Sept. 15, 1964 J. G. MOORE ET AL 3,148,630

RAILWAY TRACK APPARATUS

Filed April 20, 1961 4 Sheets-Sheet 1

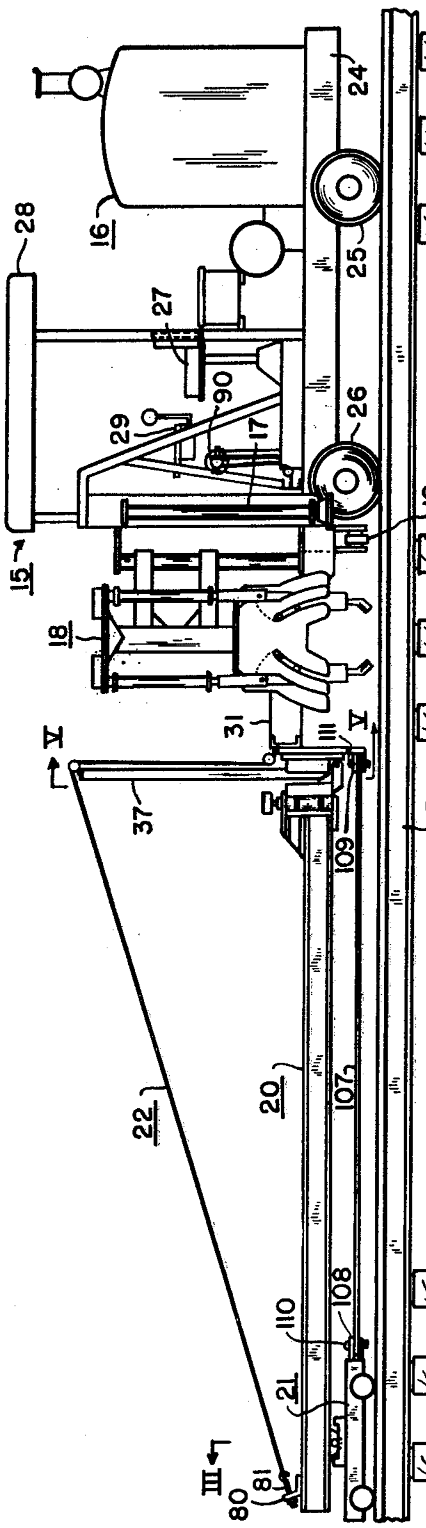

Fig. 1

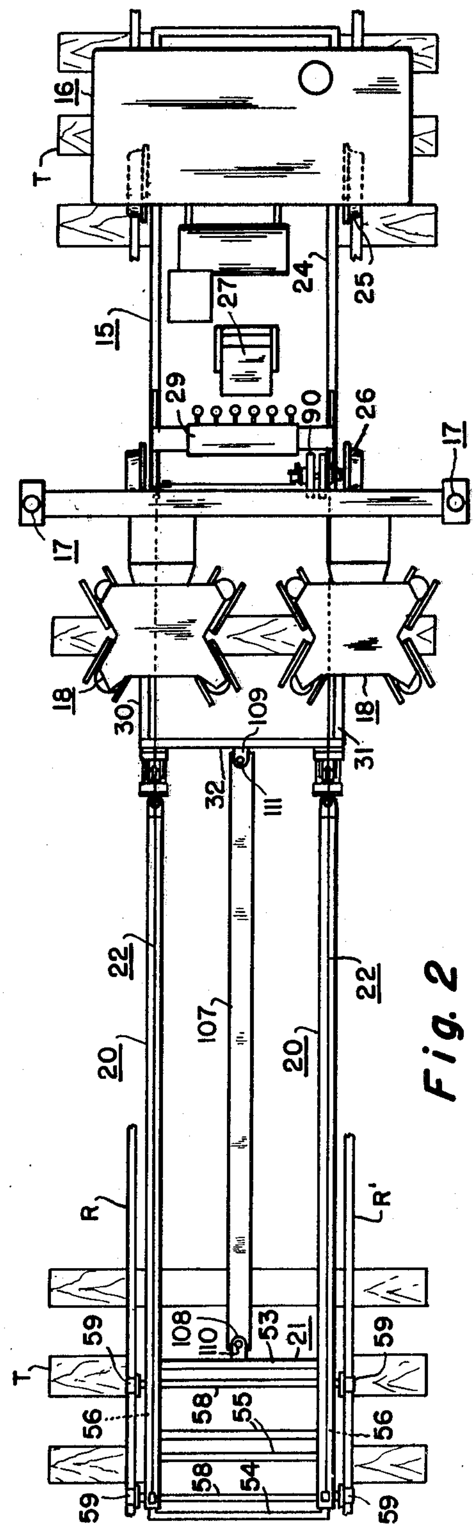

Fig. 2

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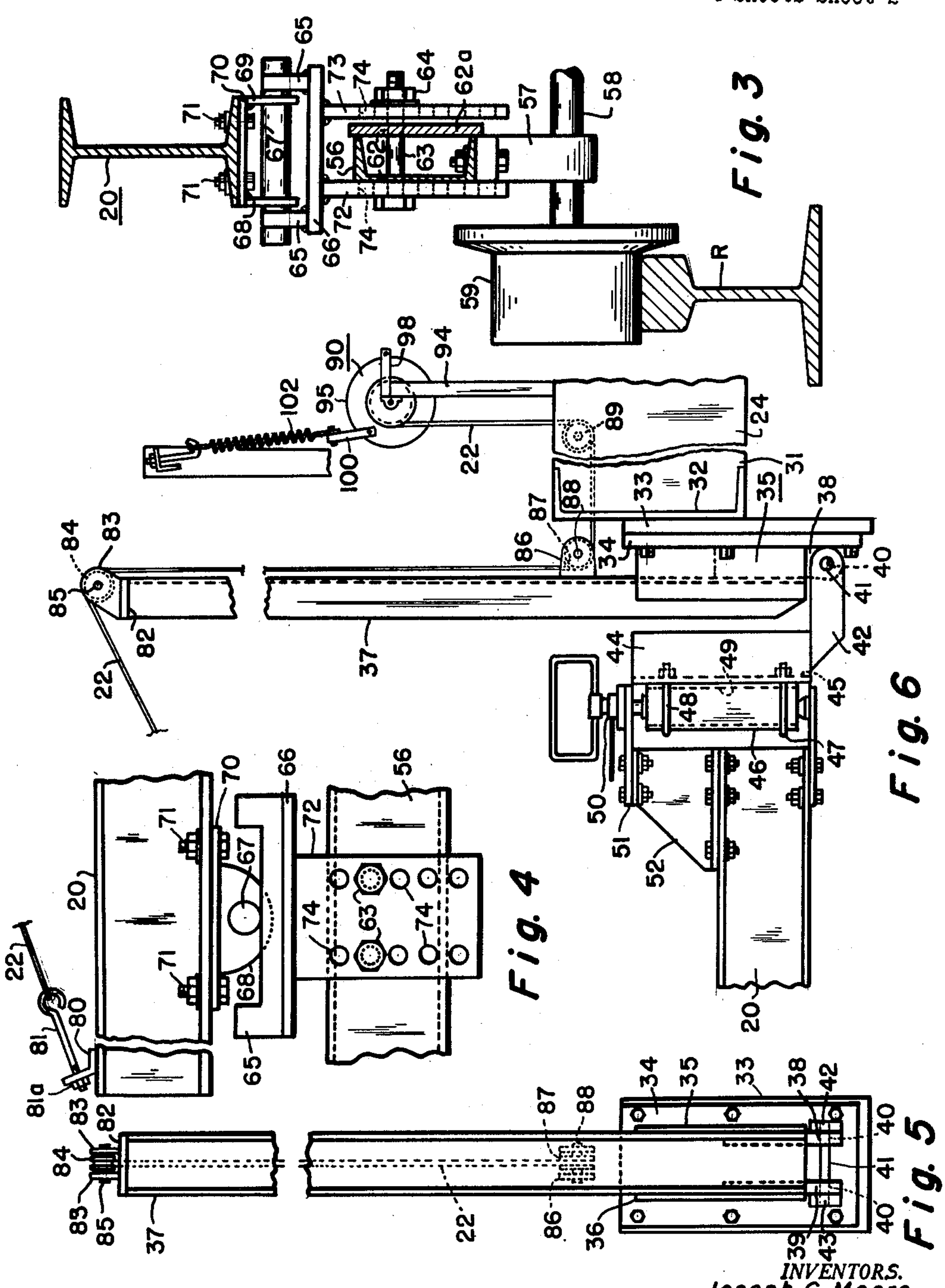
