

Sept. 17, 1968

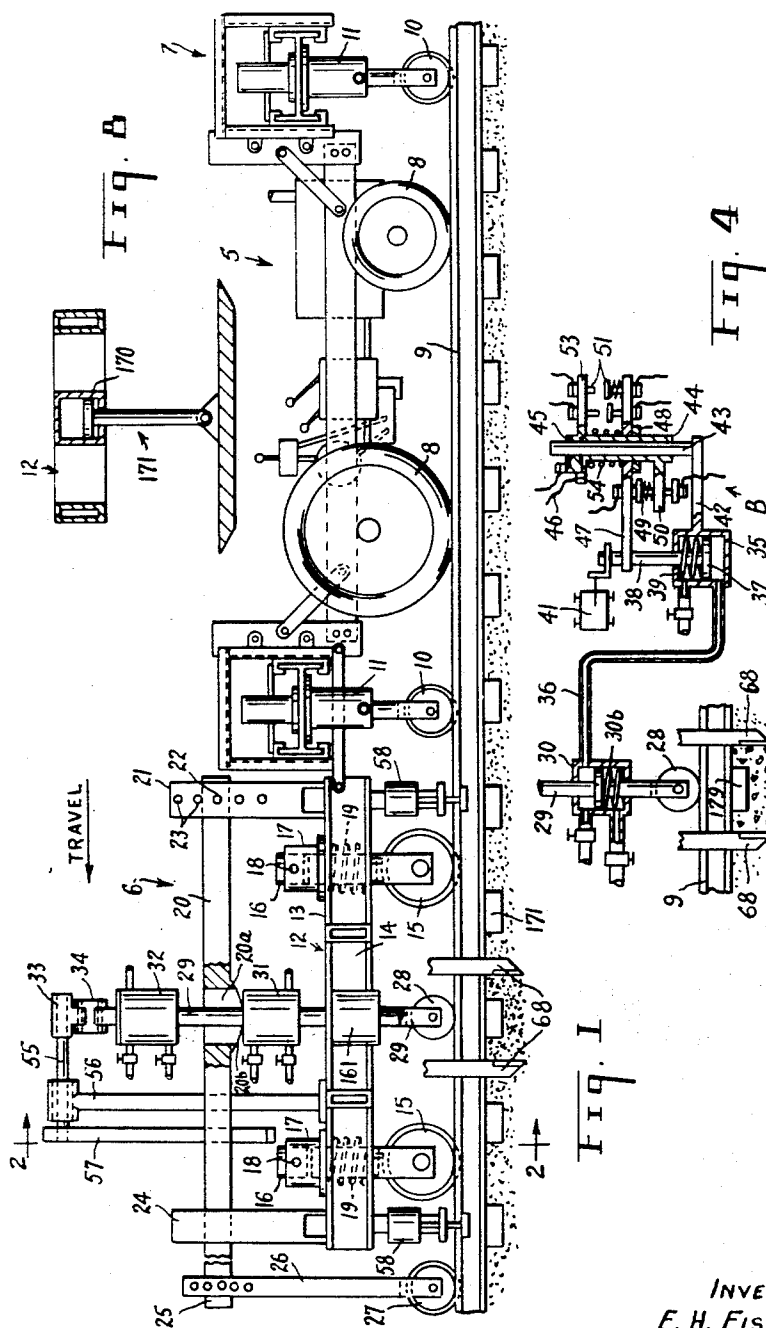
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3,401,642

AUTOMATIC JACKING, LEVELLING AND LINING RAILROAD TRACK TAMPERS

Filed Nov. 4, 1966

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

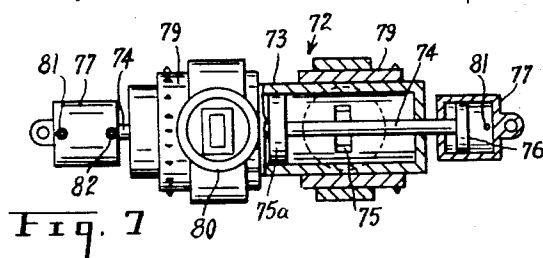
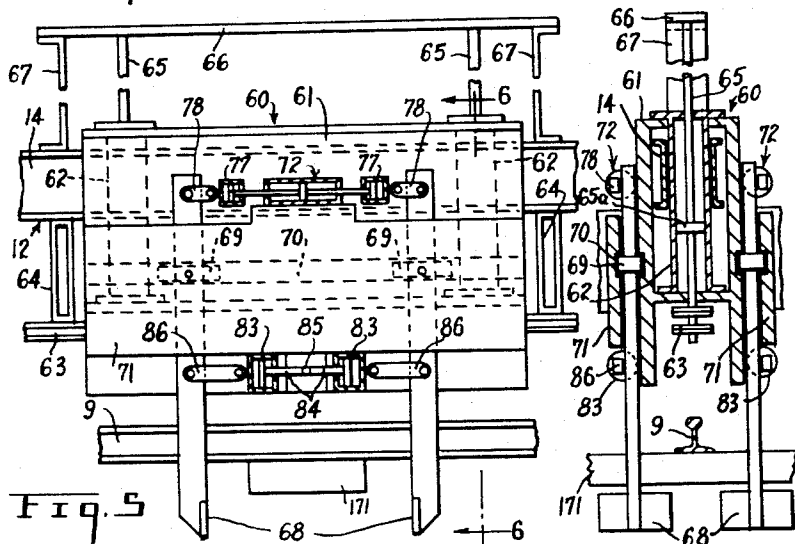
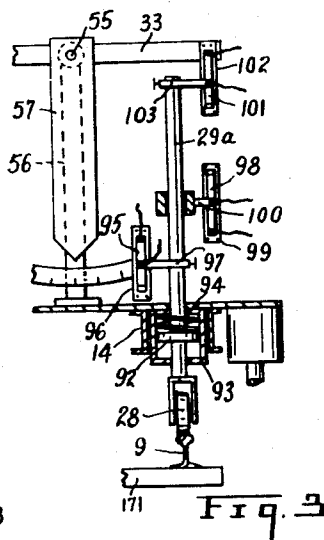
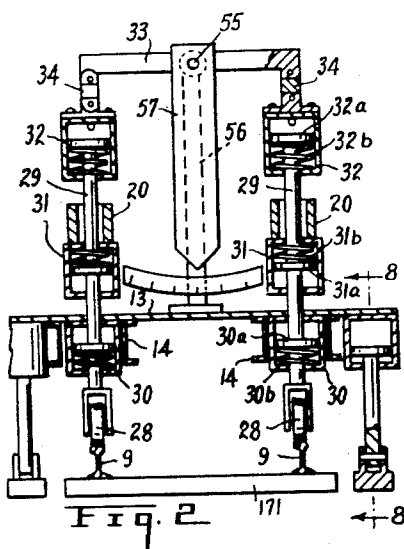


