Feb. 23, 1965 J. W. CHRISTOFF 3,170,410

APPARATUS AND METHOD FOR ALIGNING RAILROAD TRACKS

Filed April 7, 1961 8 Sheets-Sheet 1

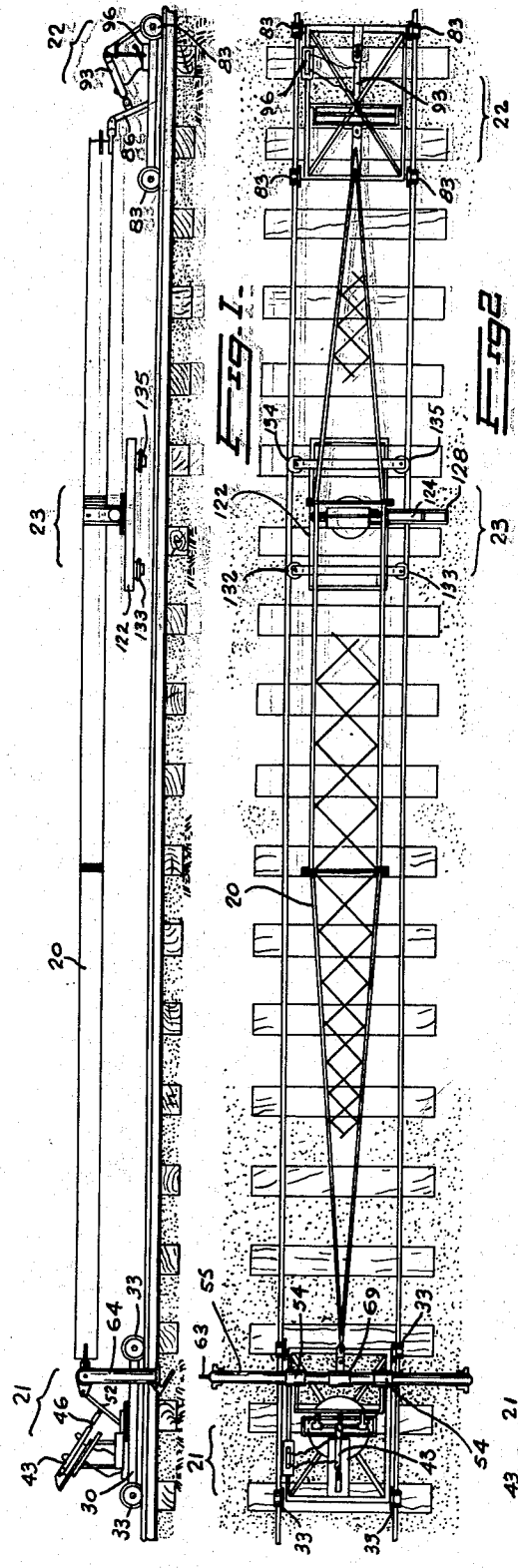


Fig. 1.

Fig. 2.

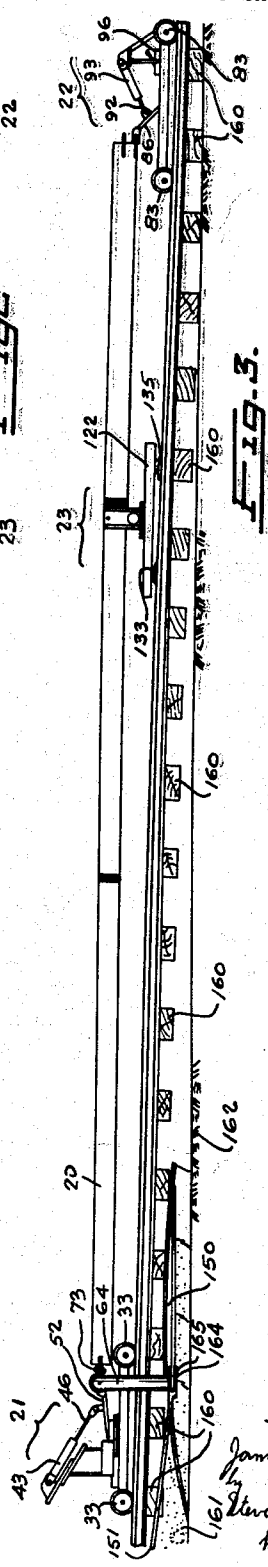


Fig. 3.

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APPARATUS AND METHOD FOR ALIGNING RAILROAD TRACKS

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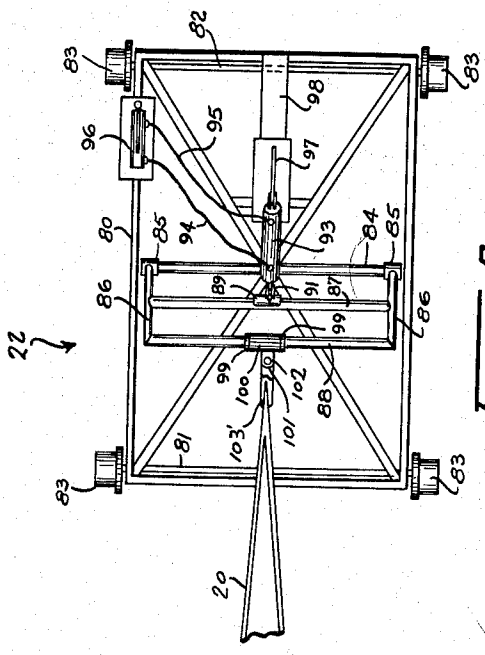


Fig. 6.

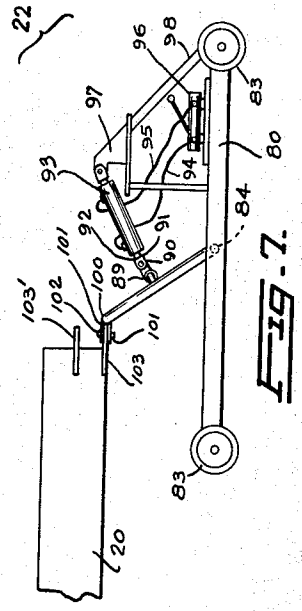


Fig. 7.

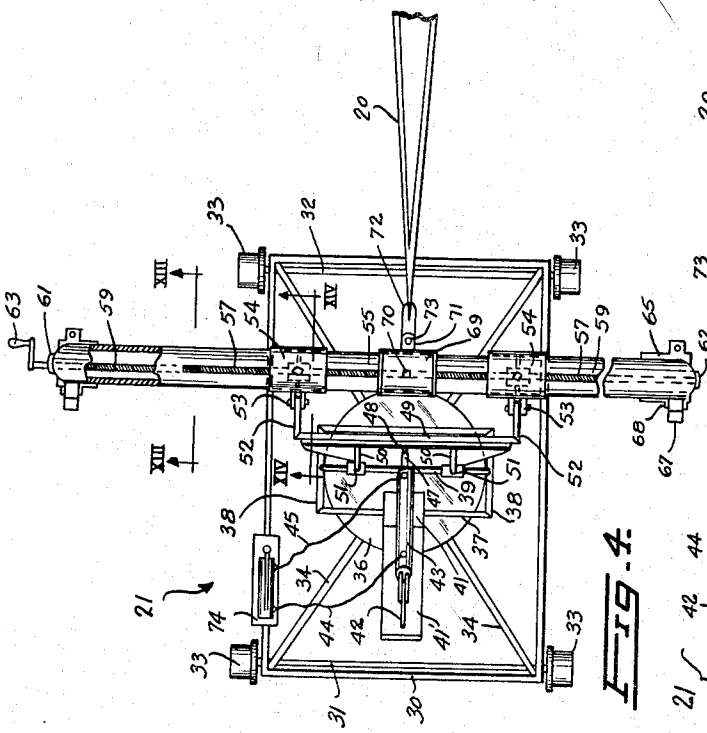


Fig. 4.

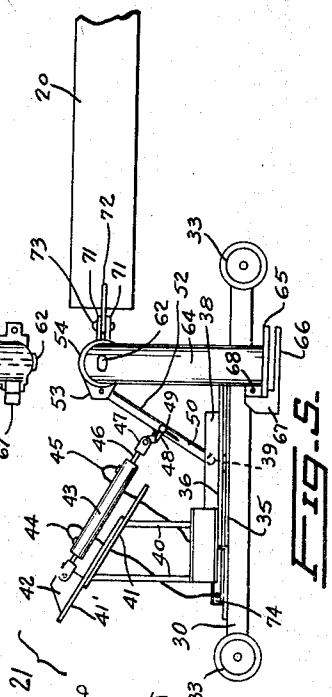


Fig. 5.