RAILWAY TRACK APPARATUS

Filed April 20, 1961 4 Sheets-Sheet 2



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RAILWAY TRACK APPARATUS

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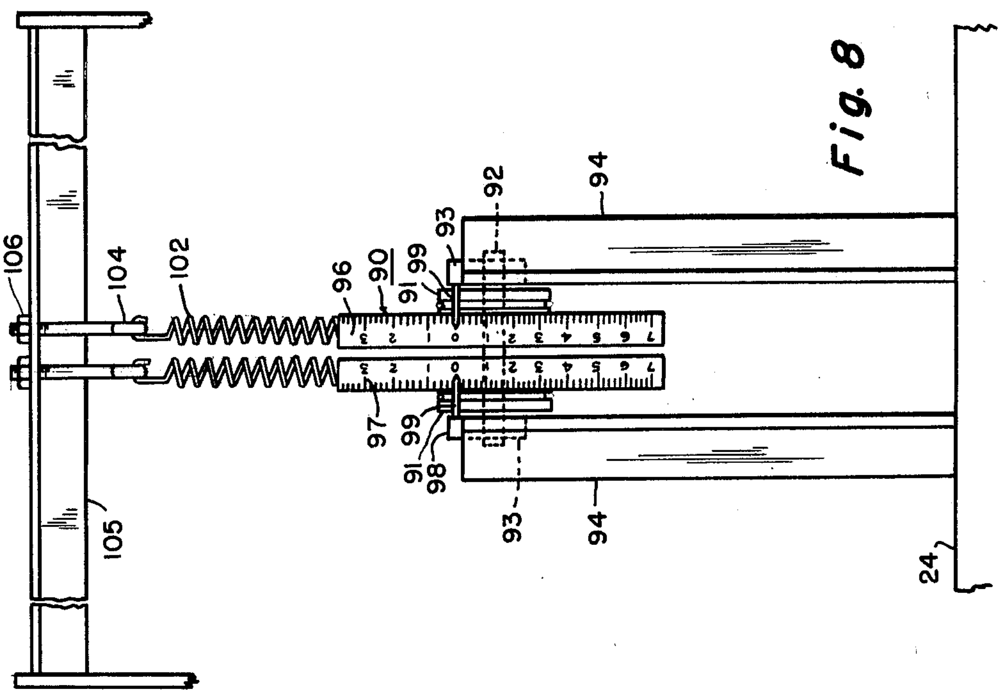

