United States Patent [19]

[11] **3,807,311**

Plasser et al.

[45] **Apr. 30, 1974**

[54] **MOBILE TRACK TAMPING AND LEVELING MACHINE**

[76] Inventors: **Franz Plasser; Josef Theurer,** both of Johannesgasse 3, Vienna A-1010, Austria

[22] Filed: **July 3, 1972**

[21] Appl. No.: **268,814**

[30] **Foreign Application Priority Data**

July 14, 1971 Austria 6142/71

[52] **U.S. Cl.** .... **104/12,** 104/7 R
[51] **Int. Cl.** **E01b 27/17,** E01b 29/04
[58] **Field of Search** .... 104/7, 8, 7 B, 12

[56] **References Cited**

UNITED STATES PATENTS

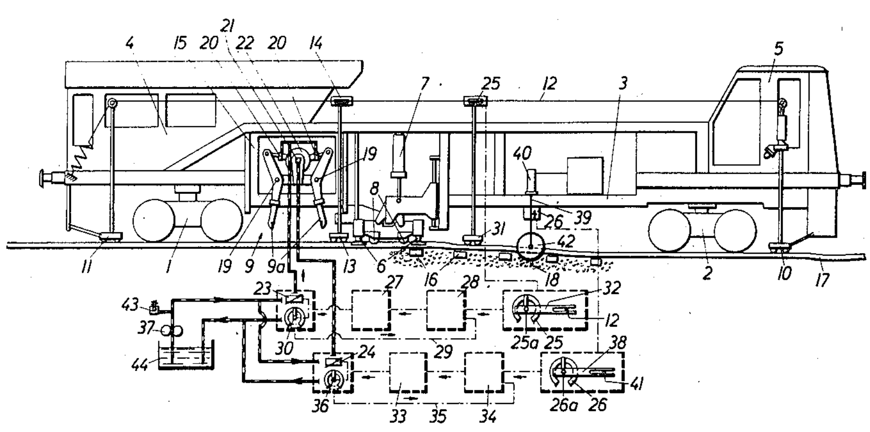
3,363,582	1/1968	Plasser et al.	104/12
3,298,105	1/1967	Stewart et al.	104/7 R
3,662,687	5/1972	Helgemeir	104/12
3,719,150	3/1973	Theurer et al.	104/12

Primary Examiner—Robert G. Sheridan
Assistant Examiner—Richard A. Bertsch
Attorney, Agent, or Firm—Kurt Kelman

[57] **ABSTRACT**

The drive for the tamping tools of a mobile track tamping and leveling machine vibrates and/or moves respective ones of the tools in respect of each other so as to exert a tamping pressure on the track ballast controlled to provide a predetermined degree of ballast compaction. The drive control for regulating this compaction is responsive to a control signal indicating the actual ballast compaction and/or the geometric position of the track.