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APPARATUS AND METHOD FOR ALIGNING RAILROAD TRACKS

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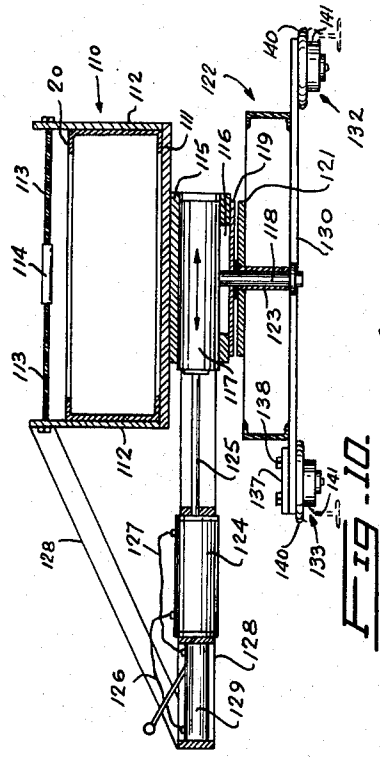


Fig. 10.

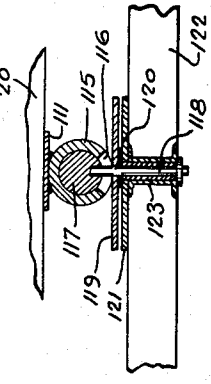


Fig. 11.

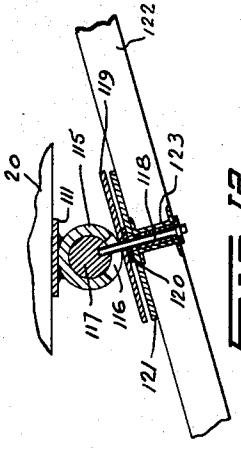


Fig. 12.

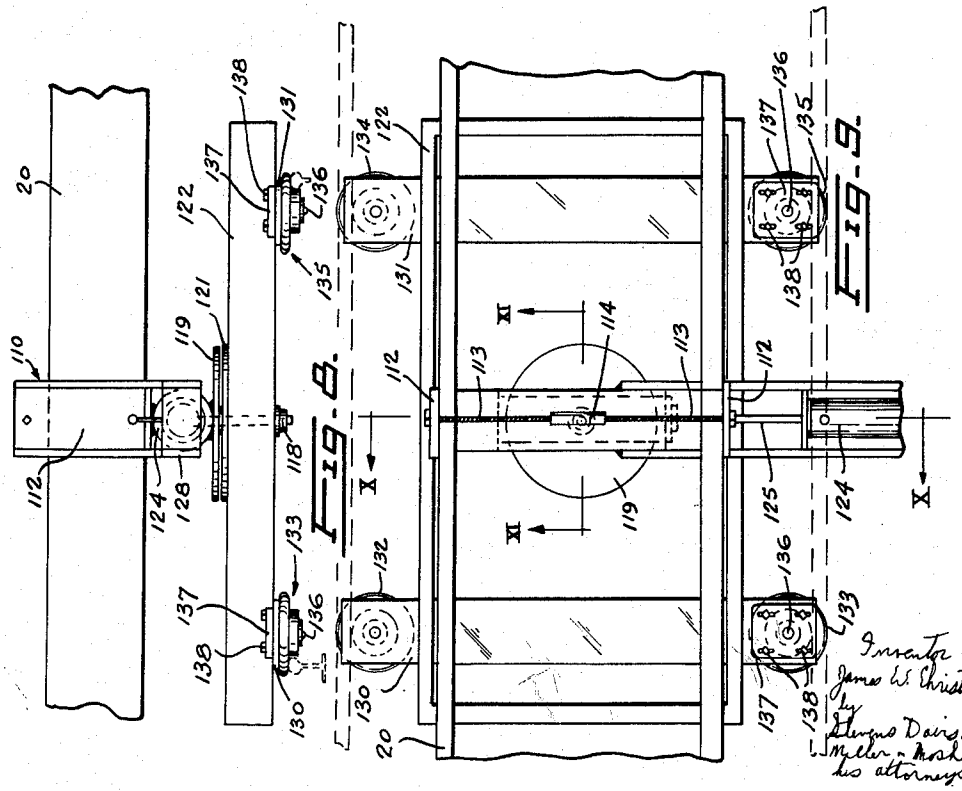


Fig. 8.

Fig. 9.

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APPARATUS AND METHOD FOR ALIGNING RAILROAD TRACKS

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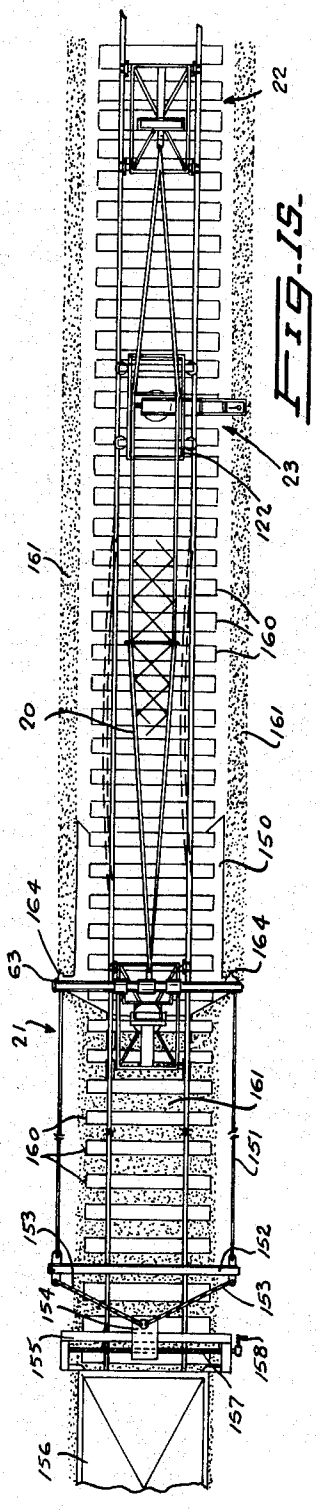


Fig. 15.

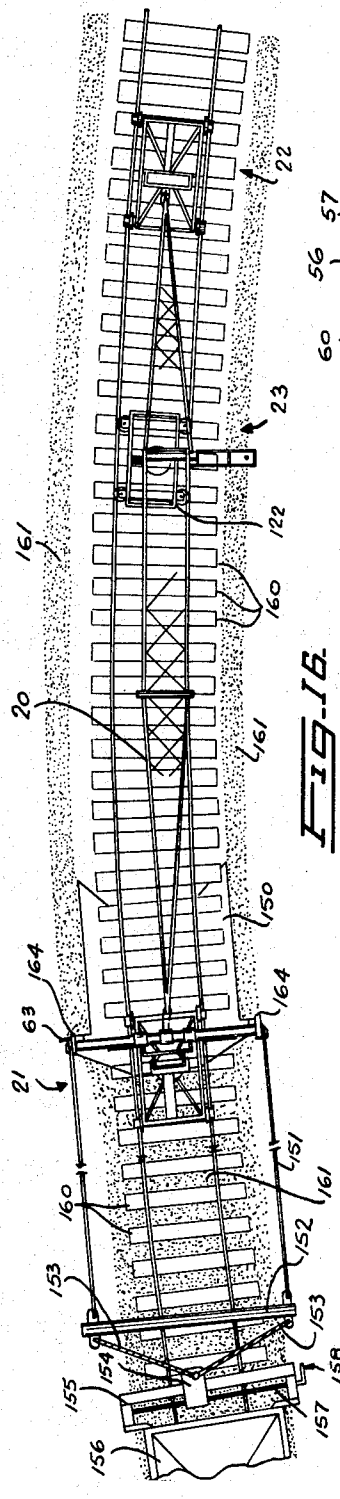


Fig. 16.

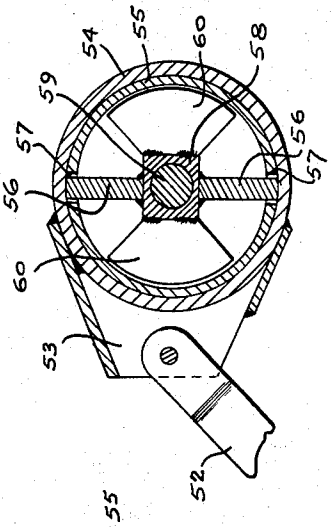


Fig. 14.

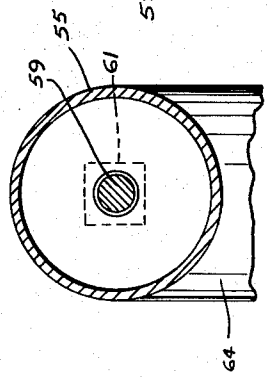


Fig. 13.