Fig. 8

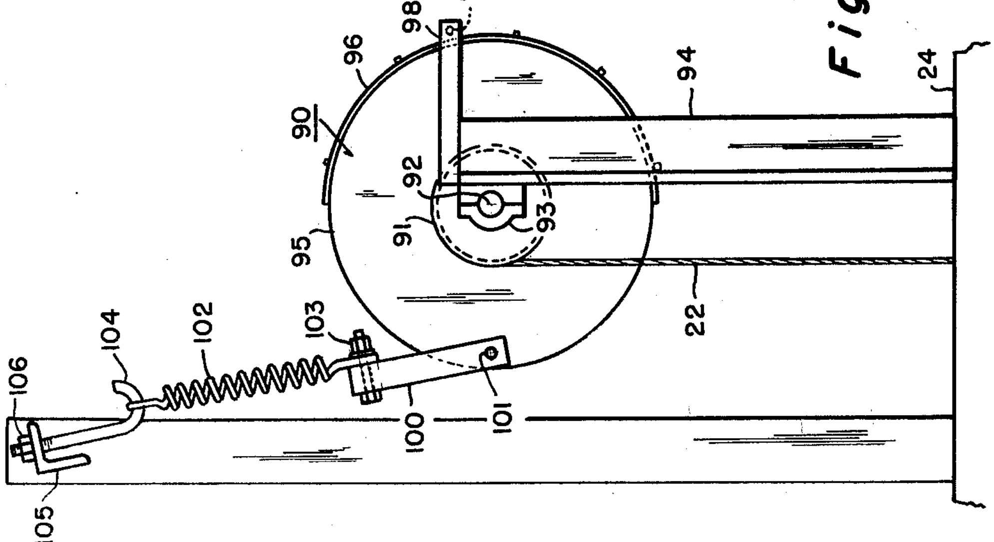

Fig. 7

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RAILWAY TRACK APPARATUS

Filed April 20, 1961 4 Sheets-Sheet 4

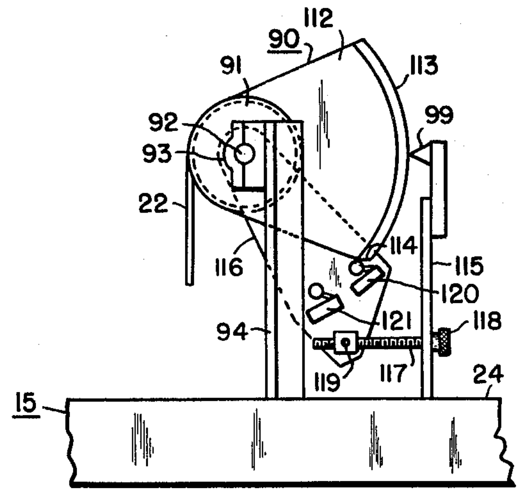

Fig. 9

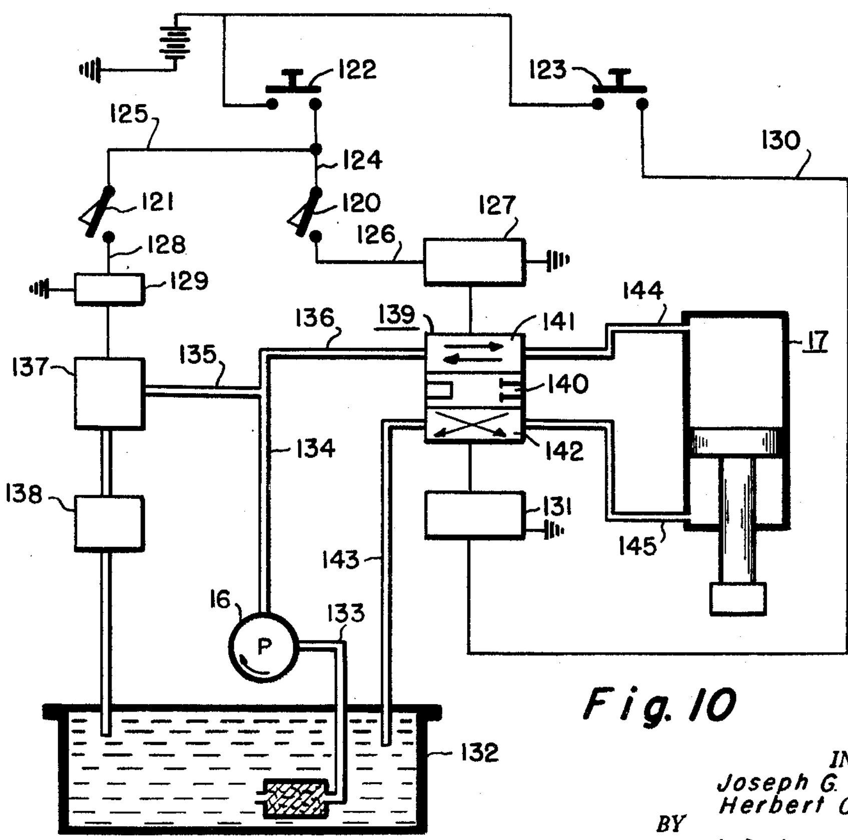

Fig. 10

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United States Patent Office

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3,148,630

RAILWAY TRACK APPARATUS

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Filed Apr. 20, 1961, Ser. No. 104,294
18 Claims. (Cl. 104—7)

This invention is useful as a railway track smoothing apparatus, and, particularly, an apparatus for locating and correcting low spots in a railway track surface such as low joints. Our invention normally is not used for raising an entire track to a new grade or locating long undulations in the railway track. An operator travels over the track on a conventional jack-tamper machine with our invention affixed to the machine, and locates low spots, usually two to six ties in length, which are not to surface. Our invention provides the operator with a simple and rapid means for locating low spots and for determining when the track has been raised to a planar surface without the usual necessity of having a second man sight along the track or using more complicated means of determining the amount that the track must be raised. Our invention serves the dual function of locating a low spot in the track and indicating when the track has been elevated to a proper height so the track is planar.

The extremely smooth track surface produced by use of our invention results in greatly increased track life.

Our invention requires a minimum of personnel when smoothing track, normally only one operator and one operator's assistant, thereby substantially reducing the labor cost in correcting low spots in the track. Furthermore, the proper operation of our invention does not depend on the skill and experience of the operator.

Our invention is simple in construction thereby reducing maintenance and initial costs.

Our invention is also useful as a track inspection machine to locate low spots in a track surface. Our invention is affixed to a self-propelled track vehicle, moved on the track to be inspected and manual or automatic recordings of the track contour are made. This record is used to determine whether the inspected track surface is sufficiently nonplanar to require correction. The operator of the inspection machine can also inspect track immediately ahead of a separate jack-tamper machine, and mark the ties underlying any low track surface and the raise required to smooth the track surface. All of the above operations can be performed automatically without supervision by an operator.

Our invention locates low spots in the track very rapidly thereby permitting inspection of large lengths of track in a very short period of time. Furthermore, there is no interference with normal train movement on the track since our machine may be quickly removed from and returned to operation on the track.

Our invention can locate low spots in both straight and curved track without any modification of the machine or its mode of operation.

In the following drawings, we have described a present preferred embodiment of our invention:

FIGURE 1 is a side elevation view of our invention attached to a jack-tamper machine;

FIGURE 2 is a plan view of our invention attached to a jack-tamper machine;

FIGURE 3 is a cross section taken on line III—III of FIGURE 1;

FIGURE 4 is an enlarged side view of part of a beam support cart of FIGURE 1;

FIGURE 5 is a cross section taken on line V—V of FIGURE 1;

FIGURE 6 is an enlarged side view of a beam mounting on the front of a vehicle according to our invention;

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FIGURE 7 is an enlarged side view of an indicator according to our invention;

FIGURE 8 is an enlarged front view of an indicator according to our invention;

FIGURE 9 is a side view of a second form of indicator according to our invention; and

FIGURE 10 is a schematic of an electrical and hydraulic system for our invention.