17 Claims, 4 Drawing Figures



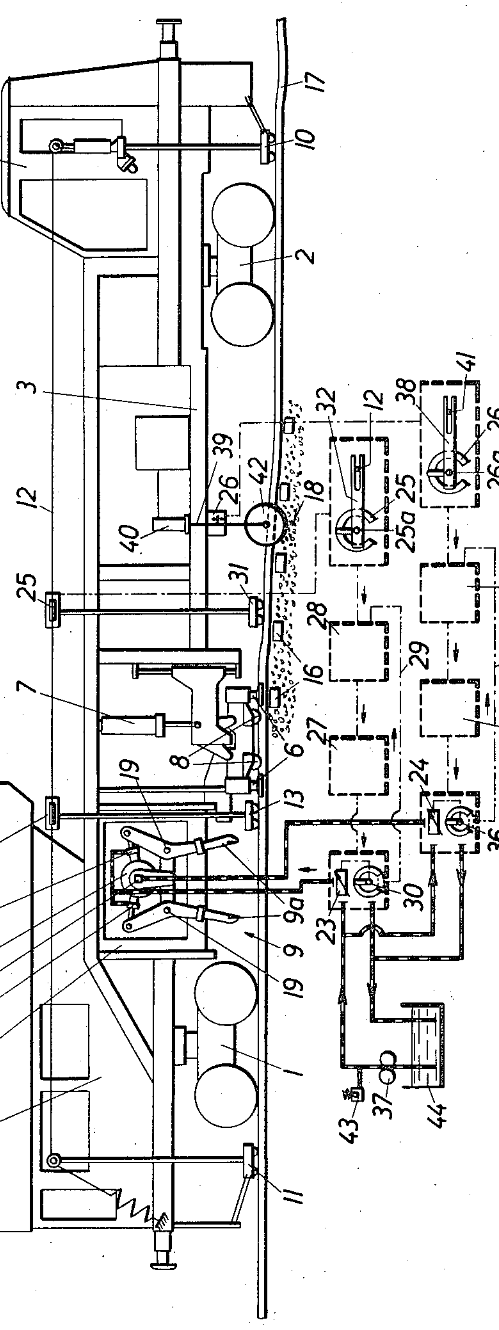


FIG. 1

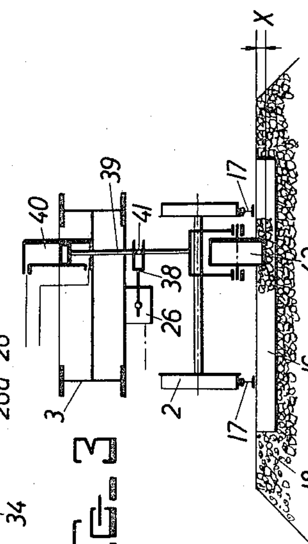


FIG. 3

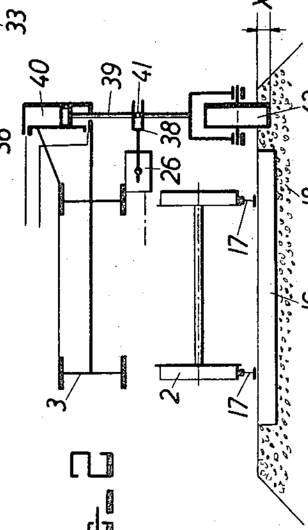


FIG. 2

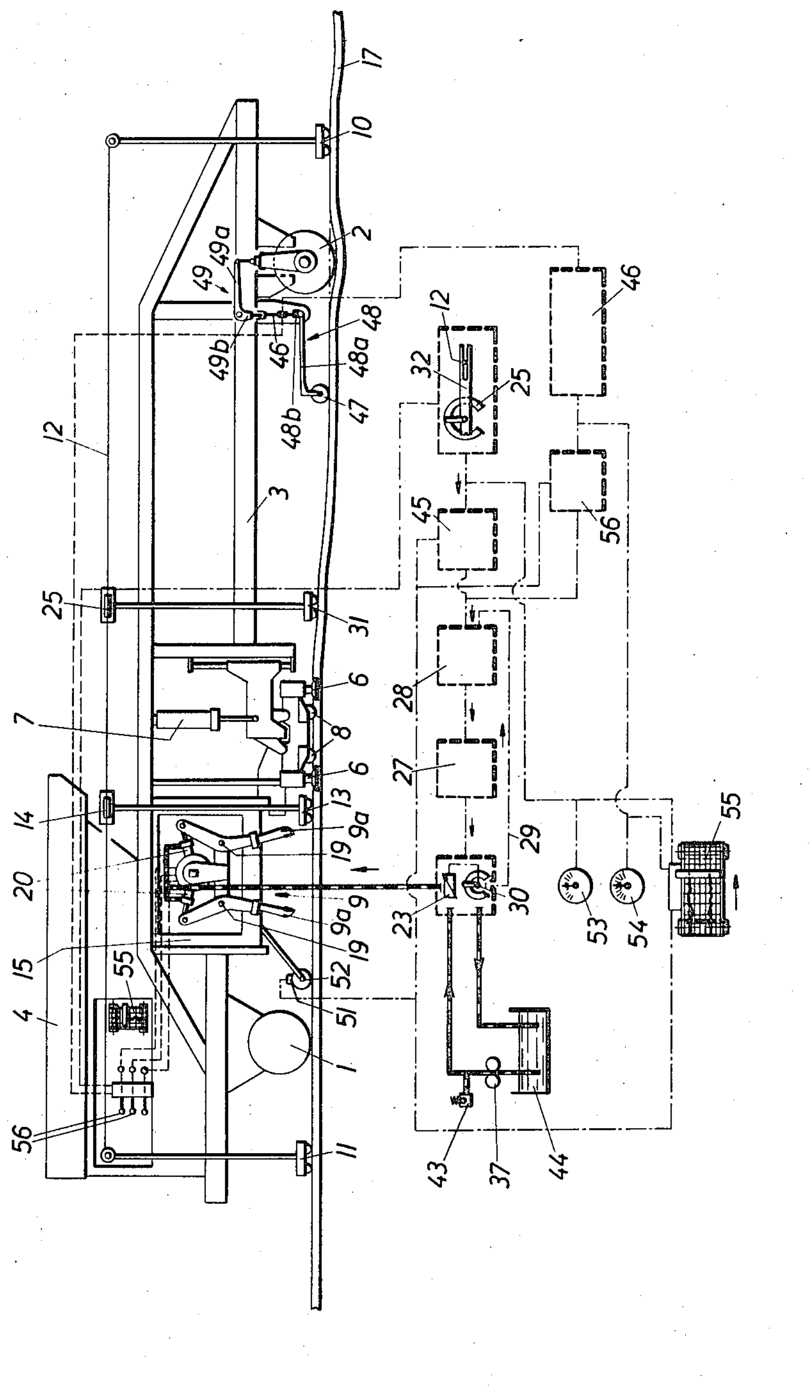

1
2
3
4
6
7
8
9
9a
10
11
12
13
14
15
17
19
20
23
25
27
28
29
30
31
32
37
43
44
45
46
47
48
48a
48b
49
49a
49b
51
52
53
54
55
56

FIG. 4

MOBILE TRACK TAMPING AND LEVELING MACHINE

The present invention relates to improvements in a mobile track tamping and leveling machine which has a reference system, track lifting means for lifting the track in respect of the reference system, vertically adjustably vibratory tamping tools, and a drive means for the tamping tools.

The drive means for the tamping tools may comprise a drive for vibrating the tamping tools and a drive for moving respective ones of the tamping tools in respect of each other to compact ballast therebetween, and actuation of the drive means drives the tamping tools to exert a tamping pressure on the track ballast controlled to provide a predetermined degree of compaction thereof.

As the mobile tamping and leveling machine proceeds along the track during a track grading operation, successive track sections to be leveled have different deviations from the desired grade and different degrees of ballast compaction. It is, therefore, desirable to exert correspondingly different tamping pressures on the ballast to obtain as uniform a degree of ballast compaction in the leveled track section as possible so as to produce a lasting track correction of high accuracy. For instance, if the uncorrected position of the track deviates considerably from the desired level, i.e. a relatively large lifting stroke is required for correction, more intensive ballast compaction is required than in a track section requiring relatively little correction. This, in turn, necessitates higher tamping tool pressures, i.e., a stronger drive force, than in those areas where the ballast is already relatively densely compacted, i.e., only minor corrections are needed.