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APPARATUS AND METHOD FOR ALIGNING RAILROAD TRACKS

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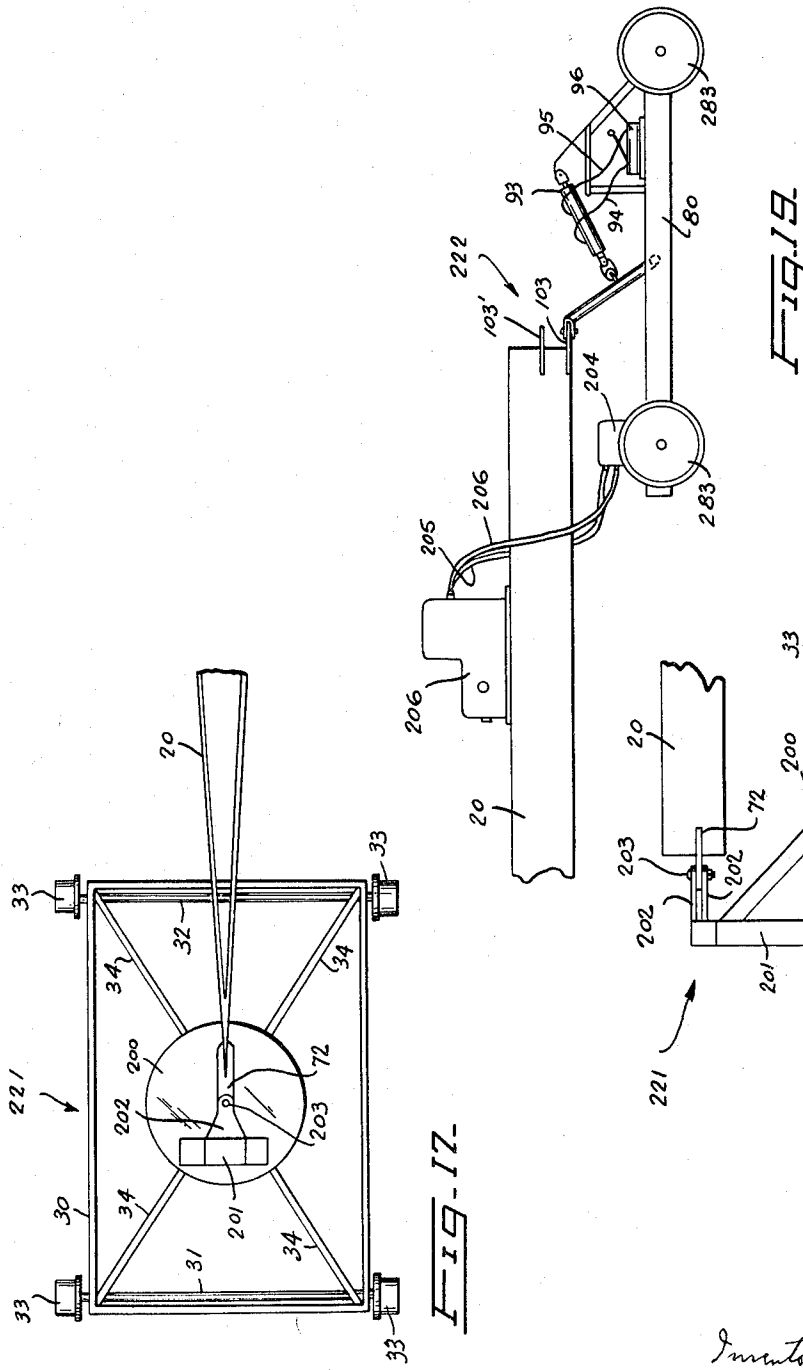


FIG. 19.

FIG. 18.

FIG. 17.

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APPARATUS AND METHOD FOR ALIGNING RAILROAD TRACKS

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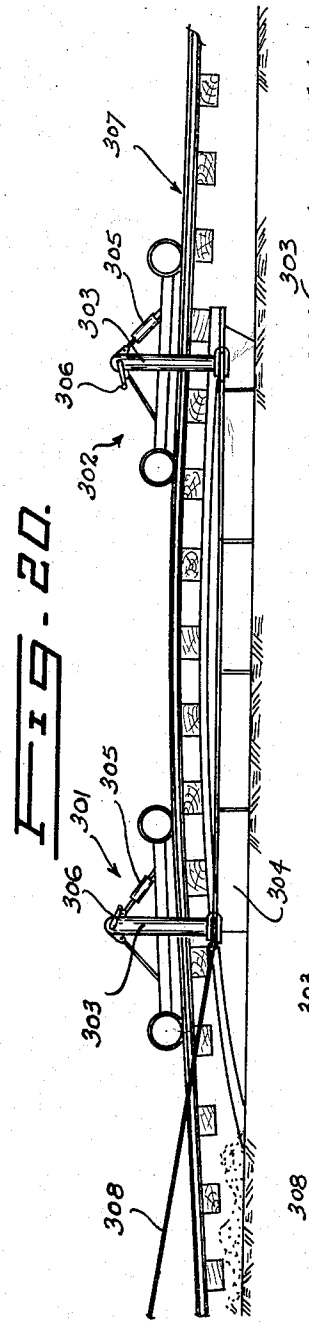


Fig. 20.

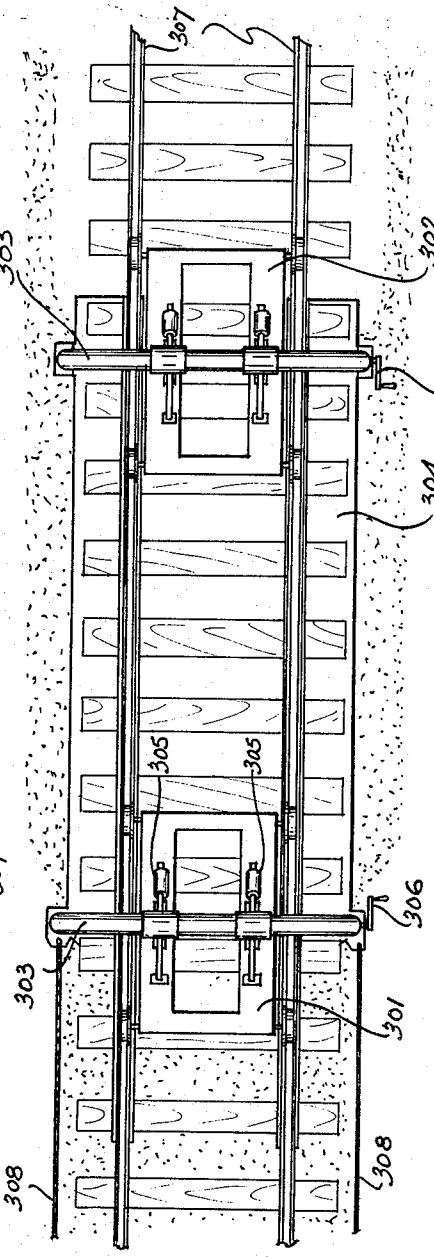


Fig. 21.

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Feb. 23, 1965 J. W. CHRISTOFF 3,170,410

APPARATUS AND METHOD FOR ALIGNING RAILROAD TRACKS

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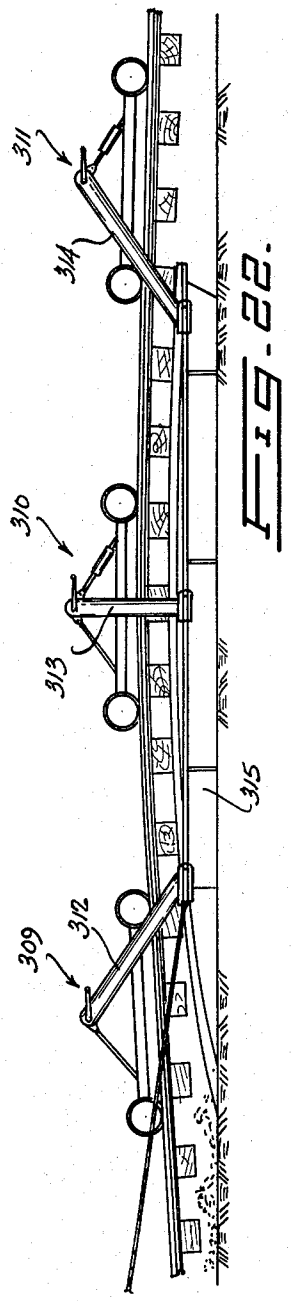


Fig. 22.

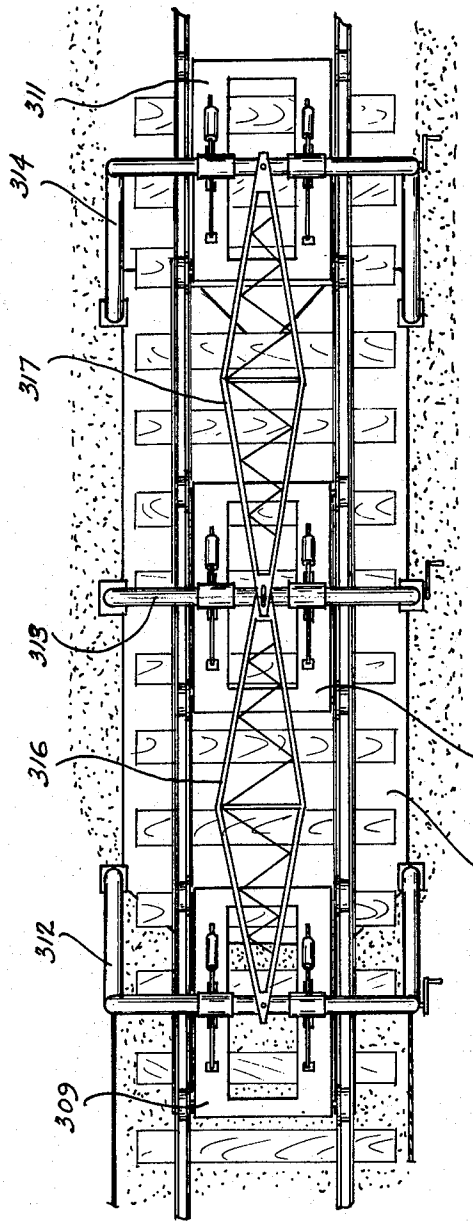


Fig. 23.