Briefly, one use of our invention is shown in FIGURES 1–8 and includes a wheel-mounted vehicle **15** having a conventional motor and compressor **16** which supplies pressurized fluid to a jack **17** mounted on each side of the vehicle, to the vertical cylinders of ballast tampers **18** straddling each rail of the track, and to rail clamps **19** which engage the rails and maintain the track and vehicle stationary relative to each other; and a second compressor which supplies pressurized air to the tamping guns of the ballast tampers **18**. All of the foregoing parts of our track smoothing machine are of well-known construction and function. One end of a beam **20** is pivotally affixed to the front of the vehicle **15** and the other end of the beam is supported on a cart **21** having wheels movable along the rails. Preferably, two identical beams **20** are individually affixed to the front of vehicle **15** with one beam substantially overlying and parallel to each of the rails of the track. A continuous, non-extensible cable **22** is affixed to the front of each beam **20** and extends to a separate indicator for each beam mounted on the vehicle. In operation, as the beam **20** pivots relative to the vehicle **15**, the quantity of cable **22** varies between its point of affixation to the beam and its point of contact with the vehicle, or, stated another way, the distance varies between the point of affixation of the cable to the beam and its point of contact with the vehicle. The pivoting of the beam **20** relative to the vehicle **15** is caused by the front wheels of the vehicle being positioned at a low spot on the track while the rear wheels of the vehicle and the wheels of the cart are on track located in the same plane, as will be described hereinafter.

The vehicle **15**, motor and compressors **16**, tampers **18**, rail clamps **19** and jacks **17** are of well-known construction as shown in the Hursh et al. United States Patents Nos. 2,843,055, 2,789,516, 2,734,463 and United States application Serial No. 687,577, filed October 1, 1957.

The vehicle **15** includes a rigid frame **24** mounted on rear wheels **25** and front wheels **26**. The wheels are integral with axles rotatable in pillow blocks affixed to the underside of the frame.

The frame **24** supports the motor and compressors **16** and auxiliary equipment for controlling and transmitting pressurized fluid and air to the jacks **17**, tampers **18** and rail clamps **19**. A driving motor is mounted on the frame and operatively connected to one of the axles to move the vehicle in either direction in a conventional manner. A seat **27** for the operator is covered by a roof **28** and the seat is located within reach of a manual control desk **29** having valves operable to control the flow of pressurized fluid and air to the various pressure operated mechanisms of the machine.

A pair of spaced, longitudinally extending beams **30** and **31** are affixed to the vehicle and extend beyond the front of the vehicle. Beams **30** and **31** are welded to and spaced by a transversely extending beam **32** and suitably reinforced by gusset plates. Suitable structure is provided on these beams for mounting the jacks **17**, tampers **18** and rail clamps **19**.

A flat plate **33** is welded to the front of beam **32** and a parallel plate **34** is bolted to the plate **33**. A pair of spaced vertically extending, parallel plates **35** and **36** are welded perpendicular to the plate **34**, and an elongated vertically extending channel **37** is welded to and between the plates **35** and **36**. The channel **37** extends a substantial height above the frame of vehicle 15. A pair of tongues 38 and 39 are welded to the inside faces of plates 35 and 36, respectively, and each have an opening 40 in alignment with each other. A single pin 41 is positioned in the openings 40 in the plates 38 and 39 and is affixed to each pair of hinge plates 42 and 43. The pin 41 pivots in the openings 40 to swingably mount the plates 42 and 43 for movement in unison. The plates 42 and 43 are welded to the underside of a box-like metal structure 44 having an integral front plate 45. A cylinder 46 is attached to the front of the plate 45 by U-bolts 47 and 48 which pass through openings in the plate 45 and nuts are threaded on the inside ends of the U-bolts. A shaft 49 is rotatably mounted in the cylinder 46 and has axial openings in its upper and lower ends to receive pivot cones. A horizontally extending plate 51 is positioned over the shaft 49 and has a threaded opening through which a locking bolt 50 passes to clamp the upper pivot cone within the opening in shaft 49. Thus, the plate 51 is swingable horizontally relative to the vehicle by rotation of the shaft 49 within the cylinder 46. The outer end of plate 51 is bolted to a short length of I-beam 52 which, in turn, is bolted to beam 20 as shown in FIGURE 6. The beam 20 is an I-beam as shown in FIGURE 3, preferably fabricated from aluminum and about fourteen feet in length. The length of beam 20 can be varied to suit the length of rail used in the track being inspected. A rail commonly used in the United States is 39 feet in length. The rail joints in the track using these rails are offset to each other so that the joints in one rail are located at about the midpoint between the joints of the other rail. Thus, a joint is encountered in one of the rails of the track about every 20 feet. A track position known as the "quarter point" is located midway between any two joints on the track, or about 10 feet from each rail joint. Normally, the low spots in the track are centered at the joints of rails. Thus, the "quarter point" is significant since it is the point which is most likely at the proper grade. We have designed our machine, and particularly the beam length, so that the cart supporting the forward end of the beam will be located at about the "quarter point" when the low spot in the rail is centered at the rail joint.

The beam 20 pivots horizontally relative to vehicle 15 due to the rotation of shaft 49 in the cylinder 46 and vertically relative to vehicle 15 due to the rotation of plates 42 and 43 and pin 41 in the openings 40 in plates 38 and 39.

In the drawings, we have shown a preferable arrangement of our invention in which a pair of spaced parallel beams 20 are pivotally mounted to the front of the vehicle with one beam overlying each of the rails R and R_1. The beams 20 are identically constructed, mounted and supported; therefore, only one will be described herein.

The forward end of beam 20 rests on a four wheel cart 21, but is not connected to the cart. The cart 21 includes a rigid frame fabricated from end channels 53 and 54 which are welded to and spaced by side channels 56. The frame is suitably reinforced by integral corner gusset plates and by center cross channels 55. Pillow blocks 57 are bolted to the cart frame and front and rear axles 58 are rotatably mounted in the pillow blocks. Wheels 59 are integral with axles 58 and movable along rails R and R_1.

Each of the side channels 56 has a small plate 62*a* welded on the open side of the channel. Plate 62*a* and channel 56 have aligned transverse openings 62 therein. A beam support structure straddles the channel 56 at the location of opening 62. Each beam support structure includes a pair of spaced, parallel U-shaped plates 65 which are welded to the topside of a horizontally extending plate 66 with the open side of the U-shaped plates 65 facing upward as shown in FIGURE 4, and a pair of spaced, parallel, downwardly directed plates 72 and 73 welded to the underside of plate 66. The plates 72 and 73 straddle channel 56 and contain a plurality of transverse openings 74 which are positioned in alignment with openings 62. A bolt 63 is inserted through openings 62 and 74, and a nut 64 tightened on the bolt to lock plates 72 and 73 rigidly to channel 56. The openings 74 permit vertical adjustment of the beam support structure relative to the cart and track to provide an over-all raise in grade of the entire track, if desired, as will be more adequately described hereinafter.

A horizontal plate 70 is affixed by nuts and bolts 71 to the underside of beam 20 near its outermost end. A pair of spaced parallel ears 68 and 69 are welded to the underside of plate 70. Each ear 68 and 69 has a transverse opening which receives a pin 67. The pin 67 is welded to the ears and is slidably received in the U-shaped opening of plates 65.

