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[54] **APPARATUS FOR LINING TRACK IN A TRACK CURVE**

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[51] **Int. Cl.** **E01b 35/08**

[58] **Field of Search** 104/7, 8; 33/287

[56] **References Cited**

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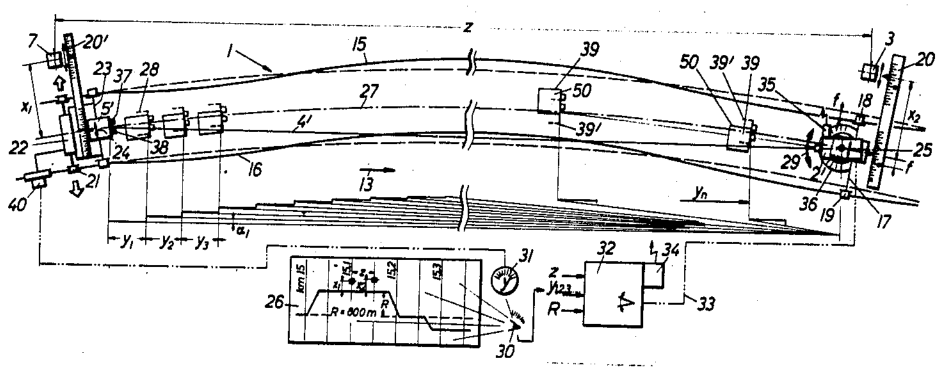
[57] **ABSTRACT**

A mobile track liner comprises a laser beam gun in an uncorrected track section emitting a reference beam forming a chord in the arc of a track curve, and a laser beam receiver mounted on the liner, laser beam gun and receiver are transversely adjustable in relation to fixed points, such as telegraph poles and like markers defining a planned track position and respectively associated with the laser beam gun and the receiver. A control means for the track lining converts lining error signals which are a function of the receiver position in dependence of the length of the path of the movement of the receiver on the track into lining control signals. In the lining method, the receiver on the liner is moved towards the laser beam gun which is mounted on a carriage in the uncorrected track section.

10 Claims, 11 Drawing Figures



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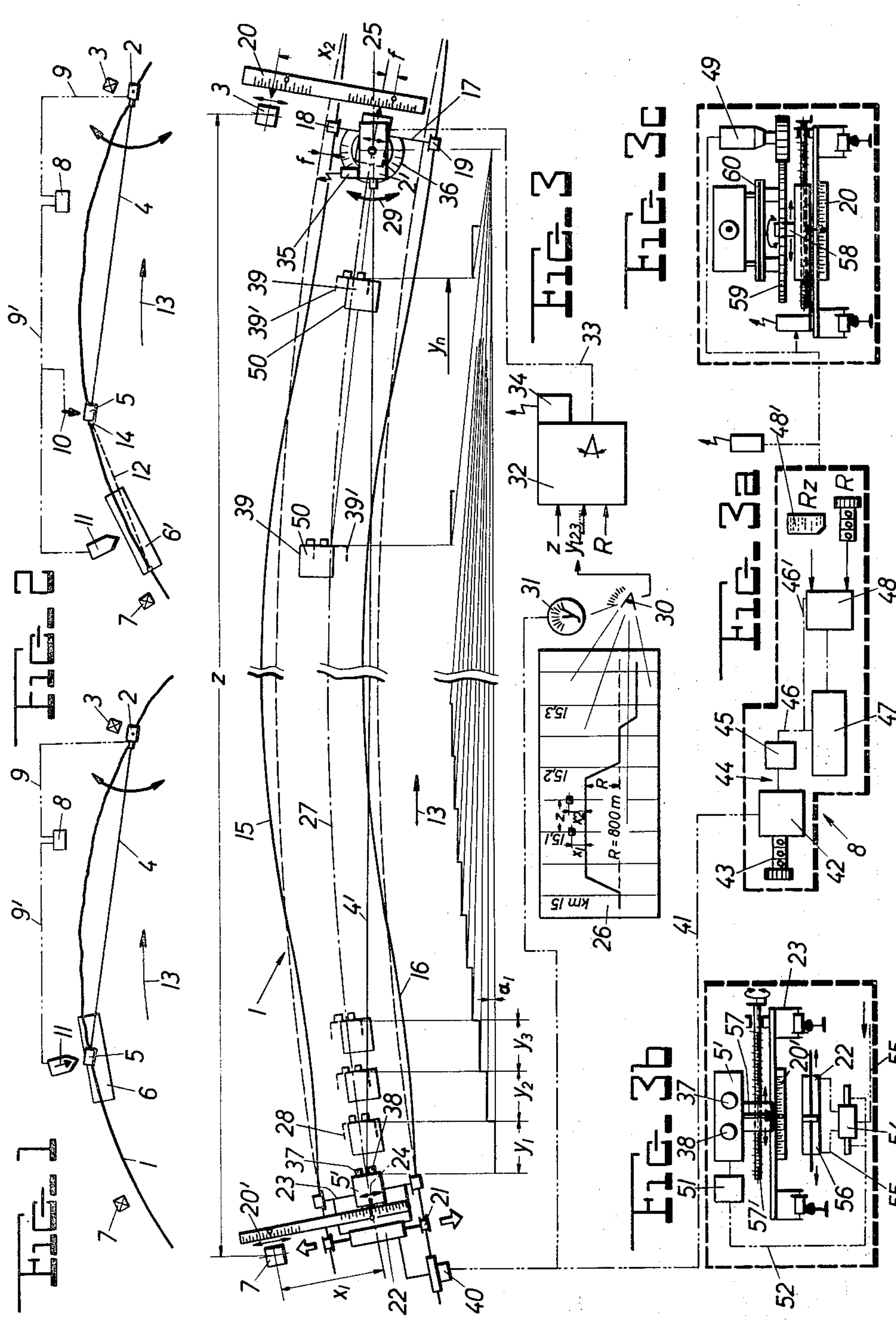


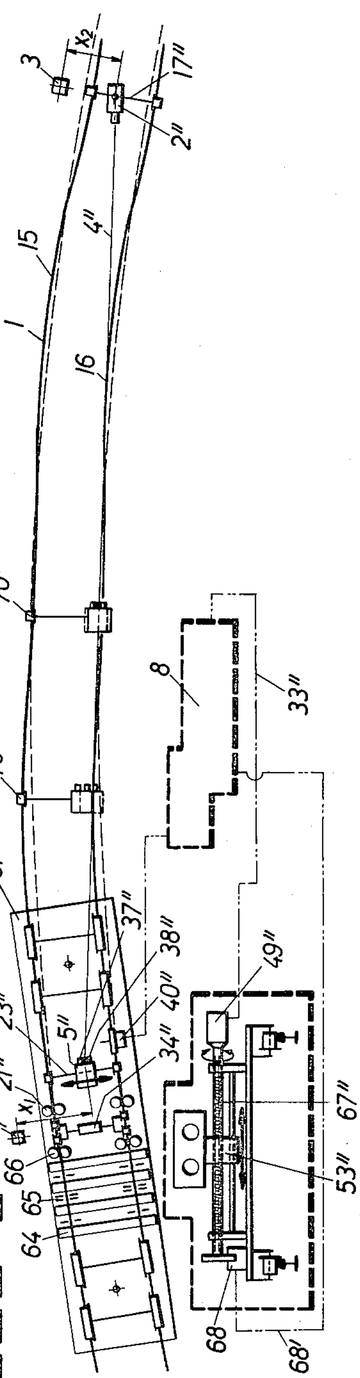


FIG. 4

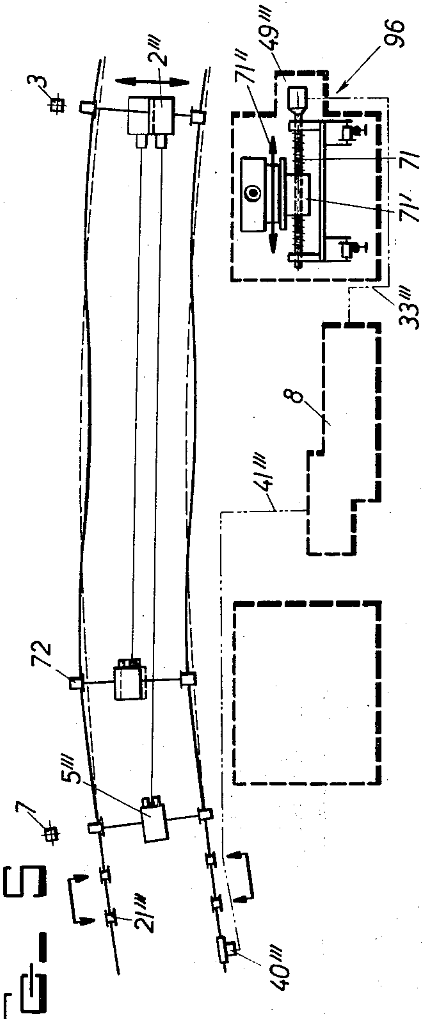
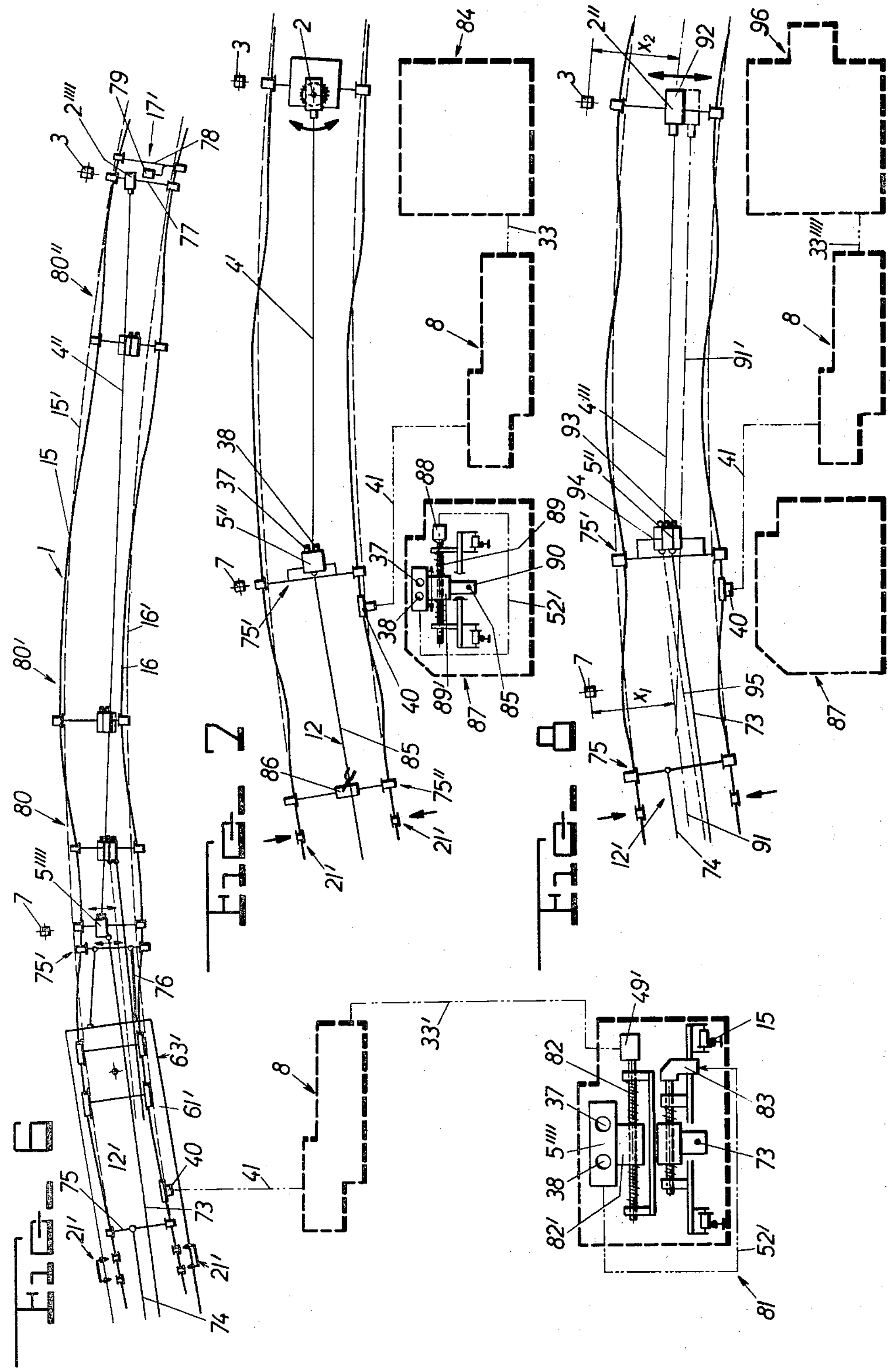


FIG. 5



APPARATUS FOR LINING TRACK IN A TRACK CURVE

The present invention relates to improvements in a method and apparatus for lining a track in a track curve in respect of a reference beam forming an accurate chord in the arc of the track curve. In such track lining methods, the actual ordinate of the surveyed track points is compared with the planned ordinate of these points, these planned ordinates being established, for instance, on a track map, and the difference between the actual and the planned ordinates serve to determine the extent of the lining.

In one known track lining method of this type, an emitter of an infrared reference beam is arranged on an independent carriage in the track curve, and the associated receiver of the reference beam is arranged at the rear end of the track liner following the carriage. Emitter and receiver are held at a fixed transverse distance from the track. The reference beam forms a chord of known length in the track curve arc. Since the radius of the arc is also known, the required ordinate of each track curve point may be calculated readily. The desired ordinate of each point may be adjusted by a laterally movable stop in the path of the beam, and the lining tools are operated until the stop is aligned with the beam.

Since infrared beams are conical and rather diffuse, and require not only an emitter and receiver but also an intermediate stop, they can be used only for short distances. If a long curve is lined in this manner by a sequence of successive lining operations, the totality of the track curve position is changed in an uncontrollable manner.

A more accurate final track position is obtained if track curves are lined in respect of fixed track points defining the planned position. It has, therefore, been proposed to line tangent track as well as track curves in relation to fixed points which are marked along the right of way or on a track map. In such known lining systems, markers are erected at the fixed points to form a visible reference line, and the markers are sighted from the liner to determine deviations from the planned track position. These deviations are then eliminated by corresponding lining of the track.

It has also been proposed to use laser reference beams in track lining, particularly in tangent track, for instance, in applicants' U.S. Pat. application Ser. No. 3762, filed Jan. 19, 1970, now U.S. Pat. No. 3,706,284.

It is the primary object of this invention to line tracks in relation to relatively widely spaced fixed points, i.e., fixed points spaced apart between 10 and 80 meters, or more, with increased accuracy in determining lining errors and correcting the same.

This object is accomplished in accordance with the invention by positioning an emitter and receiver of the reference beam in relation to fixed points of the track respectively associated with the emitter and receiver, the emitter being positioned in an uncorrected track section, and thereupon moving the receiver on the track towards the emitter. The value of deviation of the track, i.e., the lining error parameter, from the planned position of the track, as indicated by the reference beam, is determined in dependence on the length of the path of movement of the receiver by adjusting the receiver or emitter in respect of each other.

The lining operation may be automated while assuring highest accuracy and operational speed, particularly in the lining of track curves, by continuously positioning the receiver in relation to the associated fixed track point either by sensing the reference beam by laterally moving the receiver while moving it on the track, or by pivoting the receiver about an angle determined by the planned ordinate and the length of the path of movement of the receiver.

It is also advantageous to prepare a lining program for an entire track section to be lined in advance by storing the determined values of track deviation on information storage element, such as a punched tape, which information may then be retrieved on a track liner for controlling the extent of lining in response to the stored values while the liner advances without interruption along the track section. Alternatively, the information is determined and simultaneously fed to the liner so that surveying and lining proceed at the same time.

The present invention also encompasses a mobile track comprising track lining means mounted on the liner. A laser beam gun emitting the reference beam is carried by a carriage mounted for mobility in an uncorrected section of the track, and a laser beam receiver or sensor is mounted on the liner. Means is provided for adjustably positioning the laser beam gun and receiver transversely of the track in relation to fixed points, such as telegraph poles, marking posts and the like, defining a planned track position and respectively associated with the laser beam gun and receiver. A control means for controlling the track lining converts lining error signals which are a function of the receiver position in dependnece of the length of the path of movement of the receiver of the track into lining control signals. The lining control signals may control the operation of the track lining means or an end point of a further reference system controlling the operation of the track lining means.

Such a track liner can be operated with a minimum of personnel and a combined track lining, leveling and tamping machine incorporated the above structure may be used not only in track curves but also in tangent track without requiring any time-consuming adjustments.

Simple and dependable operation is assured by mounting the laser beam gun for pivoting movement about an axis perpendicular to the track plane and associating a power means with the laser gun for pivoting it about this axis. Furthermore, the position of the laser beam gun and/or the receiver may be transversely adjusted by remote control in dependence on the actual ordinate.

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

FIGS. **1** and **2** are schematic plan views of two modes of use of a mobile track position correction machine according to the invention;

FIG. **3** is a plan view of such a machine on an enlarged scale and showing some structural details;

FIGS. **3*a*** to **3c** illustrate parts of the machine of FIG. **3** on an enlarged scale in elevational side views;

FIG. 4 is similar to FIG. 3 and shows another embodiment constituted by a combined track lining, leveling and tamping machine;

FIG. 5 similarly shows yet another embodiment used in the scheme of FIG. 1; and

FIGS. 6 to 8 similarly show additional embodiments used in the scheme of FIG. 2.

Referring now to the drawing, wherein like reference numerals designate like parts functioning in a like manner in all figures, FIGS. 1 and 2 purely schematically illustrate the principles of the invention. As shown, a laser beam gun 2 is positioned in an uncorrected section of track 1 in relation to a fixed point 3 associated therewith, such as a telegraph pole, a marking post or the like, on a carriage mounted for mobility on the track. The laser beam gun emits a reference laser beam in the directon of receiver 5 which constitutes a target or sensor for the laser beam.

In the embodiment of FIG. 1, the laser beam receiver 5 is mounted on track liner 6 substantially at the point where the track is to be lined. Starting from another fixed point 7, with which the receiver 5 is associated, the liner 6 has previously lined another section of the track 1, moving during the lining operation towards the laser beam gun.

Accurate lining of the track curve is achieved by laterally adjusting, i.e., pivoting, laser beam gun 2 in dependence on the length of the path of movement of the receiver 5 on the track after each forward movement of the liner or at least before each lining operation. During this intermittent advance of the liner on the track curve, the control unit 8 pivots the laser beam gun so that the differences in the ordinates between two successive lining points are taken into consideration.

In the embodiment of FIG. 1, the control unit 8 is connected to the laser beam gun pivoting means by control line 9 to pivot the gun, whereupon the laser beam receiver or target 5 is laterally moved in the direction of arrow 11 transversely of the track until the laser beam 4 emitted from gun 2 is in alignment with the target or receiver 5, at which point the track is in the planned or corrected position. The lateral movement of the receiver 5 is effected by laterally moving the track 1 by track lining means mounted on liner 6, the liner moving with the track and the receiver moving with the liner on which it is mounted. Thus, the track and the laser beam receiver are in the desired or planned position of the track.

In the embodiment of FIG. 2, the track liner is incorporated in a combined lining, leveling and tamping machine 6′ which has its own reference system 12 which may consist of a light beam, for instance. Such a known reference system extends from a rear end point, as seen in the working direction indicated by arrow 13, which is located in a previously corrected track section to a forward end point 14 ahead of the machine in an uncorrected track section. In this embodiment, the laser beam sensor 5 is transversely movable together with the forward end point of reference system 12 in the direction of arrow 10.

In operation, the control unit 8 again laterally adjusts the laser beam gun 2 before each adjustment of receiver 5 according to data derived from the planned track position or a map of the desired track position. However, in contrast to the embodiment of FIG. 1, only the receiver 5, together with reference system end point 14, are aligned with laser beam 4 in the direction of arrow 4 without laterally moving the track. After this adjustment, the forward as well as the rear ends of reference system 12 are in the planned position reflecting the desired position of the track. This enables the track to be lined by machine 6′ in the direction of arrow 11 to assume its planned position.

Additional control line 9′ is provided in both embodiments to prevent the lateral movement of track 1 or the end point 14 of the reference system for the track lining to be effected before the position of the laser beam gun has been laterally adjusted. In both embodiments, the laser beam gun 2 and the receiver 5 are positioned at the beginning of the lining operation in relation to fixed points 3 and 7, respectively, and the laser beam gun 2 is brought into alignment with the target or sensor 5 after the laser beam gun and the receiver have been moved into the correct distances from their associated fixed points, such distances being determined by the planned position of the track. The liners 6, 6′ then move in working direction 13, together with the receiver 5 mounted thereon, until the receiver comes close to fixed point 3. At this stage, the laser beam gun 2 is moved in the working direction to a succeeding fixed point defining the planned track position, whereupon the next cycle of operations starts.

FIG. 3 shows the details of a track liner useful in the operation schematically illustrated in FIG. 1, the actual position of rails 15, 16 of track 1 being shown in full lines and the deviation of the track from the planned position, i.e., the lining error, being indicated by the difference in the full and broken lines of the rails. A carriage 17 is mounted on flanged wheels 18, 19 for mobility on the track and is positioned adjacent fixed point 3. Carriage 17 carries a scale 20 for determining the lateral adjustment in relation to fixed point 3 and a laser beam gun 2′ which is arranged for lateral movement transversely of the track as well as for pivoting movement for assuming a desired angle in relation to the track axis. In a known manner, the carriage 17 may be pressed with its flanged wheels into selective engagement with one of the rails 15 or 16 selected as the grade rail for the lining operation. In the illustrated embodiment, the grade rail is outer rail 15 of the track in the curve so that the flanged wheel 18 engages rail 15.

Suitable track lining means, such as laterally movable rail engaging rollers 21, are positioned close to fixed point 7, jack 22 being arranged to press the rail engaging rollers in a selected lateral direction to line track 1. Laser beam target or sensor 5′ is mounted laterally adjustably on a carriage 23 mounted for mobility on the track with the track lining means, the carriage also carrying a fixed scale 20′ which enables the lateral adjustment of the receiver 5′ in relation to associated fixed point 7. The carriage also has an odometer 40 rolling on rail 16 to determine the length of the path of movement of carriage 23 on the track, the odometer including an inductive signal emitter indicating the distance traveled by the carriage.

The apparatus of FIG. 3 operates as follows:

The planned track position is indicated beforehand on track map 26 and, at the beginning of the operation, i.e., either track lining or track surveying, the laser beam gun 2′ and the receiver 5′ are laterally positioned in relation to respective fixed points 3 and 7 in the direction of double-headed arrows 24, 25 so that the distance between the fixed points and the planned track axis **27** is x_1 and x_2, as determined by the map **26**, use being made of scales **20, 20'** for this lateral adjustment.

The lining error f, i.e., the distance between the actual and desired or planned track position, in the region of the laser beam gun determines the lateral movement of the gun in respect of scale **20** in the direction of fixed point **3** until the gun has the desired distance x_2.

The laser beam receiver **5'** is then moved on the track towards the laser beam gun **2** in the direction of arrow **13**, i.e., in the working direction, by length Y_1 of the path of movement of the receiver into position **28** indicated in broken lines. Before the track can be lined or the lining error determined in this position, the laser beam **4'** must be adjusted according to the changes in the ordinate or height of the arc which depend on the length of distance Y_1 and the arc radius which appears on map **26**. This adjustment is effected by pivoting the laser beam gun in the direction of double-headed arrow **29** about a vertical axis through angle α_1, as can be seen in the adjustment diagram associated with FIG. **3**.

The angular adjustment of the laser gun may be effectuated by an operator **30** who reads the values of the distance z between the fixed points as well as the arc radius R from the track map **26**, as well as the traveled distance Y_1 from the distance indicator **31** connected to the inductive signal emitter of odometer **40**, and feeds these values into a computer **32**. This computer is programmed to determine the pivoting angle of the laser beam gun **2'** for each position of receiver **5'**, control line **33** or radio transmitter and receiver **34, 35** connecting the computer with a motor which pivots the laser gun according to the computed angle.

It is also possible to provide the operator with a table showing the pivoting angles and to to adjust the angular position of the laser beam gun accordingly by use of a protractor scale **36**.

After the angular position of the laser beam gun has been thus adjusted, the receiver **5'** is aligned with the adjusted laser beam **4'** so that the beam impinges upon the receiver intermediate a pair of beam sensitive elements **37, 38** on the receiver, for instance photocells or thermoelectric elements. The alignment of the receiver **5'** is effected in this embodiment together with the alignment of the track by laterally moving track engaging rollers **21** until the beam **4'** hits the target between its beam sensitive elements, at which point the track has been lined in accordance with plan **26**.

Upon conclusion of this stage, the receiver **5'** is moved forwardly by distance Y_2, then Y_3, and so forth to distance Y_n, in the direction of laser beam gun **2'**, the above-indicated adjustments being repeated after each intermittent forward move.

When the receiver **5'** has been moved by distance Y_n close to the laser beam gun into the position **39** indicated by broken lines, the laser beam gun must be moved forwardly into the region of a fixed track point forwardly of point **3**, and the entire adjustment process is repeated for lining a succeeding track section, the fixed point **3** now becoming the point in relation to which receiver **5'** is adjusted. Thus, the track **1** is continuously moved into the planned position indicated in broken lines, this alignment being possible not only in track curves but also in transition sections of the track and of course, in tangential track, according to the track map.

FIG. **3a** shows a special control unit **8** which makes it unnecessary for the operator to determine the necessary data after each travel distance y and to feed them into the computer. This control unit operates as follows after each advance y of carriage **23**:

The signal emitted from odometer **40** to indicate the traveled distance is transmitted by electric line **41** to a timing or synchronizing unit **42**. The adjustor **43** sets the unit for a given traveled distance and, after this distance has been traveled, an impulse is transmitted by electric conductor **44** to amplifier **45**. The amplified timing impulse is transmitted to stepping logic **47** by line **46** and unit **48** by line **46'**. In response to the timing impulse, the unit **48** advances a punched or magnetic tape, or any other suitable information storage medium or element. Thus, the adjustment values for laser beam gun **2'** and for receiver **5'** corresponding to each length of the path of movement of receiver **5'** are transmitted from the information storage medium to the stepping logic **47**. The illustrated information storage medium is a punched card **48'** which stores these values in dependence on the radius of the track curve section to be lined and the distance between the fixed points delimiting this section. The data transmitted by unit **48** are transformed by the stepping logic **47** into signals for controlling the adjustment motor **49** of laser beam gun **2'** and the lateral adjustment of receiver **5'**, i.e., they are converted into a corresponding number of stepping impulses or a corresponding value of an analog voltage so that the motor **49** pivots the laser beam gun **2'** by the desired angle.

FIG. **3c** more clearly shows the adjustment motor **49** and the arrangement of the laser beam gun adjustment.

As shown in FIGS. **1** and **3**, the stepping impulses may be transmitted from logic or computer **47** to motor **49** by an electrical conductor **9** or **33**, or coded radio communication **34, 35**.

After the adjustment, the laser beam receiver **5'** is in the position **50** determined by the lining error of the track at this point and, accordingly, the laser beam will impinge on beam sensitive element **37** to produce a control signal. As shown in FIG. **3b**, this control signal is transmitted with amplifier **51** and the amplified signal is transmitted by line **52** to solenoid hydraulic valve **54**. The hydraulic valve is mounted in a hydraulic fluid pressure line **55** supplying hydraulic fluid from a source (not shown) to the jack **22**, and operation of the valve causes the fluid to flow through branch line **55'** into the jack cylinder chamber **56** so that the track is laterally moved into the planned position until the laser beam comes to impinge upon its target intermediate the elements **37** and **38**, thus discontinuing the control signal, with the receiver **5'** being in the corrected or lined position **39'** shown in broken lines. This same adjustment occurs after each advance Y_1, Y_2, etc. until Y_n.

As shown in FIG. **3b**, the receiver **5'** is mounted on a nut **57** on threaded spindle **57'** which is rotated by a hand wheel so as to adjust the lateral position of the receiver transversely to the track in relation to fixed scale **20'** until the distance between fixed point **7** and receiver **5'** has the value x_1 determined by track map **26**. The threaded spindle **57'** is mounted on carriage **23** for mobility on track **1**, the carriage running on flanged wheels which may be selectively pressed into engagement with a selected grade rail.

Similarly, as shown in FIG. 3c, the laser beam gun is also mounted on a nut on a threaded spindle to be laterally movable in relation to fixed scale **20** to assume the desired distance x_2 between fixed point **3** and gun **2'**. An axle **58** is jounaled in the mounting nut and a pinion **59** is affixed to the pinion **59** and carries the laser beam gun. The output shaft of motor **49** carries a gear meshing with pinion **59** so that the pinion and base plate may be rotated to position the laser beam gun angularly. FIGS. **4** and **5** illustrate further embodiments operating according to the scheme of FIG. **1**. In these embodiments, the position adjustment of the beam emitter and receiver in dependence on the differences in the ordinates during advance in the track curve is effected not by the angular adjustment of the beam emitter but by parallel movement of the receiver (FIG. **4**) or emitter (FIG. **5**).

In the apparatus of FIG. **4**, a carriage **17''** is mounted for mobility on track **1** in an uncorrected track section in the region of fixed track point **3** and carries the laser beam gun **2''** whose position has been laterally adjusted at the beginning of the operation so that it has the distance x_2 from the associated fixed point. After lateral adjustment, the laser beam gun is aligned with the laser beam target or sensor **5''** receiving the beam and mounted adjacent track lining rollers **21''** on track leveling, lining and tamping machine **61** for movement therewith along the track. Before this alignment, as previously described, the receiver **5''** also is laterally adjusted in relation to fixed point **7** so that it has the distance x_1 therefrom. The laser beam target or sensor is mounted on a mobile carriage **23''** in the region of the track gripping and lining rollers **21''** which are laterally moved by jack **34''** for lining the track. The machine **61** is mounted on two double-axled swivel trucks for mobility on track **1** consisting of rails **15, 16** and ties **64.** As shown, the machine also carries a tamping unit **65** for tamping the ties, the schematically illustrated tamping unit being arranged to tamp two adjacent ties simultaneously. The track gripping rollers **66** serve to lift the track in a well known manner in respect of a reference system (not shown) to level the track while lining it by operation of jack **34''** by control signals of beam sensitive elements **37''**, **38''** in the manner illustrated in FIG. *3a*.

The adjustment of the receiver **5''** to eliminate the differences in the ordinates at sucessive track points is effectuated in a manner similar to that described in connection with FIG. **3**, i.e., the length of the traveled path is measured by odometer **40''** whose signal is transmitted to motor **49''** by control unit **8''** via line **33''** to rotate spindle **67''** until the receiver **5''**, which is affixed to nut **53''**, has been laterally moved to the extent determined by control unit **8**.

The adjustment of receiver **5''** by motor **49''** should be effectuated as rapidly as possible so as not to interfere with the speed of operation of the machine. This may be accomplished by the use of pneumatic, hydraulic or electro motors of high rotational speed but may also be achieved with a hydraulic jack. The effected lateral adjustment of receiver **15''** is ascertained by a stop **68** at the other end of spindle **67''** which transmits the measured distance via return line **68'** to the control unit **8.** Upon receipt of this information, the unit stops rotation of motor **49''** so that the receiver is in the desired lateral position.

After this adjustment, the receiver is alignment together with track **1** with the laser beam **4''** under the control of the elements **37''**, **38''**. For a better understanding of the operation, two successive receiver positins **70** and **70''** are indicated on the drawing, the full lines indicating the position of the receiver **5''** after lateral adjustment by motor **49''** and the broken lines showing its position after the track alignment.

In the schematic illustration of FIG. **5**, the laser beam gun **2'''** and the receiver **5'''** are both laterally adjusted in relation to their respective associated fixed points **3** and **7** at the beginning of the operation. While the receiver advances on the track, together with the track lining rollers **21'''**, towards the laser beam gun, the signal from odometer **40'''**transmits the distance of the traveled path via line **41'''** to control unit **8.** The control unit is connected to motor **49'''** by line **33'''** to rotate spindle **71** and thus to move the nut **71'** on the spindle until the laser beam gun, which is affixed to the nut, has reached the planned position in the direction of double-headed arrow **71''**.

One illustrative position **72** of the receiver is indicated on the drawing. In this receiver position, the difference of ordinates is compensated by laterally moving the laser beam gun from the position indicated in heavy lines to the position indicated in thin lines transversely of the track, whereupon the receiver is brought into alignment with the laser beam by being moved with the track into the lined position shown in broken lines. The adjustment operation for the receiver is the same as described in connection with FIG. *3b*, wherefore this structure has been shown only by a rectangle in broken lines.

FIGS. **6** to **8** illustrate embodiments for use with the scheme shown in FIG. **2.**

The actual position of rails **15, 16** of track **1** is shown in full lines while their planned position is indicated in broken lines **15', 16'** in FIG. **6.** The front end of a track leveling, lining and tamping machine **61'** is shown to be mounted for mobility on track **1** by undercarriages **63'** (only the front axle being shown). The machine may be similar to that of FIG. **4,** including track lining rollers **21'** and a reference system **12'** for lining the track, the illustrated reference system being the well-known two-chord system comprising a lone chord **73** and a short chord **74** which are anchored to carriages **75** and **75'**, respectively, the carriages being pressed selectively into contact with a selected grade rail, i.e., outer curve rail **15.** The carriage **75** runs under the machine frame and may be lifted off the track as well as being pressed into contact with the grade rail be pneumatic jacks. The forward carriage **75'** is attached to the forward end of the machine frame by two spacing rods **76** so that it runs in an uncorrected section of the track, this carriage constituting the forward end point of the long chord of the reference system. The laser beam target or sensor **5''''** is laterally movably mounted on carriage **75'** so that its position may be adjusted transversely of the track in relation to fixed point **7** of the track as well as for compensation of changes in the ordinate in the track curve so that the lining errors occurring at the forward end point of the reference system do not disadvantageously influence the lining operation.

A double-axled carriage **17'** is mounted for mobility on the track in the region of second fixed track point **7** and carries the laser beam gun **2''''**, a pneumatic or hydraulic jack **79** being arranged for adjusting the axles

77 and 78 of the carriage so that one of the flanged wheels of axle 77 engages grade rail 15.

At the beginning of the operation, the laser beam gun is focussed on the target to establish a laser reference beam 4'' for target 5''''.

This machine operates as follows:

The machine is advanced to bring the laser beam receiver into consecutive positions 80, 80', 80'', the length of the path of the movement of the receiver being measured each time by odometer 40 which transmits a corresponding signal to control unit 8 via line 41. On the basis of the stored track data, the control unit controls the transverse movement of the receiver by operating motor 49' which rotates threaded spindle 82 to move nut 82', which carries the beam receiver, until the receiver is in the planned position.

In the position 80, for instance, the laser beam 4'' will impinge on beam sensitive element 37 of the receiver target, causing a control signal to be transmitted by line 52' to motor 83 which rotates threaded spindle 83' until the receiver 5'''', together with end point 75' of long reference chord 73, is moved on nut 83'' into alignment with the laser beam. After this alignment, the track is lined with the aid of reference system 12' in a well known manner. The prior adjustment of the forward end point of the reference system to move it into the desired or planned position of the track assured the exact lining of the track by the track lining rollers 21' since the rear end points of the reference chords 73 and 74 are already in a lined section of the track.

The embodiment of FIG. 7 is similar to that of FIG. 6 but the constantly changing ordinates in the curve are compensated by the angular adjustment of the laser beam gun 2. Again, the signal from odometer 40 is transmitted to the control unit 8 by line 41, and the values for the angular adjustment of the laser beam gun 2 are transmitted to the gun from the control unit via line 33. Since the laser beam unit 84 is identical with that of FIG. 3*c*, it has been shown only by a box in broken lines. The forward end point of reference line 85 of a conventional reference system 12 is anchored to carriage 75' which carries the laser beam target 5''. A measuring bogie 75'' is mounted in the region of the lining rollers 21', a potentiometer 86 on the bogie indicating the position of the reference line 85 in respect to the bogie and thus controlling the operation of the lining rollers. Reference systems of this and the two-chord type are well known and form no part of the present invention.

Starting from the region of fixed track point 7, the laser beam receiver 5'' is moved towards fixed track point 3 in whose region the laser beam gun 2 has been positioned. At each track point requiring alignment of the forward end point of reference line 85, the laser beam gun is first pivoted into the desired position, whereupon the receiver 5'' is aligned with the laser reference beam 4'. As shown at 87, this is effected by light-sensitive elements 37, 38 on the receiver, which controls operation of motor 88 via line 52' so that the spindle 89 is rotated by the motor until the receiver, together with the anchor 90 of the end point of the reference line 85, is transversely moved to a position where the laser beam impinges thereon intermediate elements 37 and 38, the receiver and anchor 90 being affixed to nut 89' moving on the spindle.

In the embodiment of FIG. 8, the apparatus is used with a two-chord reference system 12'. As in FIG. 6, the end point of short chord 74 is anchored to carriage 75 while the end point of long chord 74 is anchored to carriage 75' which also carries the transversely adjustable laser beam target 5''. The chain-dotted line 91 indicates the position of the long reference chord and the chain-dotted line 91' the position of the laser beam 4''' during the lateral adjustment of the receiver 5'' in relation to fixed track point 7 so that it is spaced therefrom by distance x_1. The full lines indicate the positions of the long reference chord and the laser beam during operation between fixed track points 7 and 3. Again, the odometer 40 transmits signals corresponding to the traveled distances to the control unit 8 via line 41 and unit 8 transmits control signals via line 33''' to move the laser beam gun transversely of the track in the planned position, shown at 92. After this adjustment, the emitted laser beam serves as reference for target 5'' which is in the position 93 before the alignment thereof, as indicated in full lines. Box 87 shows how rotation of threaded spindle 89 laterally moves receiver 5'' until it and the end point of long chord 73 have reached the desired or planned position 94, whereupon the chord 73 assumes position 95 shown in broken lines.

After the long chord 73 of the lining reference system has thus been accurately positioned, the lining into the desired or planned position can be effected with great accuracy. Since the laser beam gun adjustment operation has been fully shown and described in connection with FIG. 5, it has been indicated on FIG. 8 only by box 96.

Of course, it is possible to store any or all of the data used for adjustment of the laser beam gun and/or receiver on the basis of a computerized track survey, and then to use the stored information in a subsequent lining operation. Also, any suitable means, including hydraulic jacks, may be used for the lateral and/or angular movements of the gun and receiver, such jacks being operated by pulses of hydraulic fluid corresponding to the length of the path of movement of the receiver on the track, such moving means operating with great speed and thus being particularly useful in rapid lining or surveying operations. It is also possible to ascertain the data for the adjustment of the end point of the lining reference system and the lateral movement of the lining mechanism beforehand and to store this information, these movements being controlled by the stored data in a subsequent operation.

We claim:

1. A mobile track liner for lining a track in a track curve in respect of a reference beam forming a chord in the arc of the track curve, comprising

1. track lining means mounted on the liner
2. a laser beam gun emitting the reference beam,
3. a carriage mounted for mobility in an uncorrected section of the track and carrying the laser gun,
4. a laser beam receiver mounted on the liner,
5. means for adjustably positioning the laser gun and receiver transversely of the track in relation to fixed points defining a planned track position and respectively associated with the laser beam gun and receiver, and
6. control means for controlling the track lining,
   a. the control means converting lining error signals which are a function of the receiver position in dependence on the length of the path of the

movement of the receiver on the track lining control signals.

2. The mobile track liner of claim 1, wherein the lining control signals control the operation of the track lining means.

3. The mobile track liner of claim 2, wherein the control means comprises control signal storage apparatus including a storage element storing the planned ordinates of the track curve and a comparator comparing the planned ordinates with the actual ordinates indicated by the position of the receiver.

4. The mobile track liner of claim 1, comprising a further reference system controlling the operation of the track lining means, and the lining control signals control an end point of the reference system.

5. The mobile track liner of claim 1, wherein the laser gun is mounted for pivoting movement about a vertical axis, and power means is associated with the laser gun for pivoting the gun about the axix.

6. The mobile track liner of claim 1, further comprising remote control means for transversely adjusting the position of the laser gun beam and of the receiver in dependence on the actual ordinate.

7. The mobile track liner of claim 1, wherein the receiver is mounted on carriage moving with the liner in the region of the track lining means.

8. The mobile track liner of claim 1, wherein the liner comprises a carriage mobile on the track and fixedly connected to the forward end of the liner, the receiver being mounted on the carriage, and comprising a further reference system for controlling the operation of the track lining means, the carriage constituting a forward end point of the reference system.

9. The mobile track liner of claim 1, further comprising means for selectively holding the laser beam gun and the receiver at a fixed distance from one of the rails of the track selected as the grade rail.

10. The mobile track liner of claim 1, wherein at least one of the end points of the reference beam constituted respectively by the laser gun and the receiver is positioned intermediate the rails of the track.

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