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APPARATUS AND METHOD FOR ALIGNING RAILROAD TRACKS

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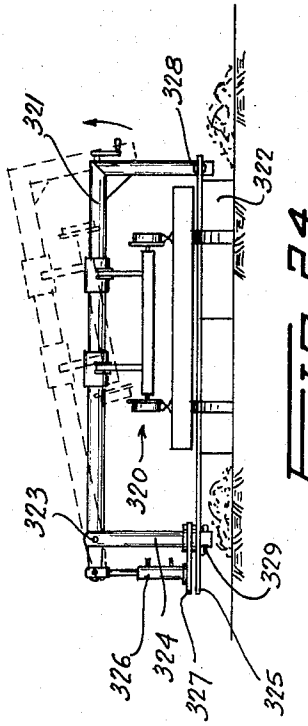


Fig. 24.

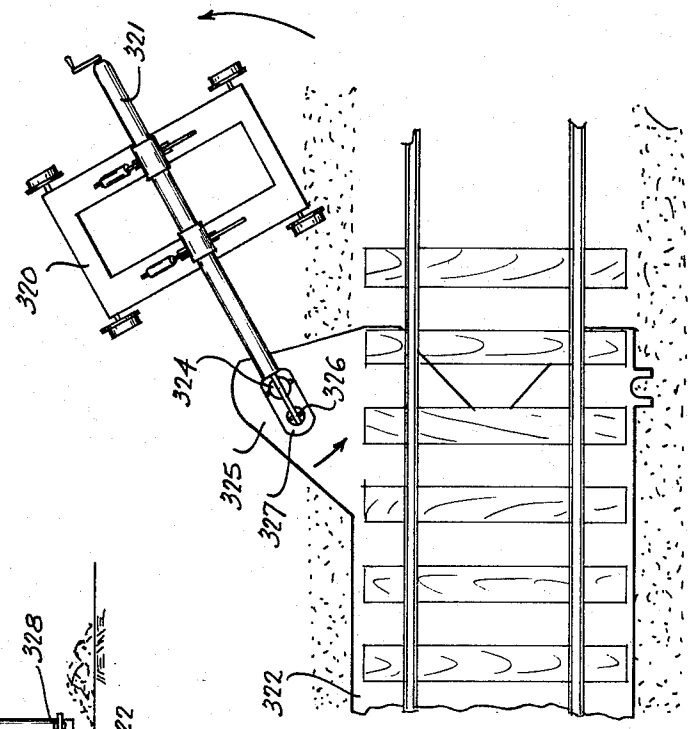


Fig. 25.

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United States Patent Office 3,170,410
Patented Feb. 23, 1965

3,170,410

APPARATUS AND METHOD FOR ALIGNING RAILROAD TRACKS

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Filed Apr. 7, 1961, Ser. No. 101,503
16 Claims. (Cl. 104—8)

This invention relates to track aligning methods and to apparatus, or so-called liner devices, for use in correcting misalignment of railroad tracks. The apparatus of the present invention is adapted for use in conjunction with under-track devices of the ballast sled and ballast plow types, although it is nevertheless capable of being employed independently of such devices.

Ballast plows are employed for removing fouled ballast from a railroad roadbed. A plow is inserted between the roadbed and the ties to which the track rails are secured and is then towed along the track in this position by a locomotive. As the plow progresses, it raises the ties from the roadbed ahead of it, supports the ties and the rails secured thereto, as the device passes underneath, and finally allows the track to settle back onto the roadbed or "sub-grade" behind the device. The weight of the track supported by the plow is considerable and the plow is therefore pressed firmly down against the ballast. By providing the plow with one or more scraper blades it is possible to separate either the full depth of ballast or a layer of ballast of chosen depth and displace this ballast to the side of the track beyond the ends of the ties, so that when the ties resettle, this displaced ballast can be readily removed.

Ballast sled devices are similar to ballast plows in that they are inserted between the roadbed and the ties and are towed along in this position by a locomotive. Sleds, however, are used either during the laying down of new tracks or to perform a reballasting operation following the pulling of a ballast plow in the manner just described. After the plow has removed the fouled ballast, or in the case of a new track laid directly on the sub-grade, after the track has been so laid, fresh clean ballast is dumped onto the track to lie on top of the ties and rails. The function of the sled is to raise the ties up to their desired level and distribute the ballast evenly beneath them. Subsequently, additional ballast will normally be dumped on the track in the cribs between each pair of adjacent ties, this latter operation usually being carried out manually, since it does not require raising of the track.

In either case (plow or sled), the under-track device yields a levelled roadbed extending to each side of the track beyond the ends of the ties. When the track resettles onto this roadbed (the sub-grade or remaining ballast behind a plow, or a layer of fresh ballast behind a sled), it is important to ensure correct lining up of the track in the same position as it occupied prior to pulling of the plow or sled, assuming that it was previously properly positioned. If it was not, then advantage of the opportunity to correct the misalignment should be taken. Resettling of the track into correct alignment can be performed manually and this is the method previously in practical use, but it renders large the number of men required to a team, and still may be subject to some error.

When plowing and sledding operations are carried out in double track, it is possible to use the second track for alignment of the track being raised and resettled. A device of this character is described in my prior United States Patent No. 2,921,537, issued January 19, 1960, but even then reliance on the proper alignment of the adjacent track is necessary, and this is not always a justified assumption. Such a device moreover is of no

value when plowing and sledding operations are carried out on single track.

An object of the present invention is the provision of alignment apparatus capable of connection to an under-track device of the ballast plow or ballast sled type for progress along the track with such device, such apparatus acting automatically to maintain alignment of the track rearwardly of the under-track device without reliance upon an adjacent track.

A further object of the invention is the provision of alignment apparatus that can be used without a plow or sled device and which will be capable of travelling along a track and improving the alignment thereof without the track being elevated and without reference to any adjacent track.

Further objects of the invention are improved methods of aligning track, operating both with and without under-track devices.

In referring to the "alignment" of a section of track, it should be made clear that the purpose is to cause such track to lie as nearly as is possible, within practical working conditions, to the theoretical track position laid down by the track engineer. In the main, the present method and apparatus is not concerned with maintenance of gauge (the distance between the two rails of a single length of track). It is assumed that this distance is maintained by the ties to which the rails are spiked. In referring to misalignment, the present application is concerned with any bodily displacement of any section of the track (both rails) laterally from its correct position in alignment with the sections of the same track that continue in each direction from the section under consideration. Tangent track should be exactly straight and free of any distortion from side to side. Curved sections of track should be uniformly circularly curved about the correct specified radius of curvature, and easements (sections of track between straight tangent track and circularly curved track) should be smooth and without any sudden changes of direction.

The various features of the invention will become apparent from the description which follows and from the appended claims. To support the description, attention is directed to the accompanying drawings, in which:

FIGURE 1 shows a general side view of alignment apparatus constructed in accordance with the present invention;

FIGURE 2 is a plan view of FIGURE 1;

FIGURE 3 is a side view similar to FIGURE 1 but showing the apparatus connected to a ballast plow;

FIGURE 4 is an enlarged plan view of the front cart of such apparatus;

FIGURE 5 is a side view of FIGURE 4;

FIGURE 6 is a plan view on an enlarged scale of the rear cart of the apparatus of FIGURES 1 to 3;

FIGURE 7 is a side view of FIGURE 6;

FIGURE 8 is a side view on an enlarged scale of the liner head of the apparatus shown in FIGURES 1 to 3;

FIGURE 9 is a plan view of FIGURE 8;

FIGURE 10 is a section on the line X—X in FIGURE 9;

FIGURE 11 is a section on the line XI—XI in FIGURE 9;

FIGURE 12 is a view similar to FIGURE 11 showing the parts in a different position;

FIGURE 13 is a section on the line XIII—XIII in FIGURE 4;

FIGURE 14 is a section on the line XIV—XIV in FIGURE 4;

FIGURE 15 is a further plan view of the whole apparatus, showing the apparatus being towed together

with a ballast plow, similiar to the conditions shown in FIGURE 3 but on a smaller scale;

FIGURE 16 is a view similar to FIGURE 15 showing the apparatus on a section of curved track;

FIGURE 17 shows a plan view of a modified form of front cart;

FIGURE 18 is side view of FIGURE 17; and

FIGURE 19 is a side view of a modified form of rear cart.