The pin 67 on each beam 20 can slide fore and aft in the U-shaped openings 65 thereby permitting accurate track surfacing on curved track without modifying the arrangement of the machine.

A bent plate 80 is welded to the upper side of each beam 20 and has an opening through which a threaded hook 81 passes. The hook 81 is adjustable relative to plate 80 by loosening or tightening a nut 81*a* threaded on the shank of the hook. A cable 22 is attached to hook 81 and extends toward the vehicle to a position immediately above the channel support 37. A flat plate 82 is welded to the upper end of channel 37, a pair of spaced tongues 83 are welded to the upper side of plate 82 and rotatably support a pulley 84 on an integral pin 85. A second pair of spaced tongues 86 are welded to the back side of channel 37 and rotatably support a second pulley 87 on an integral pin 88. An additional pulley 89, if necessary, is rotatably mounted in conventional manner on the vehicle 15 to properly direct the cable 22 to an indicator 90. The cable 22 extends from the hook 81 around the pulleys 84, 87 and 89 and is affixed to take-up reel 91 on indicator 90. The take-up reel 91 is rotatably mounted on a shaft 92 which is supported in pillow blocks 93 which are affixed to a pair of spaced angles 94 extending upright and welded to the vehicle 15. FIGURES 7 and 8 show a pair of the indicators 90, one of which has a reading for the right-hand beam 20 and the other of which has a reading for the left-hand beam 20. The indicators are both mounted on shaft 92 and are identical in construction; therefore, only one will be described herein. A large disk 95 is affixed to the take-up reel 91 and contains an integral peripheral scale 96 bearing indicia 97. A horizontal arm 98 is welded to the channel 94 and has an integral pointer 99 overlying the indicia 97 on the scale 96. A coupling bracket 100 is pivotally affixed to the disk 95 by a pin 101 at a side position at approximately a horizontal plane passing through the shaft 92. The other end of bracket 100 is pivotally affixed to a spring 102 by nut and bolt 103. The upper end of spring 102 is hooked on a hook 104 having a threaded shank which passes through a hole in an angle 105 welded to a rigid portion of the vehicle 15. A nut 106 is threaded on the shank and permits rotary adjustment of the disk 95. The primary purpose of spring 102 is to urge the take-up reel 91 in a clockwise direction as viewed in FIGURE 7, thereby winding cable 22 onto the reel.

A coupling bar 107 is positioned between the front end of vehicle 15 and the rear end of cart 21. A pair of spaced tongues 109 are welded to the front channel 32 of the vehicle and a pin 111 is positioned in aligned openings in tongues 109 and the end of bar 107 to pivotally mount the bar on channel 32. A pair of spaced tongues 108 are welded to rear channel 53 of the cart and a pin 110 is positioned in aligned openings in tongues 108 and the end of bar 107 to pivotally mount the bar on channel 53.

FIGURE 9 shows a second form of our indicators 90. The cable 22 extends from the hook 81 around the necessary pulleys and is affixed to the take-up reel 91 on indicator 90. The reel is rotatably mounted on shaft 92 supported in pillow blocks 93 which are affixed to angles 94 welded to the vehicle 15 as described above. A pair of the indicators 90, as shown in FIGURE 9, are provided on the vehicle, one of which responds to the right-hand beam 20 and the other to the left-hand beam 20. The indicators are identical in construction, therefore only one will be described herein. A segmental disk 112 is affixed to the take-up reel 91 and contains an integral peripheral scale 113 preferably bearing indicia to indicate deviations from a "zero" point. The lower end of the scale is cut at an angle 114. A vertically extending plate 115 is welded to a rigid portion 24 of the vehicle. A pointer 99 is affixed to the upper end of plate 115 and overlies the scale 113. A switch support arm 116 is in a segmental shape with one end pivotally mounted on shaft 92 and its other end extending radially outward from shaft 92 beyond the outermost point of disk 112. A switch adjustment bolt 117 is rotatably mounted in a hole in plate 115 and has a knurled knob 118 on one end adjacent plate 115 for manual rotation of bolt 117. The inner end of bolt 117 is threaded into a threaded sleeve 119 which is pivotally affixed to the lower end of support arm 116. by rotating the bolt 117, the support arm is pivoted about shaft 92 and its lower end is moved in an arc toward and away from plate 115. A "slow" limit switch 120 is fixed to support arm 116 with its switch contact in position to be engaged by angle 114 and scale 113 upon rotation of the scale in a clockwise direction as viewed in FIGURE 9, and a "fast" limit switch 121 is fixed to support arm 116 to be similarly engaged after the scale has rotated a greater clockwise direction. A suitable spring mechanism, as shown in FIGURE 7, is affixed to the indicator of FIGURE 9 to urge the take-up reel 91 in a clockwise direction. Other mechanisms to perform this function can be substituted for the spring structure of FIGURE 7; such as a coil torsion spring around shaft 92 affixed to the reel and angle 94. Suitable electrical connections are supplied for switches 120 and 121 as will be described hereinafter.

Referring to FIGURE 10, a pair of manually operated switches 122 and 123 are positioned on the control desk of the vehicle within easy reach of the operator. These switches are suitably connected to a source of electrical current. Upon actuation of switch 122, current is admitted to a first wire 124 which is operatively connected to one pole of "slow" limit switch 120, and to a second wire 125 which is operatively connected to one pole of "fast" limit switch 121. The other pole of switch 120 is connected to wire 126 which is connected to a solenoid 127. The other pole of switch 121 is connected to wire 128 which is connected to a solenoid 129.

The second manually operated switch 123, upon actuation, admits electrical current to wire 130 which is operatively connected to solenoid 131.

The hydraulic system includes a sump 132 from which the motor and compressor 16 draws hydraulic fluid through a pipe 133. The fluid is pressurized in the pump and passed through a pipe 134 which separates into two branch pipes 135 and 136. Pipe 135 passes some of the fluid through a normally open valve 137 and a flow control valve 138 back to the sump 132. Thus, some of the pressurized fluid is normally bled off and returned to the sump. The valve 137 is preferably a 4 way-2 position spring offset, solenoid operated Vickers DG 454–012–A. The two positions on valve 137 are, first, a connection between pipe 135 and the flow control valve 138 to permit the fluid to bleed off to the sump; and second, a disconnection of pipe 135 and valve 138 to stop the fluid from bleeding off to the sump. The valve 137 is normally "open" or in the first position permitting bleeding off of fluid. The solenoid 129 is operatively connected to valve 137 to activate the valve to "closed" or position two such that the fluid is not bled off to the sump. When solenoid

129 is activated, the fluid bled off through the flow control valve 138 is stopped.