In known tamping and leveling machines of the indicated type, the tamping pressures have been held constant throughout the operation or the operator controlled the pressures manually on sight. If the tamping pressure remains unchanged, the corrected track soon became uneven again because it tended to sag under the loads of passing trains in those track sections where the ballast was less compacted than in adjoining sections. Control by the operator alone has left too much to the experience and skill of the operator. In view of this unsatisfactory situation, it was proposed to lift the track above the desired grade during the leveling operation so that it would eventually settle at the desired grade after some train traffic. This, too, however, obviously has not produced uniformly dependable results in producing an accurately corrected track which remains in its leveled position for an extended period of time.

It is the primary object of this invention to provide a track tamping and leveling machine of the indicated type which is free of the described disadvantages and which automatically controls the tamping pressure in response to the track condition which is a function of the extent of correction required in successive track sections, i.e., the geometric position of the track and/or the degree of compaction of the ballast, so that the machine will not only accurately level the track but also produce a controlled uniform ballast compaction under the leveled track so as to hold the track lastingly in the leveled position.

The above and other objects are accomplished in accordance with the invention with a control for the drive means for regulating the predetermined degree of ballast compaction, a signal emitter producing an electrical control signal indicating the condition of the track, and means for transmitting the control signal to the control.

More than one signal emitter may be provided, a first one, for instance, being adapted to indicate the actual degree of compaction of the ballast and a second emitter adapted to indicate the difference between the actual grade of the track and a desired grade of the track determined by the reference system.

The drive means preferably comprises a drive for vibrating the tamping tools and a drive for moving respective ones of the tamping tools in respect of each other to compact ballast therebetween, and the control is operatively associated with at least one of the drives. In this way, the tamping pressure and/or the vibration frequency or amplitude is controlled in response to the actual track condition in each track section, this control being automatically and continuously adjusted as the machine proceeds along the track. When the machine passes a track section requiring considerable track lifting and/or having a loosely compacted ballast, the control signal will be correspondingly stronger than in a section requiring little correction or tamping so that the tamping pressure will be continuously adapted to the prevailing track conditions. It will also be useful to adjust the vibration frequency and/or amplitude of the tamping tools correspondingly, for instance to increase the vibration frequency when the ballast is highly compacted, i.e., encrusted after long use.

According to one feature of the present invention, if the tamping tool drive is a hydraulic motor, the control for the motor is an adjustable means, such as a solenoid valve, for supplying hydraulic fluid to the motor. A differential unit has an output connected to the adjustable fluid supply means and two inputs connected respectively to the signal emitter for receiving the control signal therefrom and to a pressure gauge indicating the actual hydraulic pressure in the motor for receiving a signal corresponding thereto. Preferably, a signal amplifier is connected between the differential unit output and the adjustable fluid supply means. The signal emitter and the adjustable fluid supply means are pre-set so that a predetermined hydraulic pressure value in the drive motor corresponds to a predetermined lifting stroke, this pressure value having been empirically determined, or a predetermined rotational speed of the vibrating motor to adjust the vibration frequency to the density of the ballast.

The adjustable fluid supply means may be a regulator for changing the rotational speed of the hydraulic fluid supply pump motor or a solenoid bypass valve.

The signal emitter is preferably a rotary potentiometer. One such signal emitter to indicate the geometric track position in an uncorrected track section may be mounted on a track level measuring buggy mounted on the track immediately ahead of the track lifting means. The potentiometer has a rotary shaft carrying a radially extending forked arm, and the reference system comprises a tensioned reference wire received in the forked arm.

According to another embodiment of this invention, the machine comprises a frame and an undercarriage supporting the frame in an uncorrected track section, a measuring buggy is mounted on the track adjacent the undercarriage for indicating the deformation of the track under the load of the undercarriage by the vertical movement of the measuring buggy, and a further signal emitter produces an electrical control signal indicating the vertical movement of the measuring buggy.

Control in dependence on the actual ballast compaction may be provided in accordance with the invention with an additional signal emitter mounted in an uncorrected track section. A loaded pressure roller is supported by the ballast and immersed therein to an extent which is a function of the degree of ballast compaction, and the pressure roller carries the additional signal emitter, the control signal thereof being responsive to the extent of immersion of the roller in the ballast.

The above and other objects, advantages and features of the present invention will become more apparent from the following detailed description of certain now preferred embodiments thereof, taken in conjunction with the accompanying drawing wherein

FIG. 1 is a schematic side elevational view of a track tamping and leveling machine according to this invention, including a control circuit diagram;

FIGS. 2 and 3 are transverse sections showing alternative modifications of the arrangement of one of the control signal emitters; and

FIG. 4 is a view similar to that of FIG. 1 of another embodiment.

Referring now to the drawing, wherein like numerals designate like parts functioning in a like manner in all figures, and first to FIG. 1, there is shown a mobile track tamping and leveling machine comprising a frame 3 whose undercarriages 1 and 2 run on the track, the forward undercarriage 2 being in an uncorrected track section while the rear undercarriage 1 runs on the corrected track section. Operating cabins 4 and 5 are mounted at the forward and rear ends of the frame while the track lifting means 6, 7 and the tamping unit 9 are mounted on the frame intermediate therof. The track lifting means comprises the hydraulic motor 7 and the clamping rollers 6, the lifting means being combined with a lining means comprising rail clamping rollers 8. The tamping unit comprises pairs of reciprocating tamping tools 9*a*. Furthermore, a leveling reference system is provided, the system comprising a tensioned reference wire 12 supported on measuring buggies 10, 11, with the forward buggy 10 running on the rails of the uncorrected track section while the rear buggy 11 runs on the corrected track. The tensioned reference wire is associated with a sensing element 14 mounted on a third measuring buggy 13 in the region of the tamping unit and track lifting means to indicate the actual level of the track at the correction station. All of the above structures and their operation in mobile track tamping and leveling machines are well known and, therefore, further explanations are omitted to avoid prolixity.