FIGURE 20 shows a side view of another form of apparatus constructed in accordance with the present invention;

FIGURE 21 is a plan view of FIGURE 20;

FIGURE 22 is a side view of yet another form of apparatus in accordance with the present invention;

FIGURE 23 is a plan view of FIGURE 22 but with further modifications added;

FIGURE 24 is a transverse section of a still further modified construction; and

FIGURE 25 is a plan view of FIGURE 24 showing the parts in a different position.

Referring firstly to FIGURES 1 to 3, the liner apparatus will be seen to consist of an on-track vehicle comprising a main rigid boom **20** connected at its respective ends to a front cart **21** and a rear cart **22** and carrying a liner head **23**.

The structure of these individual parts will first be considered, before returning to the operation of the apparatus as a whole.

The front cart **21** is shown in FIGURES 4, 5, 13 and 14, and consists of a flat framework **30** carrying front and read axles **31** and **32** on which are mounted for independent rotation four flanged wheels **33**. Secured to the centre of the framework **30** by cross members **34** is a fixed disc **35** (FIG.5) which serves as a bearing for a second superposed disc **36** connected to the disc **35** by a central stub shaft so that the disc **36** is free to rotate relative to the base disc **35** about a vertical axis passing through the centre of the cart **21**. Secured to the upper face of the upper disc **36** is a frame **37**, the side arms **38** of which serve as bearings for a shaft **39**. The disc **36** also acts as a support for an upwardly extending framework **40** that terminates in an inclined plate **41** on which rests a further plate **41'** adjustable relative to plate **41** and carrying an upstanding web **42** to which is secured one end of a double acting hydraulic cylinder **43**. Hydraulic pressure lines **44** and **45** extend from respective ends of this cylinder **43** to a manually operable hydraulic control cylinder **74**. The piston of the cylinder **43** is connected to a rod **45** which carries at its end a forked member **47** establishing pivotal connection between the rod **46** and a bracket **48** secured to a transverse member **49** that is mounted to pivot with the shaft **39** by means of depending legs **50** that carry at their free ends sleeves **51** secured to the shaft **39**. At its ends, the member **49** carries a pair of upstanding arms **52** which each terminate in a pivotal engagement between forked plates **53** secured to sleeves **54** that embrace a transversely extending tubular yoke **55**.

At this point reference may conveniently be made to FIGURES 13 and 14. FIGURE 14 shows the manner of mounting of a sleeve **54** on the tubular yoke **55**. Each sleeve **54** has secured to its inner periphery at diametrically opposite points a pair of inwardly extending plates **56** each of which passes through a slot **57** in the upper and lower surfaces of the yoke **55**. The plates **56** carry between them a nut **58** which engages a threaded spindle **59**. Each nut **58** also carries a pair of plates **60** having outer edges complementary to and closely spaced from the inner periphery of the tubular yoke **55** to ensure proper centering of the nut **58**. The threaded spindle **59** extends the full length of yoke **55** to be mounted in bearings **61** and **62** in the respective ends thereof. These bearings mount the spindle **59** for free rotation but maintain it in fixed position in the longitudinal direction

of the yoke **55**. At one end, the spindle **59** projects beyond the end of the yoke **55** to terminate in a handle **63**.

At each end, the yoke **55** is provided with a downwardly projecting extension in the form of a leg **64** (FIG. 5) terminating in a horizontal plate **65** which co-operates with a second plate **66** pivotally secured by web **67** and pin **68** to the foot of the leg **64** to establish connection with the towing ears of a ballast plow or ballast sled.

Centrally of the yoke **55** and between the two sleeves **54** there is mounted a further sleeve **69** (FIG. 4). The sleeve **69** is normally fixed in position on the tubular yoke **55** both in respect of translation and rotation by a pin **70** which passes through the sleeve **69** and the upper portion of the member **55**, but which can be removed for dismantling or storing the apparatus. The fixed sleeve **69** carries a pair of spaced rearwardly projecting plates **71** to which the boom **20** is connected by means of a plate **72** on the end of such boom and a pin **73** that passes through holes in the plates **71** and **72**.

The rear cart **22** shown in FIGURES 6 and 7 is generally similar to the front cart **21**, although of somewhat simplified design. It consists of a framework **80** carrying axles **81** and **82** and flanged wheels **83**, similarly to the corresponding parts of the front cart. Bearing plates corresponding to plates **35** and **36** of the front cart have been omitted however in the rear cart **22** as unnecessary and the pivoting framework is mounted on shaft **84** that is journalled directly in the side members of the framework **80**. This shaft **84** has connected to it sleeves **85** that support a framework consisting of upwardly projecting members **86** and transverse interconnecting members **87** and **88**. The member **87** serves for connection of the framework through bracket **89**, pivot pin **90** and forked member **91** to the piston rod **92** of a double acting hydraulic cylinder **93** connected by pressure lines **94** and **95** to a manually operable hydraulic control cylinder **96**. The other end of the cylinder **93** is pivotally connected to a web **97** forming part of an upstanding framework **98** secured to the cart **80**.

The other transverse interconnecting member **88** of the movable framework carries a freely pivotally mounted sleeve **100** held between fixed flanges **99** to prevent longitudinal movement. A pair of plates **101** secured to sleeve **100** together with a pin **102** make pivotal connection to a plate **103** fixed to the end of the boom **20**. An alternative plate **103'** is provided on the boom **20** if the boom is required to be in a lower position relative to the rear cart **22**.

At a point approximately two-thirds of the distance along the boom **20** from the forward cart **21** to the rearward cart **22** (although this position may be varied as required depending on the circumstances) there is mounted a liner head **23**. Details of this liner head **23** are shown in FIGURES 8 to 12. It consists essentially of a fixed frame **110**—that is a frame which is fixed in position on the boom **20** once its required position thereon has been chosen. As appears best from FIGURE 10, the frame **110** comprises a lower horizontal member **111** and a pair of upwardly projecting side members **112**, the upper ends of which are connected together by a pair of rods **113** and a turn buckle **114** which serves to draw the members **112** together to clamp the framework **110** firmly around the boom **20** which it embraces. To the underside of the plate **111** there is secured a transversely extending open-ended tube **115** having in its lower periphery a wide elongated slot **116** (FIG. 11).

The tube **115** sliding supports a plug **117** to the underside of which is secured a pin **118** that extends through the slot **116** and has secured to it outside the tube **115** a disc **119**. A washer **120** separates this disc **119** from a second disc **121** that is secured to a liner head assembly **122** which is free to turn about the pin **118** in bearing **123**. The liner head assembly **122** is thus capable of three forms of movement. Firstly, it can be translated in the transverse direction of the boom **20** by longitudinal

movement of the plug **117** in the tube **115**. Secondly, it is capable of rotation about the horizontal longitudinal axis of the tube **115** within the limits permitted by the width of the slot **116**. This rotation is demonstrated by a comparison of FIGURES 11 and 12. Finally, the assembly **122** can rotate about the normally vertical axis of the bolt **118**. The assembly can execute the latter two movements freely, but the first movement is controlled by a double acting hydraulic cylinder **124**, the piston rod **125** of which is secured to the plug **117** (see FIG. 10). Pressure fluid enters the cylinder **124** by one or other of flexible hoses **126** and **127** and is manually operated by control cylinder **129**. The cylinder **124** is mounted on an extension **128** of the framework **110**.

The liner head assembly **122** itself consists of a rectangular framework supporting a pair of rigid flat members **130** and **131** (see FIG. 9) that extend transversely across the front and rear respectively of the assembly **122**. At each end the members **130** and **131** carry freely pivotally mounted rail engaging wheels **132, 133, 134** and **135**. The wheels **132** and **134** on one side of the device are mounted in fixed position on the respective ends of members **130** and **131**, while the wheels **133** and **135** on the other side of the assembly are mounted for adjustment towards and away from the first pair of wheels. This adjustment is achieved by securing the pivot pin **136** of each wheel to a plate **137** mounted for sliding on the ends of the members **130** and **131** respectively. The plates **137** are fixed in position by nuts **138** which engage the ends of bolts projecting upwardly from the members **130** and **131** through slots in the plates **137**. A corresponding slot in the members **130** and **131** allows freedom of movement to each pin **136** when this adjustment takes place.

Each of the wheels **132, 133, 134** and **135** is formed with a wide horizontally extending flange **140** (see FIG. 10) for resting on the upper surface of the head of a rail and a shoulder **141** for bearing against the vertical inside surface of the head of the rail. It should be mentioned that the distance between wheels **132** and **133**; and between wheels **134** anud **135** is normally made rather smaller than the theoretical gauge of the track (usually 4 ft. 8½ inches). The rail gauge tolerance on the track may go as high as one inch on poor track or on curves. At other times due to the use of canted tie plates the gauge is sometimes found to be up to an inch tight (4 ft. 7½ inches). For these reasons the spacing between the wheels on the two sides of the liner assembly **122** will normally be about one inch less than theoretically required for the nominal track gauge and the flange **140** is made wide to ensure that the liner head will never drop through.

