuit 208 and the right detector circuit 209.

The left detector circuit 207 in turn is again subdivided into two branches, an elevating branch 210 and a lowering branch 211 which power respectively the amplifier relays 114 and 115 as well as the solenoids 116 and 117 respectively which represent the output circuit of the amplifier relay 114. The amplifier relay 114 is connected to its solenoid 116 through the left terminal of a three-position single throw switch 211, and the amplifier relay 115 is connected to its solenoid 117 through the left terminal of a three-position double throw switch 212. The two switches are ganged by a common control member 213 so as to provide a single function switch 214 for the left side of the receiver. The function switch 214 thus has three positions: alignment at the left, off in the center, and jack return at the right.

The elements of the right detector circuit 209 are identical and are designated by the same reference numerals primed and are controlled by a single function switch 215.

The projector circuit 208 powers the light source 153, the blower 180, and may also power a beam chopper 216 to be hereinafter described.

The left and right gradient control circuits 201 and 203 include the reversible motors 56 and 56', and the double throw control switches therefor, 122 and 122' respectively.

The left and right jack return circuits 200 and 204 provide by-pass means to energize the lowering solenoids

117 and 117' respectively, and include limit switches 217 and 217' which are connected between the common lead 205 and the right terminal of the double throw switches 212 and 212' respectively. Thus when the function switch 214 is thrown to the right, into the jack return position, the detector circuit 207 is disconnected from both solenoids 116 and 117, and the solenoid 117 is directly energized from lead 205 to cause the lowering of the jack.

The jacks may either be of the upright type, as jacks 40 shown in FIGS. 3 to 8 and 17, or may be of the inverted type as shown in FIG. 26 in which the jack foot 220 is carried on the cylinder 221, and the latter is supported from the frame of the mechanism by means of the pistons 222. When the cylinder 221 engages the limit switch 217 on its return stroke, the jack return circuit 201 is automatically de-energized.

Instead of the solenoid actuated four-way valve 118 shown in FIG. 17, we prefer to use a hydraulically actuated valve 225, as diagrammatically shown in FIG. 27. In this type of valve, there are three hydraulic circuits, the load circuit 226 controlled by a three-position main valve piston 227, the elevating hydraulic circuit 228, and the return hydraulic circuit 229, both of which are controlled by a three-position auxiliary valve piston 230, which in turn is actuated by the solenoids 116 and 117. This particular type of valve is a standard article of commerce and forms no part of our invention.

Both the main piston 227 and the auxiliary piston 230 are spring centered into a neutral inoperative position, in which the hydraulic power is shut off.

For purpose of clarity, it will be assumed that the solenoids 116 and 117 operate in the same direction as the cylinders 228a and 229b, respectively, which is to say that energization of the solenoid 116 shifts the auxiliary piston 230 to the right, just as energization of hydraulic cylinder 228a shifts the main piston 227 to the right, while energization of the elements 117 and 229b shift the respective pistons to the left.

When the elevating solenoid 116 is energized, the hydraulic pressure is applied through the elevating control circuit 228 to the hydraulic cylinder 228a which shifts the main valve piston 227 to the right so that the pressure will be applied to the elevating line 226a, and the drain to the return line 226b.

When the lowering solenoid 117 is energized, the auxiliary piston 230 is shifted to the left which applies the pressure to the return hydraulic circuit 229 and cylinder 229b which causes the main valve piston 227 to be shifted to the left. In this position, the pressure is applied to the jack return line 226b, and the elevating line 226a is connected to the drain.

When the function switch 214 is thrown to the left into its automatic position, the jack foot 220 is automatically extended to elevate the jack tamper 35 together with the receiver cart 36 which is supported on the rails 33 and 34 which are being elevated by the jack tamper. The elevating is accomplished by energization of the elevating solenoid 116 as previously related, and in case of overrun the correction is made by energization of the lowering solenoid 117.

At the conclusion of the tamping operation, the function switch 214 is thrown to the right into its jack return position, which causes energization of the lowering solenoid 117 by means of the jack return circuit 200. This causes the jack to be returned to its retracted position which involves the lowering of the jack tamper 35. Continued return movement of the jack will lift the jack foot 220 off of the road bed surface 223 until the limit switch 217 is tripped, thus causing return of the main and auxiliary pistons 227 and 230 to their neutral position, in which the hydraulic pressure is cut off.