Flow control valve 138 is preferably a Waterman 320–4–8.0.

Pipe 136 passes fluid to a main valve 139 which is preferably a 4 way-3 position solenoid operated Vickers DG 554–104–CH. The three positions of the valve are: first, a neutral "no flow" position depicted by box 140; second, a "raise" position depicted by box 141; and, third, a "lower" position depicted by box 142. A pipe 143 returns fluid from valve 130 to sump 132. A pipe 144 passes fluid between valve 139 and the upper end of the cylinder of jack 17, and a pipe 145 passes fluid between valve 139 and the lower end of the cylinder of jack 17.

The solenoid 127 is operatively connected to valve 139 to move the valve to the "raise" 141 position upon actuation of the solenoid. In the "raise" position, the pressurized fluid flows from pipe 136, through the valve 139 and line 144 to the upper end of the cylinder of jack 17, thereby forcing the piston in the cylinder downward until the piston rod affixed to the piston engages the track base and raises the vehicle and underlying track. Simultaneously, any fluid below the piston in the cylinder is forced through pipe 145, valve 139 and pipe 143 to sump 132.

The solenoid 131 is operatively connected to valve 139 to move the valve to the "lower" 142 position upon actuation of the solenoid. In the "lower" 142 position, the pressurized fluid flows from pipe 136, through the valve 139 and line 145 to the lower end of the cylinder of jack 17, thereby forcing the piston in the cylinder upward until the piston rod affixed to the piston disengages the track base. Simultaneously, any fluid above the piston in the cylinder is forced through pipe 144, valve 139 and pipe 143 to sump 132.

If neither solenoid 127 or 131 are activated, the valve 139 is in the neutral 140 position blocking any flow of fluid through the valve.

Referring to FIGURE 9, when the front wheels 26 of vehicle 15 enter a low spot in the track, the cable 22 is fed onto the take-up reel 91 which rotates in a clockwise direction due to the spring bias mechanism. The disk 112 rotates simultaneously with reel 91 and moves the scale 113 into engagement with either or both switches 120 and 121. If only a slight low spot has been encountered in the track, the scale rotates only until it engages switch 120, but if a deeper low spot has been encountered the scale will rotate until the switch 121 is also engaged. The operator stops the vehicle when the maximum rotation of the scale is indicated, engages the clamps with the track, and manually actuates switch 122 or a plurality of such switches depending on the number of jacks on the vehicle. Since switch 120 will be closed by scale 113 whenever a raise is required, the solenoid 127 will be activated to move valve 139 to "raise" position 141 thereby permitting pressurized fluid to enter the upper end of the jack cylinder. If the required raise is not substantial, the limit switch 121 will not be closed by scale 113 and the valve 137 will remain open thereby permitting fluid to be bled from pipe 134. This results in a slow downward movement of the piston in the jack cylinder. However, if the required raise is substantial, the limit switch 121 will be closed by scale 113 and the solenoid 129 is activated to close valve 137 thereby stopping the bleed off of fluid from pipe 134. This results in a rapid downward movement of the piston in the jack cylinder. As the jack elevates the vehicle and underlying track, the scale 113 rotates counterclockwise since cable 22 is pulled from take-up reel 91, and the scale first disengages switch 121 thereby opening the switch and deactivating solenoid 129 to open valve 137 so fluid is bled from pipe 134. This results in slowing the downward movement of the piston in the jack cylinder as the raise nears its end point. The rotation of the scale 113 counterclockwise as the raise progresses results in ultimate disengagement of the switch **120** and deactivation of solenoid **127** permitting valve **139** to assume the neutral position **140** which holds the piston stationary with the vehicle and track elevated to the desired distance preparatory to tamping the underlying ballast.

To elevate the piston in the jack cylinder, the operator manually actuates switch **123** which activates solenoid **131** thereby moving valve **139** to the "raise" position **142**. When switch **123** is released the solenoid **131** is deactivated and valve **139** assumes the neutral position **140**.

Operation

Our method, in its simple form, includes the following steps: (1) establishing first, second and third reference points on the track; the first reference point being the location of the front cart **21** on the track; the second reference point being the location of the wheel **26** of the vehicle on the track; and the third point being the location of the wheel **25** of the vehicle on the track; these reference points are spaced a constant distance from each other; (2) establishing a fourth reference point above the track in the proximity of and movable horizontally with the second and third reference points; this fourth point in our preferred embodiment shown in the drawings is the point of contact of cable **22** and pulley **84** although this reference point can be located any place above the track (even between wheels **25** and **26** or rearwardly of wheel **25**) so long as the quantity of cable between hook **81** and the reference point will measurably change when the wheel **26** enters a low spot in the track; the fourth reference point must be maintained a constant distance from both the second and third reference points; (3) determining the distance between the first and fourth reference points when the first, second and third points are located on planar track; this measurement is a quantity of cable between hook **81** and pulley **84** and an arbitrary "zero" value is given to this quantity on the indicator **90** by proper adjustment as has been described; (4) moving said first reference point, said second reference point and said third reference point along the track until the second reference point is non planar to the plane of the first and third points; this nonplanarity is caused by the second reference point dipping into a low spot on the track while the first and third points are maintained on track located in the same plane; (5) determining the distance between the first and fourth points to establish the nonplanarity of the second point; this measurement is the quantity of cable between hook **81** and pulley **84** and is a relative value to the prior "zero" reading determined in step 3. Alternative additional steps may be performed at this point in the method: (1) recording the nonplanarity of the second point; this recordation is accomplished with well-known recording devices and provides data for a determination of whether the track required surfacing treatment or for other uses; or, (2) vertically changing the location of the track underlying the nonplanar second point until the first, second and third points are again located on planar track; this step is achieved by jacking up the vehicle **15** and the track underlying its front wheel **26** to establish a planar track.

In operation, the frame **24** of the vehicle serves as one side of a triangle, the beam **20** as a second side of the triangle, and a straight line extending parallel to the top of the rails between the right end of the vehicle and the left end of beam **20** (as viewed in FIGURE 1) as the third side of the triangle. When the straight line coincides with the other two sides of the triangle, that is, all three sides lie in the same plane extending parallel to the top of the rails, the vehicle **15** and cart **21** are positioned on planar track.