Now that the structure of the entire apparatus has been described, its manner of use will be discussed, initially with reference to FIGURES 1 to 3. FIGURES 1 and 2 show the apparatus in transporting position with the cylinders **43** and **93** of the front and rear carts **21** and **22** respectively in their withdrawn positions. In this position, the depending legs **64** of the tubular yoke **55** on the front cart **21** are raised clear of the ballast at the side of the track. Similarly the pivoting framework of the rear cart **22** is in raised position so that the boom **20** is comparatively high and the liner head assembly **122** is also raised clear of the track.

When the on-track apparatus is to be used in conjunction with a ballast sled or ballast plow, it is brought into position with the front cart **21** on the track immediately above the under-track device. In FIGURE 3, it is assumed that the alignment apparatus is to be pulled along the track while coupled to a ballast plow **150**. This plow may conveniently be a ballast plow of either the single or double track types described in L. B. Franco and J. C. Stein U.S. Patent No. 2,921,390, issued January 19, 1960. It is not deemed necessary to reiterate a detailed description of such a plow herein; suffice to say that it is towed by cables **151** from a towing bar **152** (see now the smaller scale view of FIG. 15) connected by further cables **153** to a mounting **154** which is slidable on a transverse bar **155** secured to the rear of a flat car **156**. Control over the transverse movement of the mounting **154** along the bar **155** is effected by means of a screw threaded rod **157** turned by a handle **158**. The purpose of this transversely slidable mounting is to be able to move the towing bar **152** to one side or other of the track to compensate for curvature of the track to avoid the plow **150** tending to cut the corner on a curve.

This assembly is towed along the track by means of a locomotive (not shown). As appears from FIGURES 3 and 15 the plow **150** is a single track plow and is being employed to "skeletonize" or plow out the track. Initially, in front of the plow **150**, the ties **160** are resting on a layer of ballast **161** which in turn rests on the sub-grade **162**. The advancing plow **150** slides along the sub-grade **162** raises the track in advance of itself and plows the ballast **161** out to the two sides of the track (as best appreciated from FIGURE 15). Rearwardly of the plow, the track settles back onto the sub-grade **162**.

If the apparatus were being used in conjunction with double track, there would be used a double track plow which deflects the ballast all to one side of the track; and for modified and improved constructions of such plows as well as single track plows reference may be had to my co-pending United States patent applications Serial Nos. 668,483 (Patent No. 2,924,897) and 749,740, now abandoned, filed June 27, 1957, and July 21, 1958, respectively.

As above indicated, the alignment apparatus of the present invention is equally appropriate for use with a sled device, for a description of which reference may be made to L. B. Franco U.S. Patent No. 2,769,172, issued Oct. 30, 1956, or to my co-pending United States patent applications Nos. 648,647 (Patent No. 2,961,972) and 647,523 (Patent No. 3,091,187, issued May 28, 1963), filed March 26, 1957, and March 21, 1957, respectively. Attention is also drawn to the combination plow and sled device described in my co-pending United States application Serial No. 746,451, filed July 3, 1958, now Patent No. 3,020,853, issued February 13, 1962.

To connect up the alignment apparatus with an under-track device, it is brought to a position with its front cart **21** on the track above the under-track device, in the manner shown in FIGURE 3 in connection with the plow **150**. The cylinder **43** is then operated by manual control cylinder **74** to move the piston rod **46** towards its extended position. This has the effect of lowering the tubular yoke **55** and its legs **64**, while retaining such legs in vertical disposition. The plates **65** and **66** at the foot of each leg **64** are then clamped over the respective towing ears **164** of the plow **150** and maintained in position thereon by a bolt and nut assembly **165**. Then, with the alignment apparatus securely hitched to the under-track device, the cylinder **43** is operated in the reverse direction to withdraw its piston rod **46** somewhat. This action has the effect of attempting to pull upwardly on the legs **64** and hence the plow **150**. The latter is not free to rise so that the effect of this pull is a downward thrust on the front cart **21** forcing its wheels **33** into firm engagement with the rails. The degree of this pressure of the front cart downwardly on the rails can be regulated at will by means of the operating cylinder **74**. Now, when the locomotive is moved to pull the under-track device **150**, the alignment apparatus will be drawn along the track with its front cart **21** immediately above the under-track device.

As appears from FIGURE 3, the wheels **132** to **135** of the liner head assembly **122** will now be resting on and engaging the inside faces of the heads of the two rails of the track. Any necessary adjustment to produce this effect is made at the rear cart **22** by the cylinder **93** operated by cylinder **96** effecting raising or lowering as desired

of the rear end of the boom 20. Further adjustment in this regard can also be obtained by moving the liner head 23 forwardly or rearwardly on the boom 20, or by hitching the rear cart to plate 103' of the boom 20. It will be noted from FIGURE 3 that the liner head wheels engage the track at a position where the ties 160 are still clear of the sub-grade 162 but that these ties soon engage the ground rearwardly of the liner head, being firmly positioned on the sub-grade at the point where the rear cart 22 rests on the track.

The manner of operation of the liner head is believed to be apparent from the foregoing description. It contacts and bears against the rails of the track at a point just before such track resettles onto the sub-grade (or ballast, as the case may be). If such track is in misalignment, by reason of displacement to one side or other of its proper position, it will be forced back by the wheels of the liner head. The liner head is normally held firmly against any transverse movement by the cylinder 124. It can only move transversely in response to command to this effect from the control cylinder 129, although it can swing and pivot in the other two directions mentioned, to accommodate curved and banked track. FIGURE 15 demonstrates in broken lines a section of misaligned track. Such track will be forced back by the lateral pressure of whichever pair of wheels of the liner head is called upon to move the track, in this case the wheels 133 and 135. In this manner the central section of the track on which the liner head is acting will be lined up with those sections of track on which the front and rear carts are standing. Thus, provided initially the apparatus commences its run on a properly aligned straight section of track, subsequent realignment will be automatic, except that, should the track ahead be badly misaligned, the operator may require to provide some compensation by lateral shift of the liner head assembly 122. This he will do either by aligning a suitable point on the liner head assembly 122 with fixed surveyors' stakes mounted at the side of the track, or visually by looking back along one of the rails. Normally, the section of track on which the rear cart rests will be properly aligned, having been subjected previously to the correcting effects of the liner head, while the section of track on which the front cart rests will not have yet had an opportunity of becoming misaligned as a result of the plowing or sledding operation.

However, apart from any misalignment that the plowing or sledding operation itself may tend to produce, there may also be some misalignment of the track induced through periods of service without maintenance, and in this respect some skill on the part of the operator will be necessary to ensure that any misalignment of the track first encountered by the front cart is not transmitted to the track more rearwardly thereof.

The operator has two means for effecting transverse adjustment available to him. Firstly there is the handle 63 which enables transverse adjustment of the yoke 55 and hence the under-track device in relation to the sleeves 54 and hence the front cart 21. This adjustment is in the nature of a coarse initial adjustment that normally will not require changing as plowing or sledding proceeds on tangent track. In the main, the operator will rely upon the second adjustment available to him, namely that of the transverse position of the liner head assembly 122 by means of the control cylinder 129, for those adjustments needed as the operation proceeds. These latter adjustments will be of two types, those necessary to move the liner head assembly 122 to a new theoretically correct position, as determined by the desired shape of the track, and those required in addition to the first type to compensate for any errors in the track alignment encountered by the front cart. Normally the latter will be comparatively small in amount and the operator's principal task will be to ensure that the liner head assembly 122 is set in the right position having regard to the shape of the track. When operating on tangent track, the liner head assembly will theoretically be set in its central position (that is as shown in FIGURE 10). When the apparatus commences to move into an easement and finally into a section of circularly curved track, the operator will find it necessary to offset the liner head assembly 122 in a direction towards the outside of the curve encountered. The degree of this offsetting can either be determined by eye by an experienced operator, or can be calculated from the track engineer's drawings and provided in the form of a chart for the operator to follow.

It will be apparent that the pivotal manner of mounting the liner head assembly 122 on the boom 20, combined with the comparatively short length of the assembly 122 in the direction of extent of the track in comparison with the spacing between the front and rear carts 21 and 22, results in the shifting forces exerted by whichever two of the four wheels 132 to 135 of the liner head assembly that are acting on the track being pure transverse forces that have no tendency to inhibit flexing of the track or to prevent it taking up any desired curvature about a vertical axis.

When the apparatus is running on a curve (FIGURE 16) the towing bar 152 is adjusted so that the under-track device is always being pulled in a direction which is tangential to the curve. Any necessary twisting of the front cart 21 in relation to the yoke 55 is taken care of by the freedom of pivoting between discs 35 and 36. The boom tends to cut the corner, but this effect is offset by displacement of the liner head assembly 122 in the outward direction of the curve. This offsetting is necessary not only to follow the correct curve of the track but also to prevent any tendency for the track to settle inwardly because of the "elevation" (banking of the track) which will be present on a curve.

An advantage of the use of on-track alignment apparatus of the character herein described in combination with an under-track device is that the weight of the alignment apparatus acting down on the elevated portion of the track normally improves the operation of the under-track device. The blades of a plow will cut deeper and more uniformly, while the leveling wings of a sled will smooth the ballast more evenly and more certainly.

FIGURES 17 to 19 disclose modified forms of front and rear carts that may be employed when the alignment apparatus is used alone without being coupled to an under-track device.

FIGURES 17 and 18 show a modified front cart 221 having a framework 30, axles 31 and 32 and flanged wheels 33 similar to those parts of the cart 21. A fixed disc 200 is secured to cross members 34 and serves to mount a fixed framework 201 that provides a pair of elevated plates 202 which together with a pivot pin 203 provide a vertical pivotal connection between the front cart 221 and the plate 72 on the boom 20. It will be noted that the front cart 221 differs from the front cart 21 in that the pivotal axis of its connection to the boom 20 is arranged directly vertically over the centre of the cart. This arrangement is adopted because the motive power for the modified liner apparatus is preferably provided at the rear cart so that the front cart 221 will be propelled forward by a thrusting action of the boom 20. If the boom 20 were connected to the cart 221 rearwardly of the cart's centre point, a slewing action would result. Similarly, by mounting the pivotal connection between the boom and the cart directly over the centre of the cart, the need for the pair of relatively pivotable discs 35 and 36 is avoided. This fixed position of the pivotal axis is permissible because of the omission of the vertically movable framework and yoke of cart 22.

The modified rear cart 222 is shown in FIGURE 19 and is identical to the rear cart 22 except that wheels 283 are larger than the wheels 33 because the front pair of these wheels 283 is powered by a hydraulic motor 204 connected by flexible piping 205 and 206 to a suitable prime mover, for example a gasoline engine operating a hydrau-

lic pump. This combination of prime mover and hydraulic pump is shown diagrammatically at **206** mounted on the boom **20**.

FIGURES 17 to 19 thus disclose modified forms of front and rear carts for combining with a boom **20** and a liner head **23** similar to those shown in the other drawings. The alignment apparatus so formed is capable of self propulsion along the track without connection to an under-track device. Even though the track may be bedded in ballast, the liner head assembly **122** is able to shift the track laterally, as necessary to correct or improve misalignment, provided such misalignment is not too great.

Although the principal use for the alignment apparatus of the present invention can be expected to be in conjunction with an under-track device of the ballast plow or ballast sled type, the on-track apparatus is also inherently capable of independent operation for improving the alignment of misaligned track. Assuming, as will normally be the case in practice, that the unelevated track encountered by the apparatus of FIGURES 17 to 19, when used without an under-track device, is such as to lie on the roadbed with at least the ends of the ties thereof embedded at least partially in ballast, the mode of operation which avoids elevation of the track has an advantage over prior methods in which the track has been elevated for shifting but without any means of smoothing the roadbed, in that the forcing of the track transversely while it remains substantially embedded in ballast (the present method) causes the ballast lying adjacent and beyond the ends of the ties on that side towards which the track is shifted, to be moved transversely by and with the tie ends. As a result these ties continue to lie on a smooth roadbed. If the track is elevated without provision being made for smoothing out the uneven ballast bed which remains, as some prior art proposals have suggested, when the track is shifted laterally to a new position there is a substantial risk that the ties will be lowered into their new position with uneven support, because the ballast previously banked up beyond the ends of the ties will not be shifted and will lie under the ends of the ties when these are relowered into a new position. Thus, according to the present invention, the track is either shifted without elevation, or with elevation and smoothing of the roadbed before relowering. By either method the ties continue to lie on a level support.

The modifications illustrated in FIGURES 20 to 25 show forms of apparatus which differ from the apparatus of FIGURES 1 to 19 in that two or more carts are connected to a common under-track device.

FIGURES 20 and 21 show the simplest form of such an arrangement with carts **301** and **302** each carrying a yoke **303** by which such cart is connected to a respective end of an under-track device **304**. Cylinders **305** provide for vertical adjustment of the yokes relative to the carts; and screw rods inside the yokes operated by cranks **306** provide for longitudinal adjustment of each yoke relative to its cart, that is adjustment in the transverse direction of the track **307** (subsequently referred to a transverse adjustment). It will be apparent that, as the device **304** is towed along the track by cables **308** (or alternatively, the method is equally applicable to a self-propelled under-track device), a measure of track alignment can be obtained by control of the transverse adjustments of the individual yokes. This apparatus does not have the fine control over the track alignment that the apparatus of FIGURES 1 to 19 can exercise, but it can be used to shift portions of the track laterally, or alternatively, it can be used to steer the under-track device.

FIGURE 22 shows three carts **309**, **310** and **311** coupled through respective yokes **312**, **313** and **314** to a common under-track device **315**. Similar provision is made, as before, for vertical and transverse adjustment of each yoke relative to its cart. This three-cart arrangement is more adapted to the correction of small kinks in the track alignment than is the two-cart arrangement of FIGURES 20 and 21, because the center yoke **313** can be moved towards one side of the track relative to the front and rear yokes, thus exerting a lateral force on the center cart **310** and hence the section of track between the extreme carts **309** and **311**.

Since the three carts **309**, **310** and **311** are all connected to the same under-track device, no interconnecting boom is theoretically necessary. FIGURE 22 shows this condition. If found advantageous, however, booms **316** and **317** may be provided, as shown in FIGURE 23, further to ensure the desired spacing between carts. These booms will be pivotally connected to the carts, with slotted connection at the centre cart, to provide the necessary freedom of movement to permit the full range of transverse adjustment of the yokes and to enable the apparatus to travel along a curved portion of track.

FIGURES 24 and 25 demonstrate a modified construction in which a cart of the type already described can be connected to an under-track device in a manner enabling the cart to be removed from the track by means of the under-track device. FIGURE 24 shows a cart **320** connected by a yoke **321** to an under-track device **322**. The yoke **321** is extended at one end beyond a pivotal connection at **323** to a post **324** which can turn about a vertical axis on an extended ear **325** of the under-track device **322**. The extended end of the yoke **321** is connected to the piston of a double acting hydraulic cylinder **326** which is mounted on a small platform **327** that turns with the post **324**. Withdrawal of the piston elevates the yoke and cart to the broken line position of FIGURE 24, the connection of the other end of the yoke at **328** having previously been uncoupled. As soon as the wheels of the cart are clear of the track, the whole assembly can be turned with the post **324**, to a position such as that shown in FIGURE 25, thus freeing the track for the passage of other similar carts or other on-track vehicles than can safely be passed along track under which an under-track device is positioned. The cart **320** may subsequently be returned to the track by a reversal of the operation just described, or may be lowered to the ground beside the track and disconnected from the under-track device altogether by removal of wedges **329**. Alternatively, if hoisted up rather higher than illustrated in FIGURE 24, the cart **320** may be swung onto a flatcar that has, in the meantime, been moved into adjacent position on the track.

This application is a continuation-in-part of application Serial No. 777,389, filed December 1, 1958, now abandoned.

I claim:

1. In the art of performing a ballasting operation on a section of railroad track by moving along the roadbed an under-track ballast handling device of the type constructed to pass beneath the ties while resting on said roadbed and to yield a levelled roadbed extending beyond the ends of the ties, said device elevating a span of said track with a forward portion of said elevated span immediately in advance of said device sloping upwardly thereto from the unworked roadbed and a rearward portion of said elevated span immediately in the rear of said device sloping downwardly away therefrom towards the levelled roadbed, the improvement which comprises the steps of:

(1) positioning track alignment apparatus on the track above and rearwardly of said under-track device, said apparatus comprising a rigid elongated boom, a front cart pivotally connected to said boom, a rear cart pivotally connected to a part of said boom remote from said first cart, said carts having rail engaging wheels for supporting said apparatus on the track rails for travel therealong, and a liner head assembly mounted on said boom intermediate said front and rear carts for movement relative to said boom transversely of the longitudinal extent thereof, said assembly including rail engaging means po-

sitioned to bear against a vertical surface of each rail to exert a transverse, track aligning force thereon,

(ii) so coupling said track alignment apparatus to said under-track device for travel therewith that said front cart is positioned on said elevated span generally above said under-track device, said rear cart is positioned on an unelevated portion of said track lying rearwardly of said rearward elevated span portion, and said liner head assembly is positioned to engage the rails of said track at a position in said rearward elevated span portion, and

(iii) controlling the transverse position of said liner head assembly relative to said boom whereby to exert transverse aligning forces on said rearward elevated span portion to align the same with said unelevated portion of the track as said elevated span portion is lowered into position resting on said levelled roadbed.

2. In the art of performing a ballasting operation on a section of railroad track by moving along the roadbed an under-track ballast handling device of the type constructed to pass beneath the ties while resting on said roadbed and to yield a levelled roadbed extending beyond the ends of the ties, said device elevating a span of said track with a forward portion of said elevated span immediately in advance of said device sloping upwardly thereto from the unworked roadbed and a rearward portion of said elevated span immediately in the rear of said device sloping downwardly away therefrom towards the levelled roadbed, the improvement which comprises the steps of:

(i) causing first track engaging means to travel synchronously with said under-track device and in engagement with said elevated span of track,

(ii) causing second track engaging means to travel synchronously with said under-track device and in engagement with an unelevated portion of said track lying rearwardly of said rearward elevated span portion,

(iii) causing third track engaging means to travel synchronously with said under-track device between said first and second track engaging means and in engagement with said rearward elevated span portion of the track, and

(iv) exerting a transverse force on said third track engaging means relative to said first and second track engaging means whereby to align said rearward elevated span portion of the track with said unelevated portion of the track as said elevated span portion is lowered into position resting on said levelled roadbed.

3. In the art of performing a ballasting operation on a section of railroad track by moving along the roadbed an under-track ballast handling device of the type constructed to pass beneath the ties and support an elevated span of track while resting on said roadbed and to yield a levelled roadbed extending beyond the ends of the ties, the improvement which comprises the steps of:

(i) coupling at least two track engaging means to said under-track device to travel synchronously therewith spaced apart longitudinally of the track, said two track engaging means being movable transversely of the direction of travel independently of each other, and

(ii) exerting a transverse force on a said track engaging means relative to said under-track device and hence relative to the other track engaging means coupled to said under-track device, whereby to modify the relative transverse positions of said two track engaging means to change the track alignment.

4. In the art of performing a ballasting operation on a section of railroad track by moving along the roadbed an under-track ballast handling device of the type constructed to pass beneath the ties and support an elevated span of track while resting on said roadbed and to yield a levelled roadbed extending beyond the ends of the ties, the improvement which comprises the steps of:

(i) coupling three track engaging means to said under-track device to travel synchronously therewith spaced apart longitudinally of the track, the centrally positioned one of said three track engaging means being movable transversely of the direction of travel independently of the other of said track engaging means, and

(ii) exerting a transverse force on the centrally-positioned of said track engaging means relative to said under-track device and hence relative to the other track engaging means coupled to said under-track device, whereby to modify the transverse position of said centrally positioned track engaging means relative to that of the other said track engaging means to change the track alignment.

5. A method of improving the alignment of a wholly unelevated section of railroad track while maintaining the ties thereof embedded in ballast comprising the steps of:

(i) moving along said section of track apparatus comprising a rigid elongated boom, a front cart pivotally connected to said boom, a rear cart pivotally connected to a part of said boom remote from said first cart, said carts having rail engaging wheels for supporting said apparatus on the track rails for travel therealong, and a liner head assembly mounted on said boom intermediate said front and rear carts for movement relative to said boom transversely of the longitudinal extent thereof, said assembly including rail engaging means positioned to bear against a vertical surface of each rail,

(ii) causing said rail engaging means to bear against said rails,

(iii) controlling the transverse position of said liner head assembly relative to said boom to exert transverse aligning forces on the portion of said track lying between said front and rear carts thereby shifting said track portion laterally into alignment with adjacent portions of said track, and

(iv) effecting said shifting as said track portion rests on the roadbed and concurrently therewith moving transversely by and with the ties of said track portion ballast lying adjacent and beyond the ends of said ties in the direction of shifting whereby said track continues to lie on a smooth roadbed, said aligning forces being transmitted to said shifted track portion as pure transverse forces acting on said last-mentioned track portion in such manner as to leave the same free to flex and take up a curvature about a vertical axis.

6. A method of improving the alignment of a wholly unelevated section of railroad track while maintaining the ties thereof embedded in ballast comprising the steps of:

(i) causing first, second and third track engaging means to travel synchronously with each other in dispositions spaced out along said track with the second said track engaging means intermediate the first and third said track engaging means,

(ii) engaging a vertical surface of at least one rail of said track with said second means,

(iii) while maintaining the track lying on the roadbed with at least the ends of the ties thereof substantially embedded at least partially in ballast, exerting a transverse force on said second track engaging means relative to said first and third track engaging means to transmit a lateral shifting force to the portion of said track lying between said first and third track engaging means, thereby shifting said track portion laterally into alignment with adjacent portions of said track, and

(iv) effecting such shifting as the said shifted track portion rests on the roadbed and ballast lying ad-

jacent and beyond those ends of the ties towards which the said track portion is shifted is moved transversely by and with the ties of the track so that the track continues to lie on a smooth roadbed, said shifting force being transmitted to said shifted track portion as a pure transverse force acting on said last-mentioned track portion in such manner as to leave the same free to flex and take up a curvature about a vertical axis.

7. Railroad track alignment apparatus comprising a rigid elongated boom, a first cart pivotally connected to said boom, a second cart pivotally connected to a part of said boom remote from said first cart, said carts each having rail engaging wheels arranged to support said carts on the rails of a railroad track for travel therealong with said boom extending in an elevated position along a section of said track, a liner head assembly mounted on said boom intermediate said first and second carts for movement relative to said boom transversely thereof, said assembly being short in the direction of extent of the track in comparison with the spacing between said carts, and control means for adjusting and maintaining the relative transverse position of said assembly and boom, said assembly including rail engaging means positioned to rest against the upper horizontal surface of each rail and to bear against a vertical surface of each rail to exert a track aligning force thereon, wherein said first cart includes means for coupling said cart to an under-track device, said coupling means comprising transversely extending yoke means projecting outwardly to each side of the track beyond the ends of the ties and terminating in downwardly projecting legs having means for connecting the lower ends thereof to sidewardly projecting fixed portions of said under-track device.

8. Apparatus as claimed in claim 7, wherein said liner head assembly comprises a framework, at least four wheels freely pivotally mounted on said framework and so constructed and arranged that two of said wheels are in position for engagement with a vertical surface of one said rail, while the other two said wheels are in position for engagement with a vertical surface of the other said rail, said vertical surfaces being oppositely directed.

9. Apparatus as claimed in claim 8, including means mounting said liner head assembly on said boom for freedom of relative pivoting about a vertical axis extending substantially through the centre of said framework.

10. Apparatus as claimed in claim 8, including means mounting said liner head assembly on said boom for freedom of pivoting movement about a horizontal axis extending transversely of said boom.

11. Apparatus as claimed in claim 7, including means connecting said first cart to said yoke means for adjustable movement of said first cart and the portion of railroad track engaged thereby in the transverse direction of the track relative to said yoke means and hence relative to an under-track device secured to said yoke means.

12. Apparatus comprising the combination of an on-track railroad vehicle having rail-engaging wheels, an under-track device adapted to be moved along between the roadbed and the ties while elevating a span of track and supporting the weight thereof, means rigidly interconnecting said vehicle and said under-track device for travel together along the track with said wheels of the vehicle engaging the elevated span of track, and means for adjusting the position of said vehicle relative to said under-track device in the transverse direction of the track.

13. In combination, a section of railroad track, two carts each having rail engaging wheels mounting said carts on said track section, an under-track device positioned beneath said track section to elevate a span of track and support the weight thereof, means projecting outwardly of the track beyond the ends of the ties and coupling said carts to said under-track device with said carts spaced apart longitudinally of the track and said wheels of both the carts engaging the elevated span of track, and means on said coupling means including means for adjustable movement of at least one of said carts in the transverse direction of the track relative to said under-track device.

14. In combination, a section of railroad track, three carts each having rail engaging wheels mounting said carts on said track section, an under-track device positioned beneath said track section to elevate a span of track and support the weight thereof, means projecting outwardly of the track beyond the ends of the ties and coupling said carts to said under-track device with said carts mutually spaced apart longitudinally of the track and said wheels of all said carts engaging the elevated span of track, means for adjustably moving the centrally positioned cart in the transverse direction of the track relative to the under-track device and hence relative to the other carts.

15. Apparatus comprising the combination of an on-track railroad vehicle having rail-engaging wheels, an under-track device adapted to be moved along between the roadbed and the ties while supporting the weight of a span of track and said on-track vehicle, and means interconnecting said vehicle and said under-track device for travel together along the track, said interconnecting means including means mounted on said under-track device for lifting said vehicle from engagement with said track and supporting said vehicle in a position withdrawn from said track.

16. Apparatus comprising an under-track device constructed to be moved along between the roadbed and the ties of a railroad track while supporting the weight of an elevated span of track, said device including means for interconnecting said device with an on-track railroad vehicle having rail-engaging wheels for travel with said device along the track, said interconnecting means including means mounted on said under-track device for lifting said vehicle from engagement with said track and for supporting said vehicle in a position withdrawn from said track.

References Cited in the file of this patent

UNITED STATES PATENTS

748,503	Holbrook	Dec. 29, 1903
1,100,006	Arbenz et al.	June 16, 1914
1,325,356	Dobson	Dec. 16, 1919
1,929,617	Walbridge	Oct. 10, 1933
2,575,390	McFadden	Nov. 20, 1951
2,861,521	Vito et al.	Nov. 25, 1958

FOREIGN PATENTS

748,676	France	Apr. 25, 1933
311,016	Germany	Feb. 21, 1919
328,155	Germany	Oct. 23, 1920
571,297	Germany	Apr. 7, 1933
576,282	Germany	May 12, 1933
622,014	Germany	Nov. 18, 1935
162,617	Australia	Apr. 28, 1955
1,614	Great Britain	Jan. 21, 1914
243,244	Great Britain	Nov. 26, 1925