Thus, the function switch 214 provides for automatic operation of the jack which is controlled by the aligning device including detector circuit 208, and it also provides for the jack return when the function switch is manually

moved to jack return position. In the middle position of the function switch, the valve 225 is de-energized and inoperative, causing the jack to remain either in its extended or retracted position as the case may be.

To summarize the operation which previously has been detailed with the description of the various parts and subassemblies, let it be assumed that a section of track is to be surfaced at zero gradient, which means level track. Let it also be assumed that thirty feet of track have been leveled according to prior art methods. Then, referring to FIG. 1, the projector cart 37 is located on the previously corrected surface which is at a level a few inches above the maximum elevation of any portion of the uncorrected track which lies at the left of it. The jack tamper 35 and the receiver cart 36 are located on the uncorrected track. The detectors D and D' are set at zero, as indicated by the pointer 73 and scale 72. This may be accomplished by manipulation of the gradient control switches 122 and 122'. The rail clamps 42 are then actuated to grip the rails. Then the off-and-on-switch 121 is closed, energizing the projector P and the detectors D and D'. Then the function switches 214 and 215 are thrown to the left into automatic position which causes the track to be elevated up to the new grade plane. Then the function switch is thrown to the middle position, and the tampers are actuated.

High resistance indicator lights 231 may conveniently be provided for each of the detector branch circuits 210, 211, 210', 211', so that any change in elevation due to over tamping will be indicated to the operator, and similarly a change due to under tamping will be indicated as soon as the function switches are thrown to the jack return position, so that correction can be made before the jacks are finally retracted and the assembly moved to the next position.

If no such correction is necessary, the jacks are retracted, and the assembly advanced to a new position. According to prior art practice corrections are made at approximately eight-foot intervals, and the same practice is followed in connection with the operation of our invention.

Where it is desired to establish a positive gradient of, say, four inches per hundred feet, the gradient control switches 122 and 122' are thrown to the left as shown in FIG. 26 which causes the detectors D and D' to be lowered. The scale 72 preferably reads in inches per hundred feet so that the elevation of detectors D and D' can be conveniently adjusted with respect to gradient. However, it will be understood that since the distance between the projector P and the detectors is twenty-five feet, that a scale reading of 4 will represent a lowering of the detector by one inch. From this point on, the operation is the same as when correcting for zero gradient track. However, to avoid abrupt changes in gradient, we prefer to distribute the change in gradient over a substantial linear distance. This means that instead of lowering the detector immediately to the positive four-inch position, it can be lowered in one-half inch scale increments over a series of eight or more correcting operations.

Assume that on a stretch of rezo gradient track, a superelevation of two inches is desired on the right rail 34. First the projector P is shifted to a position over the inside or left rail 33. Then the elevation of the right hand detector D' is lowered to the positive eight inch scale reading, which represents an absolute lowering of two inches, since the scale reads in inches per hundred feet. The left hand detector D remains in its zero position. Then the tamping operations are repeated as previously described. However, in this instance also, abrupt changes in gradient are to be avoided, with the result that the change from zero to positive eight inches on scale is desirably distributed over a series of correcting operations at, say, one-half inch on the scale for every eight feet of track.

As shown in FIG. 17a, the light beam 52 may be

modulated by a beam chopper 216 comprising a shutter driven by a constant speed motor to provide a detector signal of a predetermined frequency. A suitable discriminator circuit 232, 233 is provided for each of the amplifier relays 214, 215 so that the detector will be responsive only to the modulated beam and not to ambient light. This arrangement permits elimination of one or more of the following elements: the tunnel or casing 86, the sun shade 88, the shield 134, the hinged side wing 173, and the honeycomb 85, together with the control rod 102 and its associated parts. However, the response characteristics of the photo-responsive cells 112 and 113 renders elimination of all of said elements inadvisable.

The gravity oriented mounting of the projector, together with an optical system providing fine image definition, is necessary for satisfactory operation due to the optical lever effect by which small angular variations from the absolute horizontal would introduce substantial error in surface determination. However, the response oriented mounting of the detectors is not as essential because a slight angular variation of the detector, if the honeycomb 85 be omitted in favor of beam modulation, will not introduce any substantial error.

Although only a preferred embodiment of this invention has been shown and described herein, it will be understood that various modifications and changes may be made in the construction shown without departing from the spirit of our invention as pointed out in the appended claims.

We claim:

1. Apparatus for surfacing a section of uncorrected track which is adjacent to a previously corrected section of higher elevation, comprising, in combination, reference means for projecting toward the uncorrected track section a horizontal beam of light from a point which is at a fixed reference distance above the previously corrected track section, a detector device for sensing said light beam, rail clamping means associated with said detector device for maintaining a vertical distance between said detector device and the uncorrected track section which is equal to said reference distance, jack means associated with and controlled by said detector device for elevating said rail clamping means and said detector device while said second mentioned distance is maintained, and up to a point where said detector device is aligned with said light beam, thereby causing said uncorrected track to be elevated into horizontal alignment with said previously corrected track section to provide a new corrected track section, means for maintaining a fixed horizontal distance between said reference means and said detector device, and means for maintaining said light beam in a horizontal plane as said apparatus is moved into a new position in which said rail clamping means overlies another uncorrected track section.

2. In combination, a surfacing device including a jack, reference means for establishing a horizontal reference plane in the form of a horizontal band of light, a self-aligning receiver for controlling the operation of said surfacing device, said receiver including a detector for sensing said light band, a valve for regulating the extension of said jack, and means electrically actuated by said detector for controlling the operation of said valve, means for maintaining a fixed horizontal distance between said reference means and said receiver, and means for maintaining said light beam in a horizontal plane as said reference means and said surfacing device are moved into a new position.

3. In combination with a surfacing device including a jack, reference means for establishing a horizontal reference plane in the form of a horizontal band of light, said reference means including a beam projector and gravity actuated means for maintaining the optical axis of said beam projector horizontal and a self-aligning receiver for sensing said light band and for controlling the operation of said surfacing device, said receiver including said jack,

a detector for sensing said light band, a valve for regulating the extension of said jack, means electrically actuated by said detector for controlling the operation of said valve, and control means for adjusting the vertical position of said detector with respect to said receiver in order to determine the gradient of the surface established by said surfacing device.

4. In combination with a surfacing device including two laterally spaced jacks, reference means for establishing a horizontal reference plane in the form of a horizontal band of light, said reference means including a beam projector and gravity actuated means for maintaining the optical axis of said beam projector horizontal, a self-aligning receiver for sensing said light band and for controlling the operation of said surfacing device, said receiver including said jacks, a valve for regulating the extension of each jack, two laterally spaced detectors for sensing said light band, one for each valve, means electrically actuated by each detector for controlling the operation of its associated valve, and control means for adjusting the vertical position of one of said detectors with respect to the other in order to determine the lateral inclination of the surface established by said surfacing device.

5. A track surfacing device comprising a jack having a ballast engaging foot, a rail clamp associated with said jack so that operation of the jack will elevate a section of rail, cart means resting on said rail for supporting said jack and said rail clamps, a projector spaced from said cart means and located a fixed distance above a corrected rail section, a detector associated with said cart and located above the rail section on which said cart is resting, jack actuating means controlled by said detector, the assembly of said jack, said jack actuating means, and said detector providing a self-aligning device with respect to the light beam of said projector for aligning the rail section on which said cart means rests with respect to said corrected rail section, means for maintaining a fixed horizontal distance between said projector and said cart means, and means for maintaining the optical axis of said projector in a horizontal plane as said cart means and projector are moved into a new position in which said rail clamp overlies another uncorrected track section.

6. A track surfacing device comprising a jack having a ballast engaging foot, a rail clamp associated with said jack so that operation of the jack will elevate a section of rail, cart means resting on said rail section for supporting said jack and said rail clamp, a projector spaced from said cart means and located a fixed distance above a previously corrected rail section, gravity actuated means including gimbals for maintaining the optical axis of said projector in a precisely horizontal plane, a detector associated with said cart means, a detector support located at a fixed distance above the rail section on which said cart is resting, jack actuating means controlled by said detector, the assembly of said jack, said jack actuating means, and said detector providing a self-aligning receiver with respect to the light beam of said projector, control means for adjusting the distance between said detector and said detector support whereby the self-aligning characteristic of said receiver is utilized to establish a predetermined gradient for the rail section on which said cart rests with respect to said corrected rail section, and means for moving said cart means and said projector as a unit down the track to a new position.

7. In a surfacing device which includes a jack for regulating the elevation thereof in accordance with a desired grade plane, and valve means for controlling the operation of said jack, the combination of a detector associated with said surfacing device so that the elevation of said detector is also controlled by said jack, said detector controlling the operation of said valve means, reference means located a predetermined distance from said detector for projecting toward said detector a light beam which is horizontal and of a predetermined elevation

above said grade plane at a point below said projector means, said reference means including gimbals, a beam projector mounted on said gimbals, and a pendulum attached to said beam projector and control means for regulating the elevation of said detector with respect to said surfacing device whereby the operation of said jack can be controlled in accordance with the gradient of said grade plane.

8. In a surfacing device, reference means for establishing a horizontal reference plane in the form of a band of light comprising a projector, a wheeled framework for supporting said projector at a fixed distance above a previously corrected surface, gimbals for mounting said projector with respect to said supporting framework, a pendulum carried by said projector, said projector including a slot objective, whereby the beam of light projected by said projector will form a band of substantial width, and whereby said pendulum causes said band to be projected in a horizontal direction irrespective of irregularities in the surface on which said wheeled framework rests.

9. In a surfacing device, reference means for establishing a horizontal reference plane in the form of a band of light comprising a projector, a cart having structure for supporting said projector at a fixed distance above a previously corrected surface, gimbals for mounting said projector with respect to said supporting structure, a pendulum carried by said projector, a container carried by said supporting structure, said pendulum extending into said container, and a liquid disposed in said container for dampening the oscillations of said projector and pendulum arising from movement of said cart, said projector including a slot objective whereby the beam of light projected by said projector will form a band of substantial width, and whereby said pendulum causes said band to be projected in a horizontal direction irrespective of irregularities in the surface on which said cart rests.

10. Reference means as claimed in claim 9 in which said supporting structure includes a pair of spaced transverse rails, and in which the assembly comprising said projector, gimbals, pendulum, and container is slidably mounted on said transverse rails for movement between two positions.

11. In a surfacing device, self-aligning mechanism comprising a frame, a jack mounted on said frame and engaging a supporting surface, valve means for regulating the operation of said jack, a detector mounted on said frame, said detector comprising a split lens assembly, a pair of light responsive cells associated therewith, and an amplifier relay means for each of said cells, an output circuit for each of said amplifier relay means, and means energized by said output circuits for controlling the operation of said valve means, whereby energization of one or the other of said light responsive cells by a light beam will cause operation of said jack to move said detector into alignment with said light beam, and motor driven control means for regulating the elevation of said detector with respect to said frame.

12. In a self-aligning surfacing device which includes a jack for supporting the same and valve means for controlling the operation of said jack, a detector for controlling the operation of said valve means, projecting means spaced from said detector for projecting a light beam for actuating said detector, said projecting means comprising a beam projector and pendulum means for maintaining the optical axis of said beam projector horizontal so that said light beam will be maintained in a horizontal plane the combination of means for mounting said detector comprising a frame, a reversible motor supported on said frame, a vertical lead screw driven by said motor, said detector being slidably mounted in said frame, and nut means connected to said detector and engaging said lead screw whereby the elevation of said detector with respect to said frame may be controlled by

energization of said reversible motor in one direction or the other.

13. In a self-aligning surfacing device which includes a jack for supporting the same and valve means for controlling the operation of said jack, a detector for controlling the operation of said valve means, projecting means spaced from said detector for projecting a light beam for actuating said detector, said projecting means comprising a beam projector and pendulum means for maintaining the optical axis of said beam projector horizontal so that said light beam will be maintained in a horizontal plane the combination of means for mounting said detector with respect to a supporting structure associated with said surfacing device comprising a swinging frame, gimbals for supporting said swinging frame, a reversible motor supported from said swinging frame, a vertical lead screw driven by said motor, said detector being slidably mounted in said swinging frame, and nut means connected to said detector and engaging said lead screw whereby the elevation of said detector with respect to said supporting structure may be controlled by energization of said reversible motor in one direction or the other.

14. The combination claimed in claim 13 which includes an oil pot disposed beneath said swinging frame, said swinging frame and said motor extending into said oil pot whereby the oscillations of said swinging frame will be dampened.

15. In a self-aligning track surfacing device which includes a jack for supporting the same during a tamping operation, valve means for controlling the operation of said jack, receiving means for controlling the operation of said valve means, and projecting means spaced from said receiving means for projecting a fan-shaped horizontal light beam for actuating said detector to produce self-alignment of said surfacing device with respect to a desired grade plane, the combination in which said receiving means comprises two laterally spaced detectors, one mounted above each rail of said track, and which includes means for mounting said projecting means over either one of said rails, said fan-shaped horizontal light beam actuating both of said detectors simultaneously, means for mounting each of said detectors for rotation about a substantially vertical axis so that each detector may be focused toward said projecting means, and means connecting said two detectors and for shifting the angular disposition of both of said detectors with respect to a medial longitudinal plane so that both of said detectors may be focused on said projector in either of its two positions.

16. In a self-aligning track surfacing device which includes a tamper, a jack for supporting said device during operation of said tamper, and valve means for controlling the operation of said jack, a detector for controlling the operation of said valve means, and projecting means spaced from said detector for projecting a fan-shaped horizontal light beam for actuating said detector, the combination of an elevating solenoid and a lowering solenoid for actuating said valve means, a control circuit having two branches adapted for alternative energization by said detector, each branch including one of said solenoids whereby the operation of said jack is automatically controlled by said detector to provide self-aligning operation, a source of power for said control circuit, a by-pass circuit connecting said source of power with said lowering solenoid to cause return of said jack, and a manually controlled function switch for breaking the connection between said branch circuits and said solenoids and for connecting said by-pass circuit to said lowering solenoid whereby the automatic alignment control provided by said detector may be dispensed with at the conclusion of the tamping operation so as to permit return and retraction of said jack.

17. A surfacing device including, in combination a self-aligning receiver and reference means for controlling

the operation thereof, said reference means including a projector for projecting a horizontal band of light, gimbals for supporting said projector, and a pendulum for maintaining the optical axis of said projector in a horizontal plane, and said receiver including two laterally spaced detectors for sensing said light band and gradient control means for independently adjusting the vertical position of each detector with respect to said receiver.

18. A surfacing device including, in combination a self-aligning receiver and reference means for controlling the operation thereof, said reference means including a projector for projecting a horizontal band of light, means for mounting said projector in either one of two transversely related positions, and gravity actuated means for maintaining said band of light in a horizontal plane, said receiver including two laterally spaced detectors for sensing said light band, a honeycomb mounted on each detector to exclude ambient light, and means for shifting the angular position of each detector with respect to a vertical axis so that both detectors can be focussed on said projector in either one of said positions.

19. A track surfacing device including, in combination, a self-aligning receiver and reference means for controlling the operation thereof and movable as a unit along said track in a predetermined spaced relationship, said reference means including a projector for projecting a horizontal band of light and gravity actuated means for maintaining said band of light in a horizontal plane, said receiver including a detector for sensing said light band, control means for independently adjusting the vertical position of said detector with respect to said receiver, a scale carried by said receiver, a slidably mounted pointer cooperating with said scale, and means connecting said pointer with said detector so that the position of said pointer indicates the vertical position of said detector.

20. A surfacing device including, in combination, a self-aligning receiver and reference means for controlling the operation thereof, said reference means including a projector for projecting a horizontal band of light, and means for maintaining said band of light in a horizontal plane, said receiver including two jacks, a jack control means for each jack, two laterally spaced detectors for sensing said light band, gradient control means for independently adjusting the vertical position of each detector with respect to said receiver, an alignment circuit connecting each detector with one of said jack control means for controlling the operation thereof, a jack return circuit by-passing each alignment circuit, and switch means for disconnecting said alignment circuit from and for connecting said jack return circuit to said jack control means to render said self-aligning receiver inoperative and to retract said jacks.

21. A surfacing device including, in combination, a self-aligning receiver and reference means for controlling the operation thereof, said reference means including a projector for projecting a horizontal band of light and means for maintaining said band of light in a horizontal plane, said receiver including a detector for sensing said light band, means for independently adjusting the vertical position of said detector with respect to said receiver, a vertically oriented scale carried by said receiver, a slidably mounted pointer cooperating with said scale, and means connecting said pointer with said detector so that the position of said pointer indicates the vertical position of said detector, said connecting means comprising a chain, pulley means for said chain located above said detector and said pointer, and a counterweight secured to said chain to facilitate the adjustment of said detector.

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