Fig. 6

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4 Sheets-Sheet 3

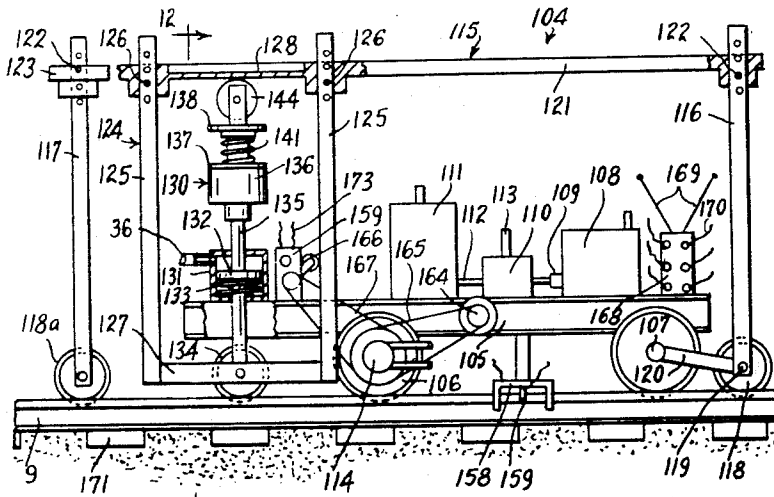


Fig. 11

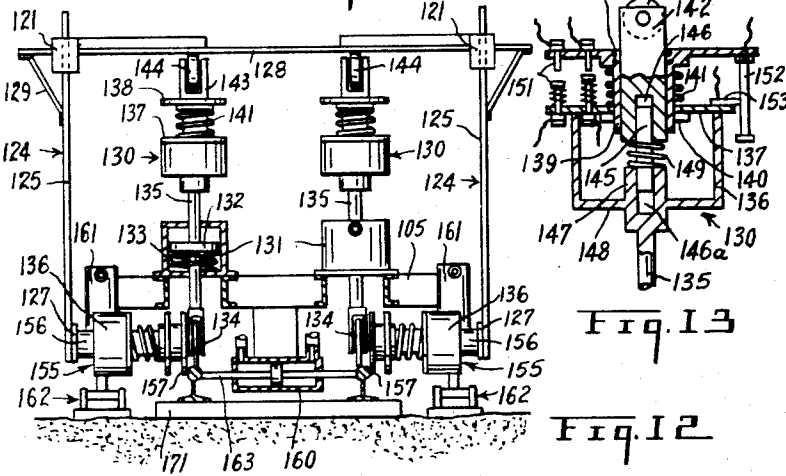


Fig. 12

Fig. 9

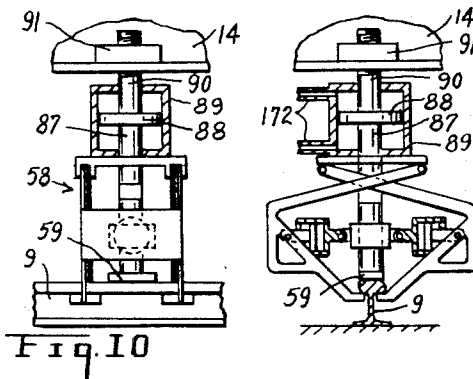


Fig. 10

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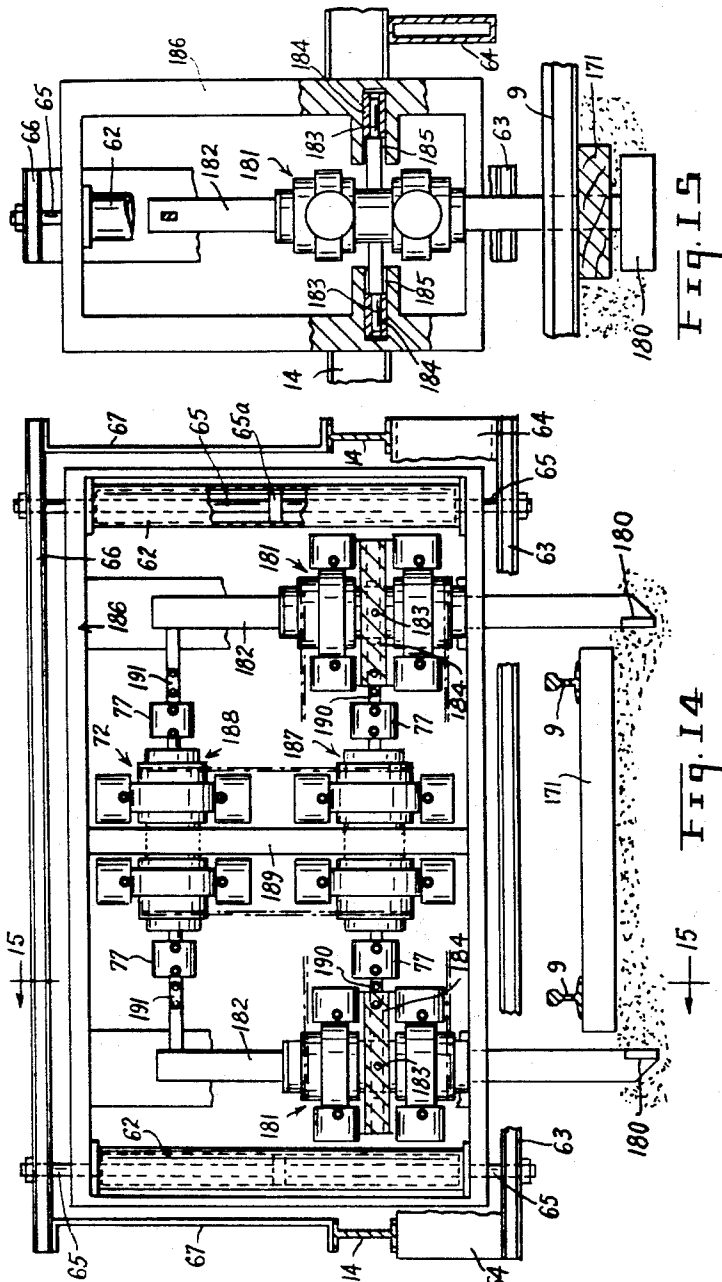
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4 Sheets-Sheet 4



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3,401,642 AUTOMATIC JACKING, LEVELLING AND LINING RAILROAD TRACK TAMPERS

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16 Claims. (Cl. 104—8)

This invention relates to automatically jacking, leveling and lining tampers controlled and directed with or without a tape cut by a computer or received direct from a track recording device, etc.

In the past, tamper equipment has been costly with the power source permanently attached to the machine and, therefore, not available for other use. The amplitude and frequency of the tamping vibratory action cycle was fixed, and therefore, not flexible. Furthermore, the tamping tools, for the most part, left an inverted wedge or pyramid shape of compacted ballast under the tie after the tamping cycle had finished, which was not a stable structure in all cases, the tamping tools having left a shear plane along the faces where the tamping had compacted the ballast. In addition, the squeeze force was cut off when a predetermined hydraulic pressure for the compaction of ballast under the tie had been reached. This type of cut off action for the compaction of ballast under the ties causes a non-uniform force of reaction between the ballast, tie and tie plate and rail, in many instances. With the present type of tamper the optimum raise, level and line condition is not always provided considering the variables such as volume of traffic, train speeds, axle loadings, weight of rail, condition of ballast and cost of materials, etc., that should be considered.

The subject invention overcomes the above mentioned limitations associated with the conventional tamping machines in that it is operated in conjunction with my previous invention entitled, "Roadrail Vehicle Having a Self-Aligning Retractable Flanged Wheel Arrangement," U.S. Ser. No. 421,326 filed Dec. 28, 1964, now Patent No. 3,338,184, thereby providing a detachable power source which is used for locomotion and hydraulic power source for the tamper as well as other hydraulic power source and other pneumatic tired vehicle use when not used for an attachment power source for the tamper. The use of a mass produced pneumatic tired vehicle will materially reduce the overall cost of doing work for both the tamping and other work as required. Furthermore, the elimination of a power source and hydraulic power components from the tamper enables the tamper to be much lighter and less costly than would otherwise be the case.

It has been possible to vary the amplitude and frequency as well as the impact of the vibratory action of the tamping cycle by incorporating my previous invention, entitled, "Hydraulic Intake and Exhaust Valving Arrangement," U.S. Ser. No. 423,073 filed Jan. 4, 1965, now Patent No. 3,369,459, into the tamping head of the present invention. At the same time, this overall arrangement of the tamping head permits the establishment of a compacted ballast section as with the present tampers, as well as a pyramid or wedge-shape of compacted ballast under the ties with the top of the wedge or pyramid cut off; or it can provide a rectangular shape of compacted ballast under the tie.

A more uniform compaction of ballast under the ties is obtained by using a part of my previous invention, "Hydraulic, Mechanical, Electrical, Sensing Device," U.S. Ser. No. 445,123 filed Apr. 2, 1965, now Patent No. 3,364,579, and here the tamping action is cut off by this means, when the rail is raised a predetermined amount against a restraining pressure, thereby ensuring that the ballast is always uniformly compacted under the tie and that the tie plate and rails are always uniformly tight, one with the

other. Variations of this invention are used in the sensing of the track, so that suitable correction can be made to it when applied to the automatic jacking and levelling tamper hereinafter described.

With the automatic jacking and levelling tamper, controlled by a "tape," etc., variations of the "sensing" invention are used to control the exact amount of correction as dictated by the tape, etc.

With the automatic jacking and/or lining tamper the sensing means to dictate the amount of raise or alignment and to control the exact amount of movement to obtain this end is an integral part of the tamper.

The automatic jacking, levelling and/or lining tamper operating from a computer tape is distinctly different from the automatic jacking, levelling and/or lining tamper in that the movement to obtain the desired raise and/or alignment is dictated from a computer tape which was basically made by another piece of equipment such as a track recording car and then corrected by a computer after variables such as train speeds, axle loadings, ballast conditions, volume of traffic, etc. have been taken into consideration.

It can be seen that when a tamper is operated from a "tape" that much of the complexity has been removed from it as the sensing means has been incorporated into an independent track recording machine as described in my invention, "Hydraulic, Mechanical, Electrical Sensing Device," Ser. No. 445,123. It follows that the simplified automatic tamper operated by direction of a "tape" will not require as highly skilled operators and mechanics as with the present conventional tampers that operate without a "tape." This reduced skill requirement will in many instances be more in keeping with the talents of the labour force available to maintain and operate the less complicated machine operating by direction of a "tape."

The simplified tamper operated by direction of a "tape" will be less costly to build and will be more reliable because much of the complexities have been removed from it and placed in a track recording machine that can service many tampers. In addition, the "tape" tamper will provide track to a minimum required when train speeds, weight of rail, volume of traffic, ballast conditions, etc. have been taken into consideration and evaluated accordingly.

Another benefit is that the analysis of what is required to be done to the track and the actual work done to the track has been separated and consequently the assessment of what should be done has been removed from any parochial thinking and is based on fact, rather than opinion.

These and other objects of the invention will be apparent from the following specification and the accompanying drawings, in which:

FIGURE 1 is a side elevation of the automatic jacking and levelling tamper according to the present invention combined with a separate detachable pneumatic tired power source equipped with a self-aligning, retractable flanged wheel arrangement.

FIGURE 2 is a transverse sectional elevation partly in section taken on the line 2—2 of FIGURE 1 showing the longitudinal and cross levelling devices as well as the tamping cycle cut-off device.

FIGURE 3 is a partial view similar to one half of FIGURE 2 but showing resistance devices in the place of hydraulic cylinder devices.

FIGURE 4 is a diagrammatic illustration of the apparatus associated with each of the hydraulic cylinders shown in FIGURE 1 for transmitting control signals (sheet 1).

FIGURE 5 is an enlarged partial side elevational view of the tamping head, showing its arrangement with respect to the tamper, frame, tie and rail.

FIGURE 6 is a vertical sectional view taken on the line 6—6 of FIGURE 5.

FIGURE 7 is an enlarged sectional view of the hydraulic valving arrangement shown in FIGURES 5 and 6 to provide vibratory cyclic action for the tamping tools.

FIGURE 8 is a detailed longitudinal section of the jacking arrangement for the tamper unit (sheet 1).

FIGURE 9 is a transverse section of the rail clamping arrangement between tamper frame and rail.

FIGURE 10 is a side elevation, partly in section of the device shown in FIGURE 9.

FIGURE 11 is a side elevation of the automatic jacking levelling and lining tamper unit operating from a tape, mark sensing device or receiving device, etc. operating through signals received from apparatus such as is illustrated in FIGURE 2.

FIGURE 12 is a transverse view, partly in section taken on line 12—12 of FIGURE 11.

FIGURE 13 is an enlarged sectional detail of the sensing devices shown in FIGURES 11 and 12.

FIGURE 14 is a schematic vertical transverse elevation partly in section of a modified form of tamping tool arrangement for tamping from the ends of the tie and the tamping head is similar to the tamping head illustrated in FIGURES 5 and 6.

FIGURE 15 is a vertical section of the arrangement shown in FIGURE 14, taken on the line 15—15 of FIGURE 14.

Referring to the drawings, the various devices are shown more or less schematically. It will be realized that these various devices can take various forms and, in many instances they can be units which are available and readily incorporated into the complete automatic jacking, levelling and lining railroad track tamper hereinafter described.

The railroad tamper A illustrated in FIGURES 1—11 inclusive comprises a pneumatic tired tractor 5 which is the power source to provide locomotion for the tamper unit 6, and hydraulic power for the various tamper unit functions.

The tractor 5 is preferably equipped with self-aligning retractable flanged wheel assemblies 7 of the type disclosed in my co-pending U.S. patent application Ser. No. 421,326 whereby the tractor 5, as a unit, can be run on a roadway by means of the pneumatic tired wheels 8 or beside the railroad tracks 9 when the flanged wheels 10 are elevated by the hydraulic cylinder devices 11, or the flanged wheel assemblies can be elevated and moved transversely to engage with the tracks and the tractor 5 with its pneumatic tired wheels 8 is then elevated and moved transversely to bring the wheels 8 into alignment and contact with the tracks 9. Nevertheless, it can readily be seen that the tractor 5 can be operated off the tracks and hydraulic power supplied to the tamper unit 6, by hydraulic lines or that power can be supplied from the tractor by electrical cables to an electric motor-hydraulic pump arrangement, which will supply hydraulic power to the various operating elements of the tamper unit.

The tamper unit 6 has a frame 12 with a deck plate 13 attached thereto. The frame 12 consists of two pairs of channels 14 supported by running and set-off wheels 15. The wheels 15 are mounted on the lower ends of the shafts 16 which are vertically aligned in the sleeves 17 secured on the deck 13. The shafts 16 and consequently the wheels 15 can be rotated through 90° within the sleeves 17 to align the wheels 15 for running on the tracks 9 or positioned at right angles for engagement with set-off rails for a set-off operation. The shafts 16 are held in their adjusted position by the pins 18.

Pressure spring 19 about the shafts 16 between the frame 12 and the running and set-off wheels 15 provide a springing action and ensure that the wheels will remain in contact with the tracks 9.

It can also be seen that the tamper 6 could be equipped with a self-aligning retractable flanged wheel arrange-

ment as with the tractor 5 and jack itself on and off the track in a similar manner as with tractor 5.

A pair of longitudinal level beams 20, one for each rail of the tracks 9, are adjustably mounted on the vertical support members 21 by means of the pins 22 passing through selected apertures 23. A pair of vertical guide members 24 provide a maximum lateral movement for the beams 20 with respect to the frame 12. The outer ends 25 of the beams 20 are each adjustably attached to one of the pair of vertical members 26 located out ahead of the tamper unit 6, and the sensing wheels 27 mounted on the lower ends of the members 26 engage with and sense the contour of the tracks 9.

A pair of sensing wheels 28, one for each rail of the tracks 9, are located between the running and set-off wheels 15. The wheels 28 are mounted on the lower end of the piston rods or shafts 29.

Hydraulic cylinders 30, 31 and 32 are associated with each of the shafts 29. The cylinders 30 are cut-off cylinders; cylinders 31 are for longitudinal levelling, and cylinders 32 are for cross levelling. The arrangements of the cylinders 30, 31 and 32 are the same as described in my co-pending U.S. application Ser. No. 445,123.

Pistons 30a, 31a and 32a are secured on the shafts 29, pistons 30a being within the cylinders 30, pistons 31a being within the cylinders 31 and the pistons 32a being within the cylinders 32.

The cylinders 30 are secured under the deck 13 between pairs of frame channels 14 (see FIG. 2); cylinders 31 are located under the beams 20, while the cylinders 32 are of the floating type and are attached to the cross-bar 33 by the links 34.

Piston 30a is return biased by the spring 30b; piston 31a is return biased by the spring 31b, and piston 32a is return biased by the spring 32b.

The shafts 29 pass upwards through the enlarged clearance opening 20a in the beams 20 and a boss 29b on the under side of the beams 20 surrounding the clearance opening 20a have their surface rounded to make rolling contact with the top surface of the cylinders 31. The cylinders 31 are held in contact with the bosses 29b by the springs 31b as the beams are moved relative to the frame 14 by the vertical displacement of the sensing wheels 27.

Associated with each of the cylinders 30, 31 and 32 are recording apparatus B of the type shown schematically in FIG. 4. This recording apparatus B will be described in association with cylinders 30 and will be similar for each of the cylinders 31 and 32. The recording apparatus B includes a hydraulic cylinder 35 connected with the cylinder 30 through the conduit 36. A piston 37 and piston rod 38 are associated with the cylinder 35 and the piston 37 is return biased by the spring 39. The spring 39 is normally stronger than the spring 30b.

A stylus arm 40 is fixed to the piston rod 38 and is associated with a movable graph roll 41.

Integral with the cylinder 35 is an arm 42 carrying a fixed upright post 43. A sleeve 44 is slidable on the post 43. The upper end of the sleeve 44 terminates in an electromagnet 45 fed by leads 46. An arm 47 is adjustable on the piston rod 38. The sleeve 44 passes through this arm 47 and is adjustably held on the sleeve 44 by the ring 48. A pair of electrical contacts 49 are mounted between the arm 47 and an arm 50 projecting from the lower end of the sleeve 44. Two or more pairs of electrical contacts 51 are mounted between the arm 47 and an arm 53 extending from the upper end of the sleeve 44. A spring 54 about the sleeve 44 bears at one end against the arm 47 and at the other end under the arm 53.

The electrical switch contacts 51 are each set with a predetermined gap corresponding with a predetermined permissible elevation rise of the track rails 9 with which the wheel 28 is in contact with. While two sets of contacts 51 are shown, it is understood that more than two can be employed each set for a different elevational rise of the track rails 9. Any one-set of contacts 51 will cut-

out the operation of the tamping tools 68 when the permissible rise of the track rail is achieved. Similarly, the contacts 51 in the recording apparatus B associated with the cylinders 31 and 32 will act to cut-out the operation of longitudinal levelling and cross levelling when the desired degree of adjustment has been achieved.

The switch contacts 49 are used to provide a warning signal should the rail be too high or too low beyond the predetermined setting of any of the contacts 51. For instance, should the rail be too high the piston 30a in the cylinder 30 would be displaced upwards, displacing upwards, in turn, the piston 37 in the cylinder 35 which would, in turn effect opening of the contacts 49.

The crossbar 33 is centrally secured to the stub shaft 55 which, in turn, is journaled in the upper end of the vertical member 56 mounted at its lower end on the deck 13. A heavy pendulum 57 secured to the stub shaft 55 keeps the crossbar 33 always in a horizontal position. The pendulum may be damped by conventional magnetic or hydraulic damping means as well as other such means all of well known design.

Two pairs of rail clamping devices 58 are mounted under the four corners of the frame 12 or at any other suitable location on the frame. A typical form of rail clamping device 58 is illustrated in FIGURES 9 and 10.

The pressure springs 19 associated with the running and set-off wheels 15 are compressed when the shoe members 59 of the clamping devices 58 are pulled down into contact with the track rails 9.

The tamping head or heads 60 are shown particularly in FIGS. 5 and 6. The transversely disposed frames 61 of the tamping heads 60 are of inverted U shape, one straddling each of the longitudinal pairs of frame channels 14. A pair of vertically disposed double acting hydraulic cylinders 62 are mounted with the U-shaped frames 61, each cylinder being positioned above one of the track rails 9 thereby permitting the frame 12 to take the load and shock rather than the wheel and axle assemblies 15.

A pair of longitudinally disposed members 63 are secured at a spaced distance below the frame 12 by means of the spacers 64. The piston rods 65 of the double acting cylinders 62 are secured at their lower ends to the members 63 and, at their upper ends, are secured to the members 66 which are spaced above the frame 12 by the brackets 67.

Pairs of tamping tools 68 are pivotally mounted on the blocks 69 which are constrained to move in a horizontal direction inwardly and outwardly in the slots 50 within the vertical walls 71 of the U frame 61.

A hydraulic intake and exhaust valving assembly 72 (FIG. 7) of the type described in my co-pending U.S. application Ser. No. 423,073, connects the upper ends of pairs of tamping tools 68 (see FIGS. 5 and 6). The double acting cylinder 73 of the assembly 72 is mounted on the upper portions of the U-shaped frame 60, one assembly on either side as shown in FIG. 6. The piston rods 74 are connected to the piston 75A of the cylinders 73 and to the pistons 76 of the cylinders 77, and these cylinders 77 are, in turn, connected to the upper ends of the tamping tools 68 by the links 78.

The valving assemblies 72 include synchronously driven sleeves 79 synchronized to rotate 180° out of phase to open and close intake and exhaust ports, a pair are situated on both sides of piston 75A and designated as 75 in FIGURE 7. When the intake port is open this large intake port compared to the intake line with the nitrogen accumulator 80 attached to it provides an instantaneous movement of fluid at a sustained pressure immediately when the intake port is opened. At the same time when the intake port suddenly closes the accumulator 80 will act as a cushion for the sudden stoppage of flow of fluid.

If for any reason the instantaneous movement of fluid at a sustained pressure is not required, the nitrogen accumulator could be removed and the intake pressure lines

attached directly to the intake port arrangements or the nitrogen accumulator removed and some kind of cushioning device used in its place.

The exhaust port and return lines are also large to provide a minimum of back pressure when the fluid is exhausting from the valving arrangement.

When sleeves 79 are rotated the alternating of the opening and closing of the intake and exhaust ports located on either side of piston 75A and being 180° out of phase with respect to each other will cause piston 75A to reciprocate back and forth in the cylinder 73. At the same time piston rod 74 will also reciprocate back and forth. Pistons 76 are attached to the ends of piston rod 74 and form a part of double acting hydraulic cylinders 77. It will be seen that the reciprocating movement of piston 75A will be restrained depending upon the manner in which the intake and exhaust lines 81 and 82 for cylinders 77 are manipulated as well as the restraining influence that the member provides that the double acting hydraulic cylinders 77 are attached to, in this case, tamping tools 68.

A pair of double acting cylinders 83 have their piston rods 84 connected to the tamping head 60 by means of the pin 85, while the cylinders 83 themselves are connected to the tamping tools 68 by the links 86 at a position below the pivot blocks 69.

When the tamper unit 6 is located in place on the tracks 9 for a tamping operation, the jacking pads 59 of the rail clamping devices 58 are lowered into contact with the tracks to provide solid anchorage for the unit. The jacking pads 59 are pivotally connected to the lower ends of the piston rods 87 which, in turn, are connected to the pistons 88 within the cylinders 89. The cylinders 89 are of the floating type and the whole assembly is supported under the frame 12 by the upwardly extending shafts 90 anchored to the frame by the fastening nut 91.

All of the cylinders described above are serviced by hydraulic fluid fed through the conduits shown, and controlled by suitable valves in well known manner except where otherwise described.

In FIGURE 3 there is illustrated an alternative means to the hydraulic system shown in FIGURE 2. In this arrangement the piston 92 of the cylinder 93 is biased with the spring 94 above the piston instead of below the piston as in cylinder 30 in FIGURE 2. The piston rod 29a extends above the deck 13. A cut-off resistor 95 is mounted on a bracket 96 on the deck 13 and the contact arm 97 adjustably mounted on the piston rod 29a slides along the resistor 95 on vertical displacement of the piston rod 29a. A longitudinal levelling resistor 98 is mounted on a bracket 99 also mounted on the deck 13. A contact arm 100 is mounted on the beam 20 and makes sliding contact with the resistor 98 in response to upward or downward movement of the sensing wheel 27 located ahead of the tamper unit. A cross levelling resistor 101 is mounted on a bracket 102 extending downwards from the outer end of the crossbar 33. A contact arm 103 is adjustably mounted on the upper end of the piston rod 29a for sliding contact on the resistor 101 on vertical displacement of the piston rod relative to the steady-level-held crossarm 33.

All resistors and contact arms are provided with suitable leads leading to suitable devices to indicate or cut out the particular operation when the correct amount of movement has been made when the unit is being used as a correction device. The information can also be fed to a computer tape or card, etc. if the unit is being used to sense a contour of a surface or surfaces. It will be seen that the same conditions will apply for the hydraulic cylinder arrangements explained for FIGURE 2. In addition it will also be seen the recording devices explained for FIGURES 2 and 3 could be used for recording the contour of a surface as well as the correction of it.

It will be readily seen that the simple type of sliding

resistor shown could be replaced by a type of linear potentiometer of a well known manufacture.

Also it can be seen that although the unit is shown as raising and levelling a railroad track that the unit could be mounted with other wheels and steering devices, etc. and used for the longitudinal and cross levelling of, for example, the forms used for concrete work, or for the correction of cross and longitudinal level of a highway or it could be used to sense a contour of such a surface and record the data on computer tape etc.

Referring now to FIGS. 11, 12 and 13, the apparatus shown is an automatic jacking, levelling and lining tamper machine 104 operating from a computer tape, sensing or receiving devices, etc.

The frame 105 is supported on the wheels 106 and axles 107 and carries a power unit 108 such as an internal combustion engine, a transmission 109, a hydraulic pump 110 driven from the transmission 109, and a hydraulic fluid tank 111 supplying fluid to the pump 110 through the line 112. Fluid is discharged under pressure from the pump 110 through line 113, to the various hydraulic mechanisms on the tamper machine 104.

The machine 104 is driven along the tracks 9 by the hydraulic motor 114 attached to one of the axles 107 and operated from the pump 110 through suitable controls which will start and stop and locate the tamper 104 in relation to the ties under the rail tracks or predetermined markings on the rails as will be explained later. Although one hydraulic drive motor 114 is shown, it can be readily seen that more than one could be provided and, furthermore, the machine could be propelled by various other drives including those of the hydraulic mechanical type.

The automatic jacking, levelling and lining apparatus consists of a subframework arrangement 115 which extends over the top of and down parts of the sides of the tamper frame 105 but does not touch it. This framework arrangement 115 consists of vertical members 116 and 117 located above each of the rails of the track rails 9. A sensing wheel 118 is mounted on the lower end of the members 116 and 117 and is aligned to run on the track rails 9. The axle 119 of the rear wheels 118 is attached to the axle 107 by the tow bar 120, thereby keeping the forward movement of the frame 115 in phase with the tamper frame 105.

The upper ends of the members 116 and 117 are adjustably secured in the pair of longitudinal members 121, by pins 122. The forward ends 123 of the members 121 together with the members 117 and sensing wheels 118a extend considerably in front of the forward end of the tamper frame 105 so that the portion of the track rails 9 contacted by the wheels 118a will not be disturbed when levelling and/or lining jacking takes place.

A U-shaped frame member 124, one for each side of the tamper unit, has its pair of free ends 125 adjustably mounted in the longitudinal members 121 by means of the pins 126. The closed lower end of the U-shaped members 124 consisting of the horizontal members 127 are located at a level immediately above the track rails 9 and spaced outwardly therefrom (see FIG. 12).

A feel plate 128 extends between and outwardly beyond the longitudinal members 121 and is braced at its outer ends by the brace members 129.

For reasons of clarity the tamping heads 60 and the rail clamping devices 58 are not shown in FIGURES 11 and 12. However, they would be assembled in the machine 104 in the same manner as is illustrated in FIGURES 5, 6, 9 and 10, and perform in the manner above described.

A pair of vertical sensing devices 130 are located one above each of the rails of the track rails 9, and are shown in detail in FIGURE 13. Each of these devices 130 are operated in conjunction with a hydraulic cylinder 131 mounted on the frame 105. The piston 132 within the cylinder 131 is return biased by the spring 133. Sensing

wheels 134 running on the track rails 9 are journaled in the forked lower ends of the piston rods 135.

Each piston rod 135 extends upwards from the piston 132 and is connected to a cylinder 130 whose top end is sealed off by the plate 137. An upper plate 138 has a depending axial sleeve 139 passing down through the plate 137. A collar 140 adjustable on the sleeve 139, together with the spring 141 hold the plates 137 and 138 in spaced relation to each other.

A shaft 142 axially movable in the sleeve 139 has its upper end forked at 143. A feeler wheel 144 is journaled in the forked end 143. A squared stub shaft 145 has its upper end axially slidable within the square bore 146 in the shaft 142 and its lower end axially slidable in the square bore 146a in the boss 147 in the lower wall 148 of the cylinder 136. This stub shaft 145 maintains the shaft 142 and wheel 144 in axial alignment with the piston rod 135 and the spring 149 surrounding the stub shaft 145 maintains the feeling wheel 144 in contact with the under surface of the feeling plate 128.

An electromagnet 150 in the upper portion of the sleeve 139 is energized to freeze the sleeve with the shaft 142.

A series of pairs of switch contacts 151 located on the opposing faces of the upper plate 138 and the lower plate 137 are set at various predetermined gaps. These switch contacts 151 are operated by well known electrical or hydraulic means which are controlled by a computer tape or card. The switch having the desired predetermined gap is selected by the computer and will cut out the operation of the tamper tools 68 when the selected switch is closed.

Also the switch contact points 151 can be of the movable type that will open or close on command from the computer tape, card or magnetic disc, etc. This type of control is of well known manufacture and used in the automatic tool industry for the control of machining and other functions etc.

One of the switches 151 will act to provide a warning signal, in the same manner as the switch contacts 49 previously described, to indicate whether the track rail is too high or too low, than the raise dictated by the computer tape.

The spring 149 provides an upward force on shaft 142 and a downward force on the boss 147 which is a part of piston rod 135. It follows that as the wheel 134 which is mounted on piston rod 135 is restrained from movement up or down by rails 9, it also follows that sensing feeler wheels 144 will always be in contact with feeling plate 128. With sleeve 139 frozen to shaft 142 by electromagnet 150, therefore, as rails 9 are raised up, piston rod 135 will likewise move upward as will plate 137. Plate 138 is frozen from vertical travel by electromagnet 150. Therefore, spring 141 will be compressed and the gap between points 151 will close and when they meet a signal will be made that will automatically cut off or warn that the movement of the rails 9 upward should be stopped.

The switches 151 may be replaced by linear resistances 152, which are mounted on the upper plate 138, while a contact arm 153 mounted on the lower plate 137 makes sliding contact with the resistor on vertical displacement of the wheels 134.

Although a simple type of resistor is shown it can be readily seen that a commercial type of linear potentiometer of well known manufacture could be used in its place.

A pair of horizontal sensing devices 155, similar to the vertically disposed sensing devices 130, shown in detail in FIG. 13, are mounted on the inward facing surface of horizontal members 127 of the U-shaped frame members 124. The cylinders 136 of these devices 155 are fixedly secured to the members 127 by the shafts or brackets 156. The shaft 142 is provided with an end feeler plate 157 which makes contact with the top bead of the adjacent track rail 9. The feeler plates 157 are maintained in contact with the top bead of the rail by the spring 149 about the square shaft 145. The sensing

devices 155 are provided with the required electrical contacts 151 or other similar devices as above described and illustrated in FIGURE 13.

The horizontal sensing device 155 is similar to that of 130 and its operation is the same.

A mark sensing device 158 is actuated when the sensing member 159 is triggered by material such as radioactive paint or magnetic action that has previously been applied to the track rails 9 in such a way as to portray the amount of rise or line required at that particular location on the track. The signal output from the sensing device 158 connects with automatic control apparatus 159 which provides the input and cut-off control for the hydraulic fluid that actuates the double acting line jacking cylinders 160 attached to the underside of the frame 105 and the double acting cylinders 161 of the tamper jacking-up devices 162. The double acting line jacking cylinders 160 have piston rods 163 which contact and adjust the alignment of the track rails 9.

A distance actuated interrupter device 164 driven by the chain drive 165 from the wheels 106 interrupts and actuates the circuits to the automatic control apparatus 159 so that the jacking and lining function can be carried out at prescribed intervals as and if required.

The automatic control apparatus 159 is a tape slave machine which receives signals from the various control devices such as the devices B (FIG. 4) or from a computer by means of pre-recorded tape, and directs the amount of jacking of the tamper by the jacking-up devices 162 or the track lining by the cylinder device 160, required at a specific location. The tape receiving wheel 166 is driven from the track wheel 106 by the chain drive 167, whereby the tape directs the jacking and levelling movement in a predetermined manner according to the distance travelled by the tamper.

The tape can be one made direct from a track recording machine which can be used raw or after being computerized to provide the optimum line and level, taking all the variables into consideration. Although a tape has been shown, it can readily be seen that a wire or disc recording device, etc., could be used. Furthermore, it can be seen that the actuating devices on the tamper could be directly connected to the track analyzing device by a cable if such is desired.

A signal receiving unit 168 mounted on the frame 105 is provided with a receiving antenna 169, which receives information produced by a track recording analyzing device or from information that has been suitably analyzed and adjusted by a computer to give the desired direction to the tamper. Wire leads 170 carry the signals for jacking devices 162, lining device 160 and mark sensing device 158 and any other units on the tamper which are capable of being operated on a signal.

In the operation of this apparatus, the tamper is automatically spotted over one of the ties 171 by means of one or other of the sensing devices, B of FIG. 4, the metallic sensing device 158 of FIG. 11 or other similar device. For the purpose of explanation the metallic sensing device 158 is used.

The tape control device 159 is shown as being synchronously driven from the tamper track wheel 106, therefore, as the tamper moves forward the tape is automatically positioned with respect to the tie 171 so that the exact rise or line for the tie in question is directed by the tape. The rail clamping devices 58, one on each corner of the tamper frame 105, clamp the track rails 9 automatically at the correct location for the tamping operation. The rail clamping device 58 is supplied with hydraulic fluid through the lines 172 from the hydraulic pump line 113.

The raising of the tamper by the jacking devices 162 and the rail lining movement by the cylinder 160 can be performed simultaneously or in partial sequence with each other as required, for example, the jacking for cross and longitudinal level can be performed first and

then the lining movement or the jacking during or before the tamping cycle finishes. For the example hereinafter described the jacking for longitudinal and cross level will be performed first followed by the jacking for lining in conjunction with the tamping cycle.

The magnetic sleeve 44 of the sensing device B used in conjunction with the hydraulic cylinder 131 is first locked on the shaft 43. The opening of the contact points 51 are set for a desired amount of movement of wheels 28 and piston rod 29 with respect to the frame 12 of the tamper. As previously stated, a series of contacts 51 can be used, each set with a predetermined gap for permitted movement of the track rail. This arrangement is a cut-off means for stopping the tamping operation after the rails 9 have been raised a predetermined amount against a restraining pressure. It operates the same as explained for the cut out device for FIGURE 4. The wire leads 173 from the automatic tape slave control apparatus 159 FIG. 11 transmit a signal for the desired amount of raise for the location of the rail in question, right hand or left hand of the pair of track rails 9, to the longitudinal and cross-level sensing cut-out devices 130, where contact points 151 have been predeterminedly spaced or where they have been opened or closed as dictated by the slave device 159. The linear resistance device 152 can be used to control the amount of raise by a signal for the correct resistance distance from the slave device 159 that contact points 153 has to move with respect to resistance 152.

The exact amount of jacking of the frame 12 or 105 for cross and longitudinal level is now performed by the double-acting hydraulic jacking-up devices 162. At the same time the frame 12 or 105 is clamped and held rigid with respect to the track rails 9 by means of the rail clamping devices 58. It, therefore, follows that when the jacking devices 162 raise the frame of the tamper, the track rails 9 will also be raised a like amount.

The lower portions of the sensing devices 130 of which the sensing wheels 134 are a part, are in contact with the track rails. These sensing devices 130, including the plate 137 and the contacts attached to it, will move upwards with upward movement of the track rails. The upper portion of the sensing devices including the plate 138 and the contacts attached to it are kept in spaced apart relationship to the plate 137 by the compression spring 141. The springs 149 always keep the sensing wheels 144 in contact with the plate 128 which is an integral part of the outer frame assembly 115 and separate from the tamper and, therefore do not move during the jacking-up operation for longitudinal or cross-level.

With the sleeve 139 frozen on shaft 142 by electromagnet 150 the compression springs 149 will be compressed when shafts 135 and attached parts move upwards because wheels 144 are restrained from upward movement by plate 138. Compression springs 141 are compressed and plates 137 and 138 will close relative to each other until the contacts 151 close, or the linear resistance 152 has moved the correct amount so that the packing movement provides automatically the correct amount of longitudinal and cross-level.

The tamping operation is now automatically started when the switch contacts 151 close and the jacking operation is cut-out.

The tamping heads 60, one for each rail include four tamping tools 68 have each been located in pairs one on each side of and above a tie 171. Although each tamping head 60 is shown with four tools, it is understood that they may be equipped with eight or more tools if required. It can be seen and more than one tie can be tamped at one time if desired by adding additional tamping heads 60.

The tamping heads 60 move up and down with relation to the pistons 65a and piston rods 65 when hydraulic pressure is applied on either side of the pistons in the double-acting hydraulic cylinders 62. Up and down movement of the tamping heads 60 force the tamping tools 68

down into the ballast. Simultaneously, the vibratory tamping action is started.

The hydraulic intake and exhaust valving system 72 is fully described in my co-pending U.S. patent application Ser. No. 423,073 and consists of a double-acting hydraulic cylinder 73 and a piston 75a reciprocating therein, the piston dividing the cylinder into two separate chambers, separate intake and outlet parts 75 are associated with each chamber, the synchronized rotary sleeves 79 are rotated 180° out of phase to open and close the four ports 75. The accumulators 80 communicate with each of the inlet and exhaust ports 75. On opening of each intake port its associated exhaust port is closed with the result that the two chambers on either side of the piston 75a are alternately filled with pressure fluid and the piston is reciprocated to develop a rapid vibrating action.

The double acting cylinders 73 and 77 provide a wide range of frequency, amplitude and impact for the piston rod 74 of the hydraulic cylinder 73; while the double acting hydraulic cylinders 77, attached to the top ends of the tamping tools 68 by the links 78 provide an inward or outward movement to the tamping tools. The travel of the double acting piston 75a is controlled by the pair of double acting cylinders 77 depending on how the pressure and exhaust is manipulated to the intake lines 81 and exhaust lines 82 respectively to the cylinders 77, to the extent that these cylinders are restrained from movement because of their connection, through the links 78, with the tamping tools 68.

Simultaneously with the rapid vibrating action initiated by the hydraulic intake and exhaust valving system 72, the two double-acting hydraulic cylinders 83 are activated to provide an inward and outward movement to the lower ends of the tamping tools 68.

The tamping tools 68 are pivoted in the tamping heads 60 intermediate their connection with the assemblies 72 and the cylinders 83. As the pivot blocks 69 are movable in the slots 70, the tamping tools are kept in alignment with a wide range of tamping tool angles with respect to the vertical can be obtained. The resulting varied frequency, amplitude and impact as well as the variable action of the tamping tools with respect to the vertical, is capable of compacting ballast under the ties 171 in a varied section such as (a) an inverted type of wedge or pyramid of the compaction is made with the tamping tools sloping inwards; (b) a rectangular type of section of the ballast is compacted with the tools vertical, and (c) a regular wedge or pyramid type of section of ballast with the top cut off, is compacted under ties 179 with the tamping tools sloping outwards.

The valving assembly 72 can be interchanged with the cylinders 83 or a valving assembly 72 can replace the cylinders 83. Similarly the valving assembly 72 can be attached to and become a part of the tamping blade 68 to provide a vertical reciprocating action to it.

In FIGS. 14 and 15 there is shown a modified form of tamping tool assembly in which a combination of valving assemblies similar to that illustrated in FIG. 7 are used to supply power to the tamping tools.

In this modified arrangement the tamping tools 180 are an extension of the piston rods 74 (FIG. 7) projecting from the lower end of the vertically aligned valving assemblies 181, which are mounted in the tamping head 186. The piston rod which would normally project from the upper end of the valving assemblies 181 are replaced by the fixed members 182.

The valving assemblies 181 are pivotally mounted at 183 in the blocks 184 which are slidable horizontally in the slots 185 in the tamping head frame 186.

A pair of horizontally disposed valving assemblies 187 and 188, including cylinders 77 (FIG. 7), are mounted on the upright members 189 of the tamping head frame 186. The lower valving assembly 187 is axially aligned in the horizontal plane of the pivot mounting 183 of the valving assemblies 181 and are connected to the sliding

blocks 184 by the links 190. The upper valving assembly 188 including cylinders 77 (FIG. 7) are connected to the upper ends of the members 182 of the valving assemblies 181 by the links 191.

In the arrangement illustrated in FIGS. 14 and 15 all of the valving assemblies provide a rapid vibrating oscillatory force to the tamping tools and, in addition, the valving assemblies 187 and 188 will act either to vibrate and oscillate the tamping tools horizontally in the tamping head frame 186 or cause the tamping tools to have a vibratory movement about their pivot mounting 183.

It can be seen that the tamping tool 180 could have a flat plate hingeably attached to its lower end and extending backward along the ties see FIGURE 14, the other end of the plate could be hingeably attached to an extension of frame 14. When the plate is adjusted on the backward hinge which is attached to the frame so that the bottom of the plate is even with the bottom of tool 180 and in a plane parallel to the bottom of the ties only closer to the tie at the backward end than tool 180. With this arrangement the end of the plate attached to 180 will reciprocate with 180 and with the other end hinged a rapid wedging action will take place and that ballast will be forced under the ties.

It can be further seen that members 72 and 187 could be made of two double acting hydraulic cylinders 72 and 187, instead of one at each location with a single piston rod from each leading in cylinder 77 as shown. The valving for double cylinders 72 and 187 would be synchronously driven so that the two pistons in 72 at the top and the two pistons for 187 at the bottom would move in and out together. In this way, the forces would be balanced and each force would be provided with an equal and opposite reaction thereby providing an inherent balance to the mechanism similar to that for an opposed piston engine.

The lining action is now started. The lining force is provided by the double-acting cylinder 160 which is attached directly to the tamper frame 12 or 105.

Simultaneously with the tamping action, the jacking action is started to raise the track to meet the required horizontal and longitudinal level as dictated by the displacement from the zero position of hydraulic fluid on the longitudinal double-acting cylinders 31 and cross-level double-acting hydraulic cylinders 32. It follows that the required lift of the track can be controlled by either the sensing control apparatus B associated with each of the cylinders 31 and 32 as shown in FIGURE 4, or by linear resistances 98 and 101 as shown in FIGURE 3. The track will continue to be raised until the desired cross level has been reached either for super-elevated curve or tangent track.

The tamping action continues until the upward force of the tamping pushes the tie, plate and rail upwards a predetermined amount as explained for an arrangement as in FIG. 4. When an electrical contact etc. has been activated the tamping cycle is automatically stopped.

It can be readily seen that the sensing devices (FIGS. 3 or 4) can be used to automatically stop the jacking or turn on a warning light etc., indicating that the operation should be stopped.

It can readily be seen that the tamping operation can be automatically stopped and the tamper is automatically indexed, for example, say the metallic sensing device 159.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An automatic tamper machine movable on railroad tracks for jacking, levelling and lining of the railroad tracks comprising a main wheel supported frame running on railroad tracks, sensing devices for individually sensing the longitudinal, cross level and lining of the separate rails of the railroad track means to maintain a reference datum in the said sensing devices transversely of the said frame for individually sensing the longitudinal and cross

level and the lining of the separate rails of the railroad track, control mechanisms associated with each of the said sensing devices, the said control mechanism each adapted to collect and transmit data indicative of the out of position condition of the separate rails of the railroad tracks, separate means to adjust the railroad track to a corrected position of longitudinal and cross level and lining in agreement with the data transmitted by the said control mechanism, railroad bed tamping devices mounted on the said frame, and means to operate the said tamping devices to tamp the railroad bed under the corrected position of the railroad tracks, the said latter means being started up and cut-out in response to data received from the said control mechanisms.

2. An automatic tamper machine as set forth in claim 1 in which the said sensing devices include a pair of sensing wheels for each rail of the railroad track, a vertically disposed rod supported by each sensing wheel, and means to maintain the said wheels in contact with their associated rail, one rod associated with one sensing wheel of each pair being vertically displaced when the rails of the railroad track are adjusted towards a corrected position, the vertical displacement of said rods effecting cut-out of said sensing devices when the railroad track is adjusted to a corrected position predetermined by the said control mechanisms.

3. An automatic tamper machine as set forth in claim 1 in which the said sensing devices include a pair of sensing wheels for each rail of the railroad track, a vertically disposed rod supported by each sensing wheel, and means to maintain the said wheels in contact with their associated rail, one rod associated with one sensing wheel of each pair being vertically displaced when the rails of the railroad track are adjusted vertically a predetermined amount against a restraining pressure, the vertical displacement of the said rods effecting cut-out of said sensing devices when the railroad track is adjusted to a corrected position predetermined by the said control mechanisms.

4. An automatic tamper machine as set forth in claim 1 in which the said sensing devices associated with each rail of the railroad tracks include a longitudinal level sensing device, a cross level sensing device and a lining sensing device, and a cut-out sensing device adapted to cut-out the said longitudinal and cross level and lining sensing devices when the rails of the railroad track have been adjusted to their corrected position.

5. An automatic tamper machine as set forth in claim 1 in which the said frame includes a series of hydraulic jacks adapted to hold the frame in a fixed position above the railroad tracks while the railroad bed tamping operation is being carried out, the said jacks being energized and de-energized responsive to a signal from the said control mechanisms.

6. An automatic tamper machine as set forth in claim 1 in which the means to adjust the lining of the railroad track include a hydraulic jack disposed horizontally under and transversely of the said frame, the said hydraulic jack adapted to move the railroad tracks transversely relative to the said frame in response to a signal from the lining sensing device.

7. An automatic tamper machine as set forth in claim 1 in which the control mechanisms associated with each of the sensing devices include a cut-out switch cutting out the operation of the means to adjust the longitudinal and cross level and lining of the railroad tracks when the tracks have been adjusted in accordance with a signal received from the said sensing devices.

8. An automatic tamper machine as set forth in claim 1 in which the condition of the railroad track sensed by first sensing devices is prerecorded on a recording device by the control mechanisms associated with said first sensing devices, and the means to adjust the railroad track and the means to operate the said tamping devices are set in operation by second sensing devices operable on a signal from said recording devices.

9. An automatic tamper machine as set forth in claim 1 in which a sub frame is supported on rail contacting wheels at the rear of and forwardly of the said main wheel supported frame, the said sub frame effecting displacement of sensing devices to record through said control mechanism, out of position of the individual rails of the railroad track ahead of the said main wheel supported frame.

10. An automatic tamper machine as set forth in claim 8 in which the said sub frame includes a pair of members extending downwards on either side of the said main frame and a rail lining sensing device is mounted on each of the said pair of members, the said lining sensing devices projecting inwardly of the said pair of members into spring contact with the adjacent rails of said railroad track, and a hydraulic lining jacking cylinder on said main frame, the said jacking cylinder being aligned in the vertical plane of the said lining sensing devices and operative in response to a signal from said lining sensing devices to correct the alignment of the railroad track.

11. An automatic tamper machine as set forth in claim 1 in which the tamping devices include a tamping head, first hydraulic means for adjusting the vertical height of said tamping head with respect to said wheel supported frame, pairs of tamping tools pivotally mounted in and horizontally slidable in said tamping head, and means to operate the said tamping tools in the said tamping head include second pairs of hydraulic devices associated with each of the pair of tamping tools, the said pair of hydraulic devices adapted to separately impart reciprocating movement to the pair of tamping tools in a horizontal direction above and below the pivotal mounting of the tamping tools in the said tamping head.

12. An automatic tamper machine as set forth in claim 11 in which the said second mentioned hydraulic devices include valving mechanism synchronously driven to rotate 180° out of phase to open and close intake and exhaust valves and effect rapid oscillatory vibrating movement to the said pairs of tamping tools.

13. An automatic tamper machine as set forth in claim 1 in which the said tamping devices include a tamping head, hydraulic means for adjusting the vertical height of said tamping head relative to said wheel supported frame, a pair of tamping tools pivotally mounted in said tamping head, first hydraulic means associated with each of the said tamping tools, the said first hydraulic means adapted to impart rapid oscillatory vibrating movement in a vertical direction to said tamping tools, second hydraulic means pivotally connected to each of said first hydraulic means, and a third hydraulic means connected to each of said first hydraulic means at a point located above the pivotal mounting of said first in said tamping head, said second and third hydraulic means adapted to impart rapid oscillatory vibrating movement separately in a horizontal direction to said tamping tools.

14. An automatic tamper machine as set forth in claim 11 in which the said second and third hydraulic means impart reciprocation to the said tamping tools in phase with or out of phase with each other.

15. An automatic tamper machine as set forth in claim 11 in which the said hydraulic means each include a double ended cylinder and piston device and a pair of sleeve valves rotatable through 180° out of phase with each other to open and close intake and exhaust ports associated with each end of the said double ended cylinder to effect rapid oscillatory vibrating movement to the said tamping tools.

16. An automatic tamper machine as set forth in claim 1 in which the means to maintain a transverse reference datum includes a cross bar pivotally supported intermediate its length above and transversely of the said wheel supported frame and a heavy pendulum adapted to hold said cross bar in a horizontal position, and in which the said sensing devices include a first pair of sensing wheels, one each in running contact with one rail of the railroad

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track below the said wheel supported frame, a vertically disposed rod supported by each of said sensing wheels, three pistons disposed on each of said rods at spaced apart intervals, a hydraulic cylinder about each of said pistons, the lowermost of said cylinders on each rod being fixedly 5 mounted on the said wheel supported frame, a second intermediate of said cylinders being of the floating type, and the third of the said cylinders being attached by link means to the outermost ends of the said cross bar, a return bias spring in each of said cylinders, a second pair 10 of sensing wheels, one each in running contact with one rail of the railroad tracks, the said latter wheels being located at a considerable distance ahead of the said wheel supported frame, a vertically disposed rod supported by each of said second pair of sensing wheels, a pair of 15 longitudinally disposed beams above said wheel supported frame, one end of each of said beams being pivotally supported on the frame at the rear thereof and the opposite

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end of the beams being pivotally supported on the said rods supported by said second pair of sensing wheels, the said pair of beams at an intermediate portion thereof contacting and displacing said second intermediate cylinders to effect displacement of said latter cylinder on the said vertically disposed rods on displacement of the said second sensing wheels relative to said first sensing wheels.

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