Each cable **22** extends from the front of its respective beam to the top of a channel **37**, which is preferably mounted directly over each pivot pin **40**, and then passes over various sheaves to the indicators **90** mounted on the vehicle in a position where the operator can read both indicators simultaneously. The entire machine is first positioned on track which is known to be planar, and the scales **97** are adjusted by rotating either or both nuts **81*a*** and **106** until the zero on the scales are located at pointer **99**. The calibration of the scale is not important since the machine operator is not attempting to determine the amount that the track is nonplanar, but rather is only interested in knowing when the track is planar or nonplanar.

The left ends of beams **20**, as viewed in FIGURE 1, merely rest on cart **21**, and the right ends are horizontally and vertically pivoted to the vehicle **15**. The horizontal pivoting movement of the beams enables the beams to navigate curved track, and only the vertical movement of the beams is designated on indicators **90**. The cables **22** could be connected directly to the cart **21** and the beams eliminated; however, the indicators would then designate a change in slack in the cable which would be particularly troublesome on curved track, and thus the preferred arrangement of our invention is shown in the figures.

After the indicators have been adjusted on planar track, the vehicle **15** is driven under its own power, with the beams in front of it, along the track to be leveled. As the vehicle proceeds over the track, its front wheels **26** will occasionally dip into low spots in the track, usually at a joint. When this occurs, the front end of the vehicle dips, lowering the channel **37** and the length of the cables between hook **81** and reel **91** is lessened. The spring **102** urges the indicator in a clockwise direction, as viewed in FIGURE 7, thereby winding the cable onto reel **91**. The peripheral rotation of the reel is multiplied by an identical angular rotation of the scale **96**. Thus the zero on such scale is no longer located at pointer **99**. The operator then locates the tampers **18** over a tie at approximately the center of the low spot which is denoted by the maximum deviation from zero on the scales. The rail clamps **19** are then engaged with the track to maintain the vehicle stationary relative to the track. Jacks **17** are then activated in the conventional manner by engagement with the track bed to elevate the track and vehicle to the correct level or elevation to again yield a "zero" reading on indicators **90**. Tampers **18** tamp the underlying tie to hold the track at the correct elevation, the jacks **17** are raised, the rail clamps **19** are released, and the adjoining ties are tamped. The machine is then moved forward to the next low spot.

The operation of our second form of the invention, shown in FIGURES 9 and 10, has been described above.

The vehicle also can be moved along the track with the beams **20** trailing the vehicle. As the vehicle proceeds over the track in this manner, its wheels **26** dip into low spots in the track causing the quantity of each cable **22** between hook **81** and reel **91** to lessen and the indicator **90** rotates clockwise, as viewed in FIGURE 7, to wind cable onto reel **91**. The subsequent procedure in leveling the track is the same as described above.

While we have described a present preferred embodiment of our invention, it may be otherwise embodied within the scope of the following claims.

We claim:

1. A railway track smoothing machine including a vehicle movable along the track, an elongated beam pivotally affixed to one end of the vehicle and extending along the rails of the track; a cart spaced from the vehicle and movable along the track; the free end of said beam being supported by said cart; a non-extensible cable affixed to said free end of the beam and extending toward the vehicle at an angular relationship to the track; an indicator mounted on said vehicle; the other end of said cable being operably connected to said indicator such that a variation in the quantity of said cable between its point of affixation to the beam and its point of connection with the indicator will activate the indicator to

show such variation; said quantity variation occurring whenever said beam pivots relative to said vehicle in a vertical direction due to the cart being on a portion of the track which is vertically nonplanar with respect to a portion of the track on which said one end of the vehicle is supported.

2. A railway track smoothing machine including a vehicle having ballast tampers, a track jack and a rail clamp mounted thereon and movable therewith; said vehicle being movable along the track to be smoothed; an elongated rigid member pivotally affixed to one end of said vehicle and extending substantially parallel to the longitudinal axis of the rails of said track; a cart spaced from said vehicle and movable along said track; said cart engaging and supporting the outermost end of said rigid member; a cable affixed to said outermost end of said rigid member and extending to a take-up reel indicator; said cable being affixed to said indicator; said indicator being affixed to the vehicle and adapted to register variations in the quantity of said cable between its point of affixation to said rigid member and said reel; such variations being caused by a nonplanar condition in the track being smoothed.

3. A railway track smoothing machine including a first vehicle mounted on front and back wheels for movement along said track, a rail clamp affixed to said machine and adapted to engage and hold the machine stationary relative to the track; a jack affixed to said machine and adapted to elevate the track and machine above a base underlying the track; the surface of the track engaging said front and back wheels of the first vehicle forming a first reference plane; a second vehicle mounted on wheels for movement along said track; said second vehicle being spaced from said first vehicle; a rigid beam extending longitudinally of the track and spanning the space between said vehicles; individual ends of the beam being in operative pivotal engagement with the vehicles; the surface of the track engaging the wheels of the second vehicle forming a second reference plane indicator; means mounted on the first vehicle and connected with the end of said beam on said second vehicle to indicate nonplanarity between said first and second reference planes such that said jack can be activated to raise said track and first vehicle until planarity between the reference planes is established and said tamper then can be activated to tamp the base underlying the track to maintain the planarity between the reference planes.

4. A machine according to claim 3 including an upstanding beam affixed to said first vehicle in the proximity of the juncture of said rigid beam with said first vehicle; a pulley rotatably mounted on a horizontal axis affixed to the upper end of said upstanding beam; said indicator means including a cable affixed to the end of said beam in engagement with said second vehicle and extending over and in contact with the pulley and connected to a take-up reel affixed to said first vehicle; said reel being mounted to rotate when a variation in the length of cable occurs as result of nonplanarity between the first and second vehicles; said reel being attached to an indicator for said variation.

5. A machine according to claim 3 wherein said rigid beam is pivotally joined to the first vehicle for horizontal and vertical movement.

6. A machine according a claim 3 including a pair of said rigid beams extending longitudinally of the track and spanning the space between the vehicles; one of said beams overlying each of the rails of the track; individual ends of each beam being in operative pivotal engagement with the vehicles; said indicator means including a cable attached to each beam end mounted on the second vehicle and extending to take-up reels affixed to the first vehicle; said reels activating indicators to denote changes in the length of each cable between said beam end and the reel.