The same holds true for the tamping unit 9 which is mounted on a vertically adjustable frame 15 and comprises a series of pairs of tamping tools 9*a* immersible in the ballast 18 in the track cribs adjacent a tie 16 at both sides of each rail 17. The tamping tools are pivotal about pivots 19 intermediate their ends, the upper ends thereof being linked to hydraulic motor drives 20 for moving the tamping tools of each pair in respect of each other to compact ballast therebetween. A central cam or eccenter shaft 21 is mounted between the hydraulic motors to provide a drive for vibrating the tamping tools, the shaft 21 being rotatable by hydraulic motor 22. Thus, the hydraulic drives 20 reciprocate the tamping tools in the direction of track elongation while they are being vibrated. The hydraulic pressure in motors 20 corresponds to the tamping pressure, i.e., the pressure exerted upon the ballast by the closing tamping tools, and this pressure determines the degree of ballast compaction.

In accordance with this invention, a control is provided for the drive means of the tamping tools for regulating the degree of compaction. In the illustrated embodiment, this control comprises a control device 23 associated with the temping tool moving drives 20 and a control device 24 associated with the tamping tool vibrating drive 22 to regulate the pressure of tamping tools 9*a* as well as the vibration frequency and/or amplitude thereof in dependence on the prevailing track condition, particularly the geometric level of the track and the compaction of the ballast. For this purpose, respective signal emitters 25 and 26 produce electrical control signals respectively indicating the track position and ballast compaction, these signal emitters being mounted on frame 3 in the uncorrection track section and means being provided to transmit the control signals to the respective control devices.

The control device 23 is an adjustable solenoid valve regulating the hydraulic fluid pressure in motors 20. The control circuit which transmits the control signal from signal emitter 25 comprises a differential unit 28 whose output is connected to solenoid valve 23, the output signal of the differential unit being amplified by signal amplifier 27 arranged between the output of the differential unit and the solenoid valve. A first input of the unit 28 is connected to signal emitter 25 which indicates the geometric position of the track while a second input of the unit is connected via electrical conductor line 29 to pressure gauge 30 indicating the actual hydraulic pressure in motors 20.

In the illustrated embodiment, the pressure gauge 30 is a rotary potentiometer regulated in response to the hydraulic motor pressure. The signal emitter 25 also is a rotary potentiometer mounted on measuring buggy 31 to indicate the actual level of the track in the uncorrected track seciton, where the buggy runs on the track, the potentiometer 25 having a rotary shaft 25*a* carrying a radially extending forked arm 32 receiving the tensioned wire 12 of the reference system.

The control device 24 for changing the vibration frequency of the tamping tools 9*a* is a solenoid bypass valve mounted in the supply conduit delivering hydraulic fluid to vibrating motor 22 so as to regulate the amount of fluid delivered and thus the rotational speed of the motor. The control circuit which transmits the control signal from emitter 26 comprises a differential unit 34 whose output is connected to solenoid valve 24, the output signal of the differential unit being amplified by signal amplifier 33 arranged between the output of the differential unit and the solenoid valve. A first input of the unit 34 is connected to signal emitter 26 which indicates the degree of ballast campaction while a second input of the unit is connected via electrical conductor line 35 to gauge 36 indicating the amount of hydraulic fluid delivered. This gauge, too, is embodied in a rotary potentiometer transmitting an input signal to the differential unit 34 whose magnitude depends on the setting of valve 24. If would also be possible, however, to embody gauge 36 in a governor for regulating the rotational speed of the drive motor for hydraulic fluid delivery pump 37 which supplies the fluid from sump 44 to the tamping tool drives, the governor being adjustable in response to the setting of the signal emitter 26. A safety valve 43 is also mounted on the hydraulic supply circuit.

The signal emitter 26 also is a rotary potentiometer which is fixedly mounted on machine frame 3 and has a rotary shaft 26*a* carrying a radially extending forked arm 38 engaging pin 41 projecting from piston rod 39, the piston rod having a lower end on which pressure roller 42 is mounted while the upper end thereof extends into pressure fluid cylinder 40 fixedly mounted on the frame and extending substantially vertically. Pressure fluid is supplied to cylinder 40 under substantially constant pressure so that the pressure roller is pressed against the ballast under such constant pressure as the machine moves along the track. Accordingly, as the degress of compaction, i.e., the density, of the ballast 18 changes, the loaded pressure roller is immersed therein to an extent x which is solely a function of the ballast compaction. Therefore, the control signal emitted from potentiometer 26 is responsive to the immersion of roller 42 in the ballast.

As shown in FIG. 2, the pressure roller 42 may be mounted for engagement with ballast 18 outside the track cribs in the region of the ballast shoulder, the cylinder 40 and signal emitter 26 being mounted on the frame laterally outside the track.

In the embodiment of FIG. 3, the pressure roller is mounted for engagement with the ballast between the track rails 17, 17 so that the ballast density in the track cribs is measured.

Obviously, a plurality of such pressure rollers could be mounted at different points so gauge the track compaction in the cribs and along the shoulder of the ballast bed, all of their control signals being fed to a common differentiating unit for providing an average control signal. It would also be possible to transmit the control signals from emitters 25 and 26 to a common control device 23 or 24 to control the mutual movement of the tamping tools or their vibration frequency. Also, if desired, the cylinder 40 may be under air instead of hydraulic pressure.

The embodiment of FIG. 4 uses the same reference numerals for like parts to obviate a repetition of the description of those portions of the machine that are the same as those of FIG. 1. In this embodiment, a further signal emitter 46 is provided to indicate the condition of the track under a load. A freely floating measuring buggy 47 is mounted on the track adjacent undercarriage 2 for indicating the deformation of the track under the load of the undercarriage by the vertical movement of the measuring buggy in response to such deformation. The measuring buggy 47 is mounted behind the undercarriage 2 and is freely vertically movable in relation thereto so that the relative movement between the buggy 47 and undercarriage 2 constitutes a measurement of the deformation of the track under the load of the undercarraige.

The mounting is such that a first bell crank lever 48 having an arm 48*a* longer than arm 49*b* carries the measuring buggy 47 while a second bell crank lever 49 having an arm 49*a* longer than arm 49*b* has the longer arm linked to the undercarriage. Both bell crank levers are pivoted to the machine frame 3, and a flexible rod 46 with wire strain gauge interconnects the arms 48*b* and 49*b* of the levers to produce a control signal corresponding to the deformation measured by buggy 47 riding on the rails.

The control signal from signal emitter 46 is transmitted to solenoid valve 23 via a delay circuit 56 so that the valve 23 regulates the pressure in drives 20 of tamping tools 9*a* not only in response to the geometric track position measured at 31 but also in dependence on the track deformation under load. Another delay circuit 45 is mounted in the control circuit between signal emitter 25 and the solenoid valve, the delay time in the circuits 56 and 45 being set in dependence of the distance of tamping unit 9 from the respective signal emitters 25 and 46, the distance traveled by the machine during the leveling operation being measured by odometer 52 connected to a signal emitter 51 transmitting a signal corresponding to this distance to the control circuit. Thus, the control signals from emitters 25 and 46 are delayed by circuits 45 and 56 by a time determined by the signal transmitted from the odometer so that the control 23 operates with a predetermined delay. In this manner, the hydraulic pressure in drives 20 is changed by the control signals from emitters 25 and 46 only when the machine has reached the track section where the emitters operate.

In the embodiment of FIG. 4, there are also provided visible meters 53 and 54 connected to the control signal emitters for indicating and recording the geometric position of the track and the ballast condition under load, as well as a permanent recording instrument 55 which makes a permanent record of these values, the recording drum being rotated under control of the signal pulses received from odometer 52. These recording instruments may be used, under special circumstances, for manually changing the pressure in the drives 20 and/or 22. In this manner, the operator who wishes to make adjustment does not have to depend on his judgement but is guided by actual measurements in operating adjustment handle 56 for controlling the hydraulic fluid supply to the drives.

Many variations in the structural details of the machine are possible within the scope of the present invention as defined in the appended claims. For instance, while a reference system with a tensioned wire has been illustrated, the signal emitters may be modified so that they sense a light beam reference instead. Also, the vibration amplitude may be controlled in addition to, or instead of, the frequency of vibration.

What we claim is:

1. A mobile track tamping and leveling machine, comprising

1. a reference system,
2. track lifting means for lifting the track in respect of the reference system,
3. vertically adjustably mounted vibratory tamping tools,
4. drive means for the tamping tools,
   a actuation of the drive means driving the tamping tools to exert a tamping pressure on the track ballast controlled to provide a predetermined degree of compaction thereof,
5. a control for the drive means for regulating said predetermined degree of ballast compaction,
6. a signal emitter producing an electrical control signal indicating the condition of the track, and
7. means for transmitting the control signal to the control.

2. The machine of claim 1, wherein the electrical control signal emitter is adapted to indicate the difference between the actual grade of the track and a desired grade of the track determined by the reference system.

3. The machine of claim 1, wherein the electrical control signal emitter is adapted to indicate the actual degree of compaction of the ballast.

4. The machine of claim 1, wherein the drive means comprises a drive for vibrating the tamping tools and a drive for moving respective ones of said tamping tools in respect of each other to compact ballast therebetween, the control being operatively associated with at least one of said drives.

5. The machine of claim 4, wherein at least one of the drives is a hydraulic motor, the control for the hydraulic motor is an adjustable means for supplying hydraulic fluid to the motor, and a differential unit has an output connected to the adjustable fluid supply means and two inputs connected respectively to the signal emitter for receiving the control signal therefrom and to a pressure gauge indicating the actual hydraulic pressure in the motor for receiving a signal corresponding thereto.

6. The machine of claim 5, wherein the adjustable hydraulic fluid supply means comprises a solenoid valve.

7. The machine of claim 1, further comprising a track level measuring buggy mounted on the track in an uncorrected track section immediately ahead of the track lifting means, the signal emitter is a rotary potentiometer mounted on the measuring buggy to indicate the geometric track position in said uncorrected track section, the potentiometer having a rotary shaft carrying a radially extending forked arm, and the reference system comprises a tensioned reference wire received in said forked arm.

8. The machine of claim 1, further comprising a frame and and undercarriage supporting the frame in an uncorrected track section, a measuring buggy mounted on the track adjacent the undercarriage for indicating the deformation of the track under the load of the undercarriage by the vertical movement of the measuring buggy, and a further signal emitter producing an electrical control signal indicating the vertical movement of the measuring buggy.

9. The machine of claim 8, further comprising a first bell crank lever mounted on the frame adjacent the undercarriage, one of the arms of the bell crank lever being longer than the other arm thereof, the measuring buggy being carried by the one bell crank lever arm, and a second bell crank lever mounted on the frame and also having one arm longer than the other arm thereof, the further signal emitter interconnecting the other arms of the bell crank levers, and the one arm of the second bell crank lever being pivoted to the undercarriage.

10. The machine of claim 10, wherein the further signal emitter includes a flexible rod comprising a resistive wire strain gauge.

11. The machine of claim 1, further comprising an additional signal emitter producing an electrical control signal indicating the degree of compaction of the ballast, the addition signal emitter being mounted in an uncorrected track section, and a loaded pressure roller supported by the ballast and immersed therein to an extent which is a function of the ballast compaction, the pressure roller carrying the additional signal emitter and the control signal thereof being responsive to the extent of immersion of the roller in the ballast.

12. The machine of claim 11, further comprising a frame, a pressure fluid cylinder fixedly mounted on the frame and extending substantially vertically, means for supplying fluid to the cylinder under substantially constant pressure, a piston rod mounted in the cylinder for vertical reciprocating movement, the piston rod having a lower end, and the pressure roller being mounted on the lower end of the piston rod.

13. The machine of claim 12, wherein the additional signal emitter is a rotary potentiometer mounted on the frame, the potentiometer having a rotary shaft carrying a radially extending forked arm, the piston rod having a pin projecting therefrom, and the forked arm engaging the piston rod pin.

14. The machine of claim 11, wherein the pressure roller is mounted for engagement with the ballast outside the track cribs in the region of the ballast shoulder.

15. The machine of claim 11, wherein the pressure roller is mounted for engagement with the ballast between the track rails.

16. The machine of claim 1, comprising a first one of said signal emitters mounted in an uncorrected track section spaced forwardly of the track lifting means for indicating the deformation of the track under load, a second one of the signal emitters mounted adjacent the track lifting means for indicating the geometric track position in the uncorrected track section, the control signals of both emitters being transmitted to the control, and a recording instrument connected at least to the first signal emitter.

17. The machine of claim 1, further comprising a delay circuit in the means for transmitting the control signal to the control, the transmission delay in the delay circuit being set in dependence of the distance of the tamping tools from the signal emitter, and further comprising an odometer measuring the distance traveled by the mobile machine and a signal pulse emitter for feeding a pulse corresponding to the traveled distance to the delay circuit.

* * * * *