7. A railway track smoothing machine including a vehicle having front and rear wheels for movement along the track; tampers mounted on the vehicle and engageable with the base underlying the track; a rail clamp mounted on the vehicle to engage and hold the vehicle stationary relative to the track; a jack mounted on the vehicle and engageable with said base to elevate the track and vehicle above the base; an upstanding support attached to the vehicle; a pulley rotatably mounted on the upper end of said support; a plate pivotally mounted on said vehicle in the proximity of said support, said plate being movable in a vertical plane; an elongated beam pivotally affixed to said plate, said beam overlying one of the rails of the track and being movable in a horizontal plane relative to said plate; a pin affixed to the underside of the outer end of said beam; said pin extending horizontally and transversely of the track; a cart having front and rear wheels for movement along the track; a U-shaped support affixed to the cart, the U-shaped support being positioned with its open side extending upward to receive said pin; said pin having smaller dimensions than the open side of the U-shaped support; a continuous cable attached to the outer end of said beam and extending over said pulley to an indicator mounted on the vehicle; said indicator designating any change in the length of cable between its point of attachment to the beam and said pulley; the change in length of the cable being caused by said plate and attached beam pivoting relative to the vehicle.

8. A machine according to claim 7 including a second plate pivotally mounted on said vehicle, a second elongated beam horizontally pivotally affixed to said second plate; said second plate; and second beam overlying the other of said rails of the track; a pin affixed to the underside of the outer end of said second beam; said pin extending horizontally and transversely of the track; a second U-shaped support affixed to said cart and positioned with its open side extending upward to receive said second pin; said second pin having smaller dimensions than the open side of the second U-shaped support; a second continuous cable attached to the outer end of said second beam and extending over a pulley to a second indicator mounted on the vehicle; the second indicator designating any change in the length of the second cable between its point of attachment to the second beam and said pulley; the change in length of the second cable being caused by the second plate and second beam pivoting relative to each other.

9. A machine according to claim 7 including power means to supply pressurized fluid to said jack to elevate the track and vehicle; manual means to activate said power means; automatic means on said indicator to deactivate said power means when said jack has elevated the track and vehicle a sufficient height above the base of the track.

10. A machine according to claim 7 wherein said indicator includes a rotatably mounted take-up reel to which the cable is attached such that upon rotation of the reel in a first direction the cable is wound onto the reel, and upon rotation of the reel in the opposite direction the cable is wound off from the reel, and a spring biasing the reel in said first direction.

11. A railway track machine for correcting low areas in railway track comprising a wheel-mounted vehicle movable on the track; a first elongated beam pivotally affixed to the front of the vehicle for movement in a vertical plane; said first beam extending horizontally and overlying one of the rails of the track; a second elongated beam pivotally affixed to the front of the vehicle for movement in a vertical plane; said second beam extending horizontally and overlying the second rail of the track; a supporting frame spaced from the vehicle and movable along the track in conjunction with the vehicle; said supporting frame engaging the surface of the track and supporting the outer ends of each of said beams, a continuous cable attached to the outer end of each beam and extending to an indicator mounted on said vehicle; said cable being affixed to the indicator such that variations in the

quantity of cable between one indicator and its point of affixation to the beam are designated by the indicator; such variations being effected by each of said beams pivoting relative to said vehicle about their points of affixation to the vehicle caused by a nonplanar condition of the surface of the track engaged by said supporting frame and the surface of the track engaged by the wheels of the vehicle.

12. A machine according to claim 11 wherein said indicator includes a rotatably mounted reel; upon rotation of the reel in one direction the cable is wound onto the reel, and upon rotation of the reel in an opposite direction the cable is unwound from the reel thereby decreasing and increasing respectively said quantity of the cable; a scale affixed to the reel for coaxial rotation therewith, said scale being a greater radius from the axis of rotation of the reel than the surface of the reel engaged by the cable such that any rotation of the reel is peripherally magnified on the scale.

13. A machine according to claim 11 including a power jack mounted on each side thereof to elevate the vehicle and track above the base of the track, a clamp mounted on the vehicle and engageable with the track to maintain the vehicle stationary relative to the track; and tampers mounted on the vehicle to tamp the base underlying the track.

14. A machine according to claim 11 including a rail jack on the vehicle to elevate said vehicle and underlying track to a desired elevation; a compressor on the vehicle to supply pressurized fluid to the jack; said indicator including a first means actuatable when the first predetermined value of said variation is reached, and a second means actuatable when a second predetermined value of said variation is reached, said second predetermined value being greater than the first predetermined value; said first means being operatively joined to said jack and compressor to admit said pressurized fluid to the jack at a limited flow rate upon actuation of the first means; and said second means being operatively joined to said jack and compressor to admit said pressurized fluid to the jack at a flow rate greater than said limited flow rate upon actuation of the second means.

15. A machine according to claim 11 including a rail jack on the vehicle to elevate said vehicle and underlying track to a desired elevation; means on the vehicle to supply pressurized fluid to the jack; said indicator including a rotatably mounted take-up reel which rotates to wind and unwind cable proportional to said variations; a first and second limit switch on the vehicle; means on said reel to energize said first limit switch upon a predetermined rotation of the reel and also energize said second limit switch upon a greater predetermined rotation of the reel; and said first switch being operatively connected to admit said fluid to the jack upon being energized; and said second switch being operatively connected to increase the admission rate of said fluid to the jack.

16. A railway track inspection machine including a vehicle movable along the track, an elongated beam pivotally affixed to one end of the vehicle and having an outer free end positioned over the track, a cart spaced from the vehicle and movable along the track, the free end of said beam being supported by said cart; a continuous non-extensible cable affixed to said free end of the beam and extending toward the vehicle at a vertical angular relationship to the track; an indicator mounted on said vehicle; the other end of the cable being operably connected to said indicator so that variations in the quantity of said cable between its point of affixation to the beam and its point of connection with the indicator actuate said indicator; said variations being caused when said one end of the vehicle is supported on a portion of the track vertically nonplanar with respect to the portions of the track on which the cart and the other end of said vehicle are supported.

17. A method of determining the vertical contour of a railway track, which comprises establishing first, second and third reference points on the track, said points being spaced a constant distance from each other and the second point being positioned between the first and third points; establishing a fourth reference point above the track in the proximity of and movable with said second and third reference points; the fourth reference point being a constant distance from both the second and third reference points; determining the distance between said first and fourth reference points when the first, second and third points are located on planar track; moving said first reference point, said second reference point and said third reference point along the track until the location of the second reference point is nonplanar with respect to a plane including the first and third reference points, then determining the distance between the first and fourth reference points to establish the vertical deviation between the plane containing the first and third reference points and a parallel plane containing the second reference point.

18. A method according to claim 17 including the step of vertically raising the track at the nonplanar second point until the first, second and third points are located in the same plane.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,148,630 September 15, 1964

Joe G. Moore et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 11, for "valve 130" read -- valve 139 --; column 12, lines 13 and 14, for "track vertically" read -- track which is vertically --.

Signed and sealed this 12th day of January 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents