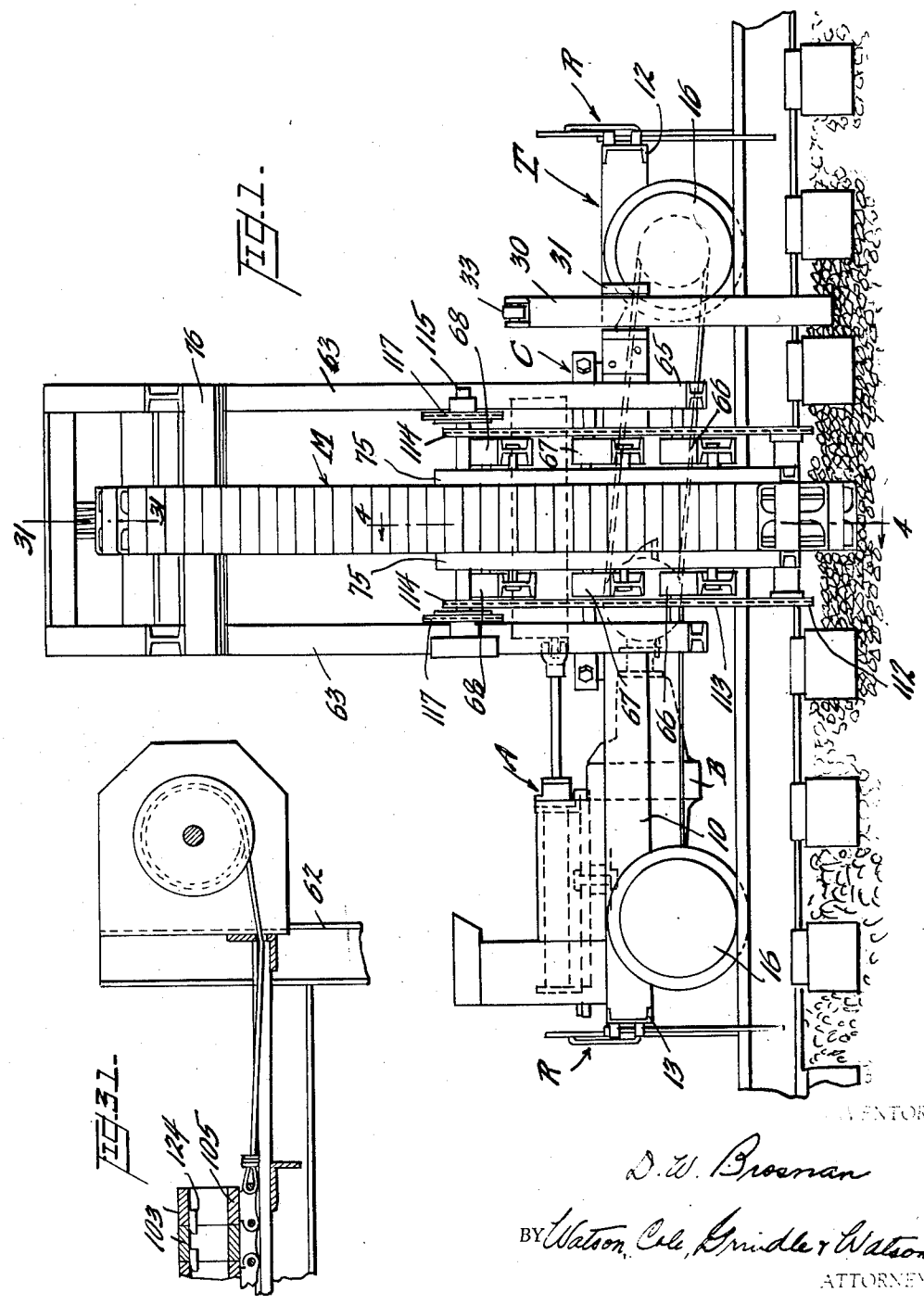
March 26, 1957 D. W. BROSNAN 2,786,426

TIE REPLACING MACHINE

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TIE REPLACING MACHINE

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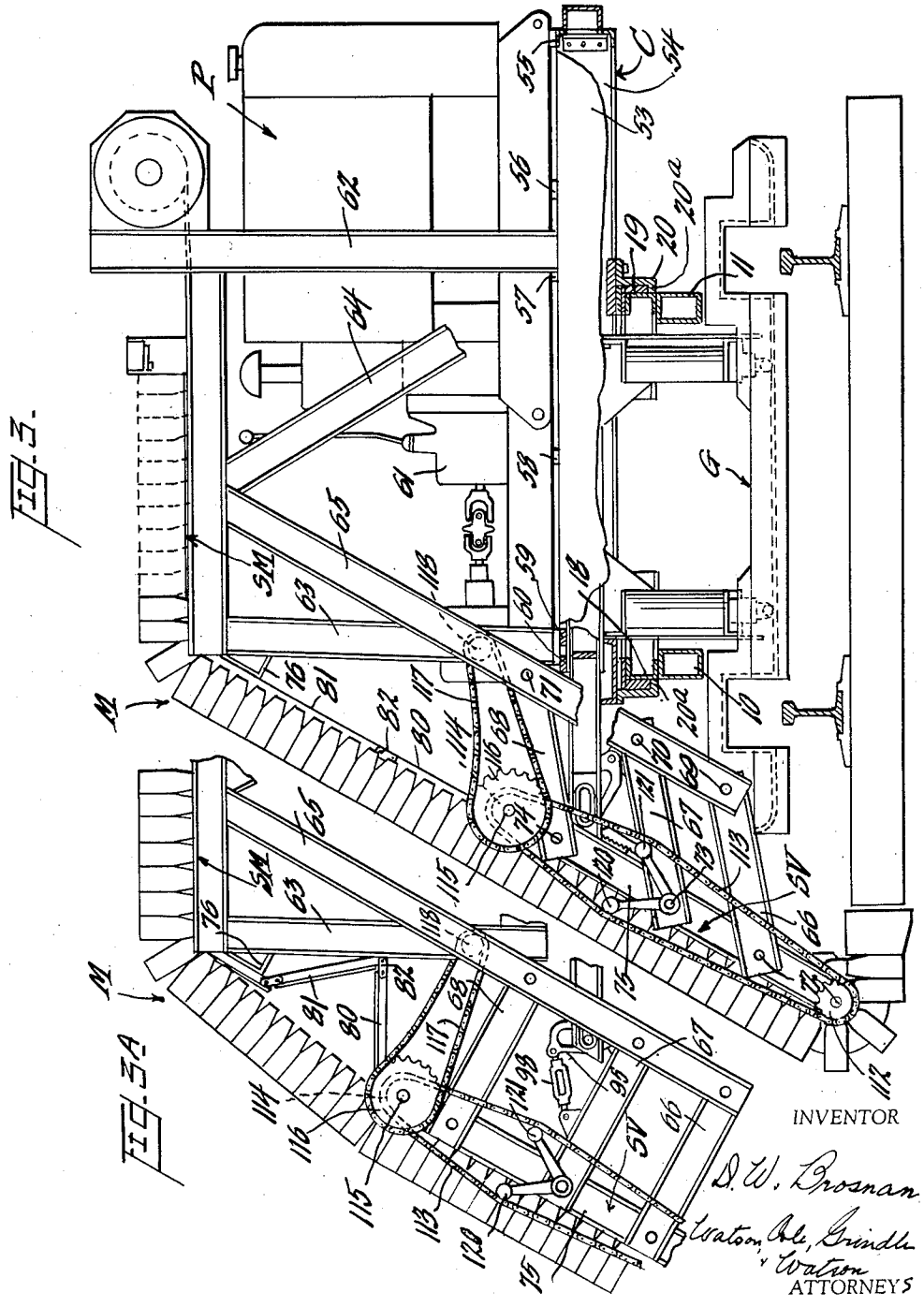


FIG. 3.

FIG. 3A

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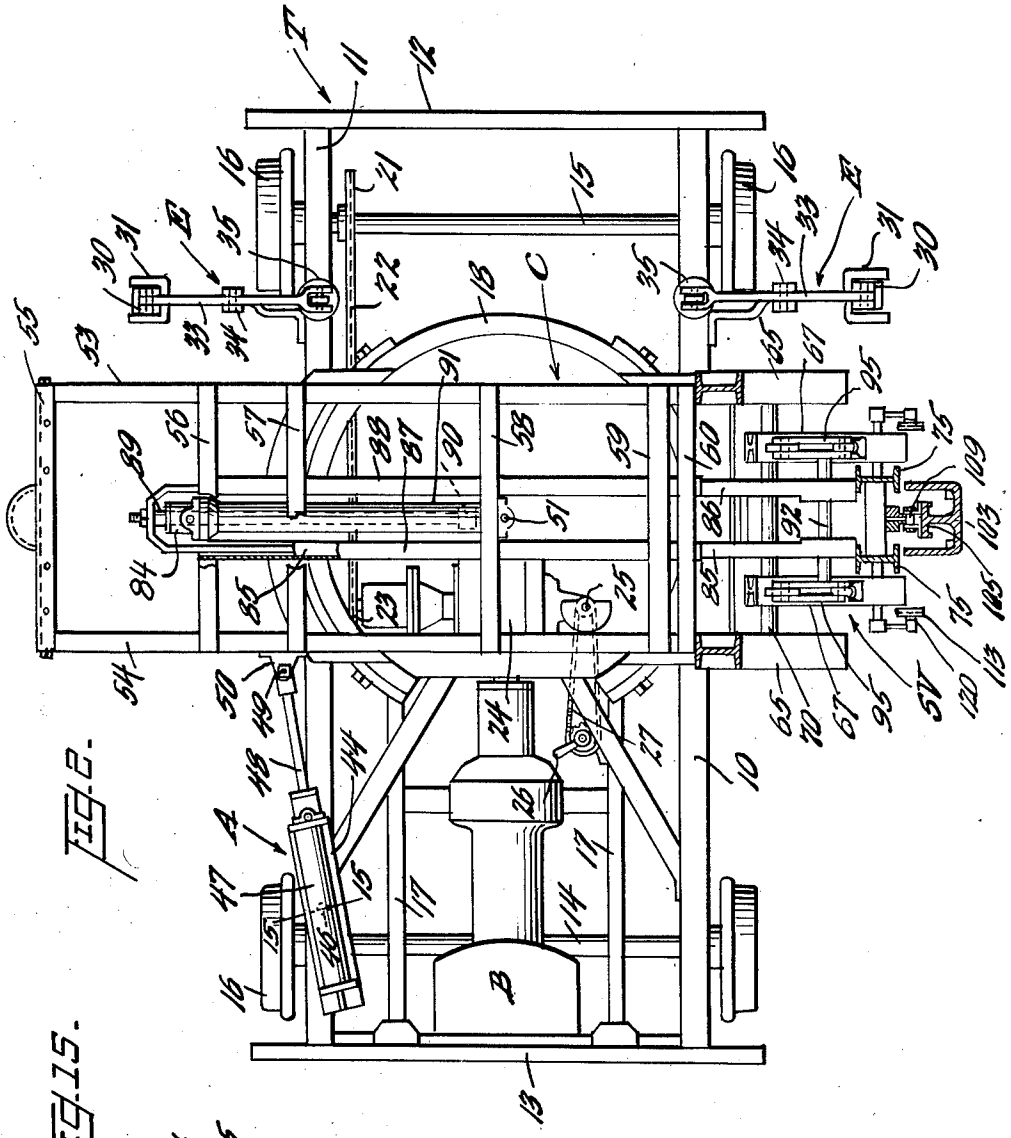


FIG. 2.

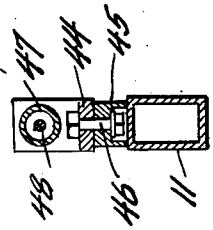


FIG. 15.

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TIE REPLACING MACHINE

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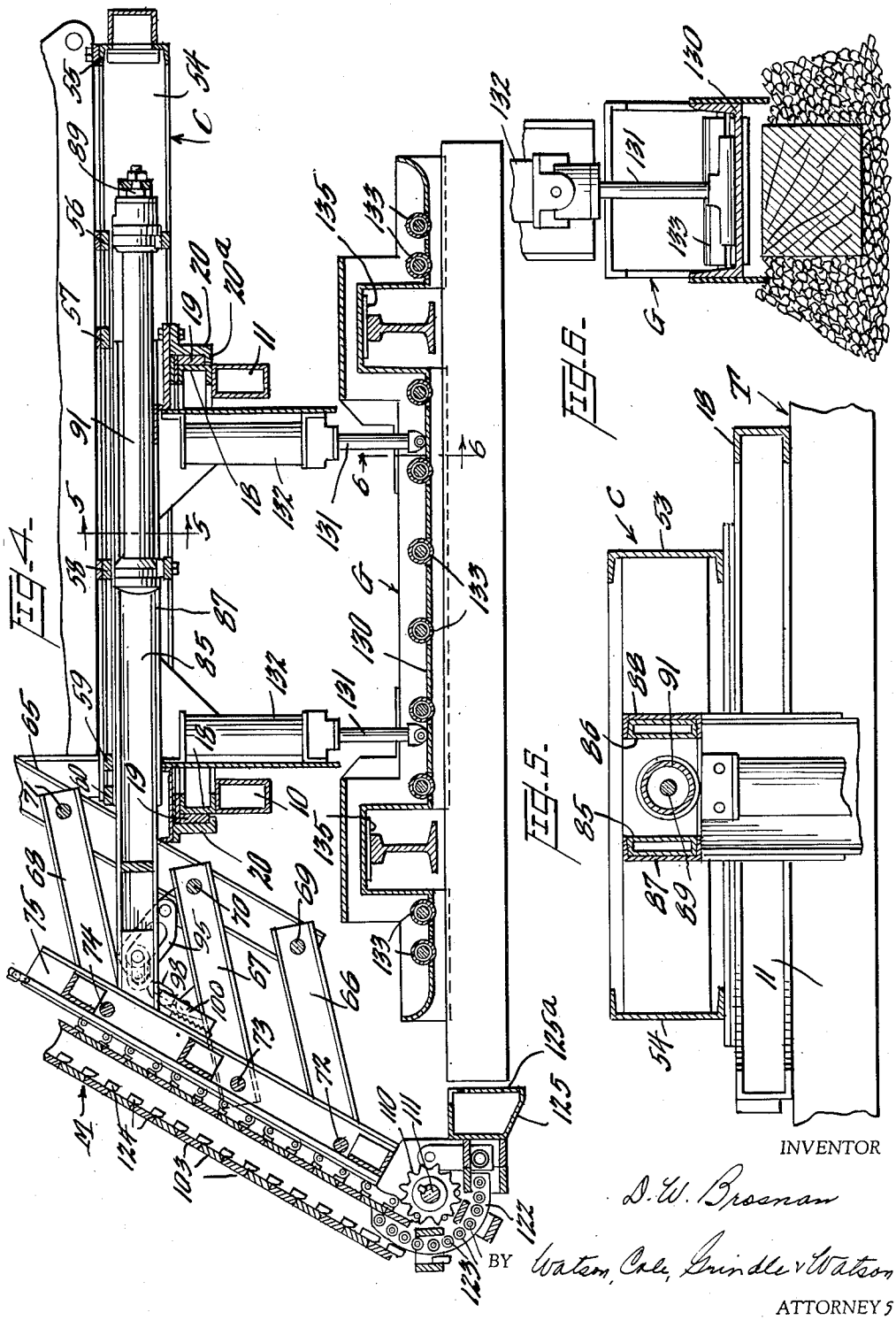


FIG. 4.

FIG. 5.

FIG. 6.

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TIE REPLACING MACHINE

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FIG. 9.

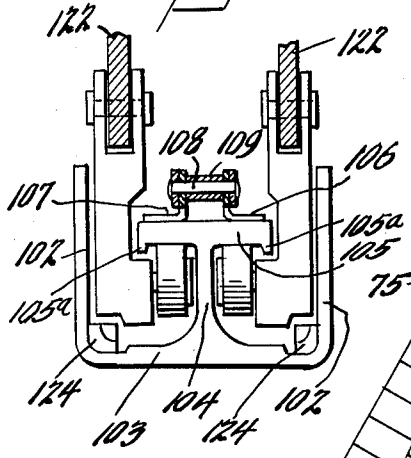


FIG. 7.

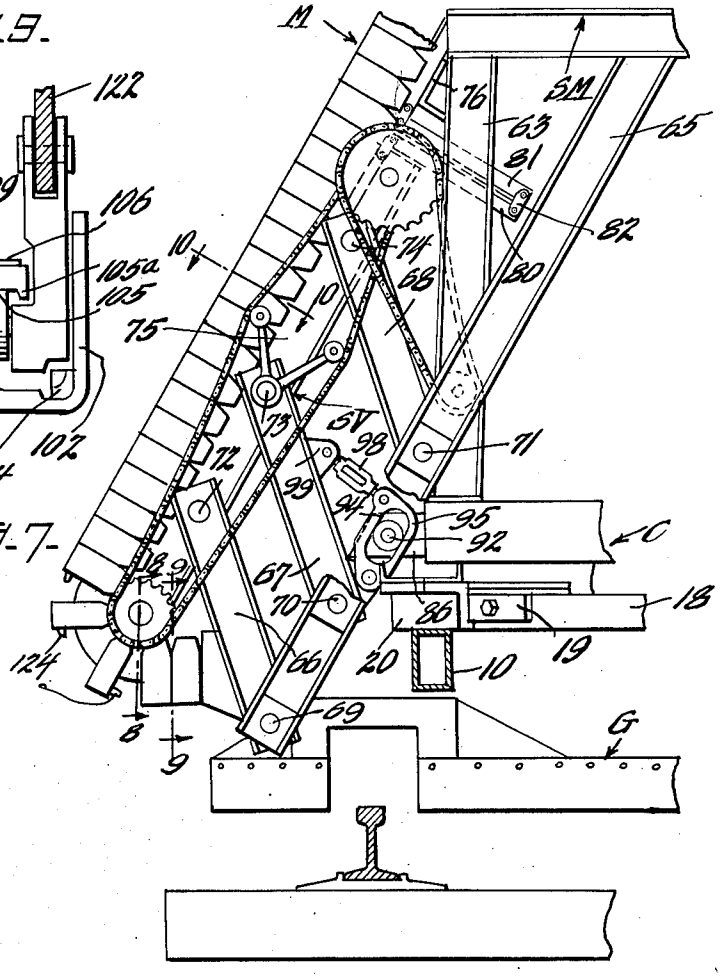
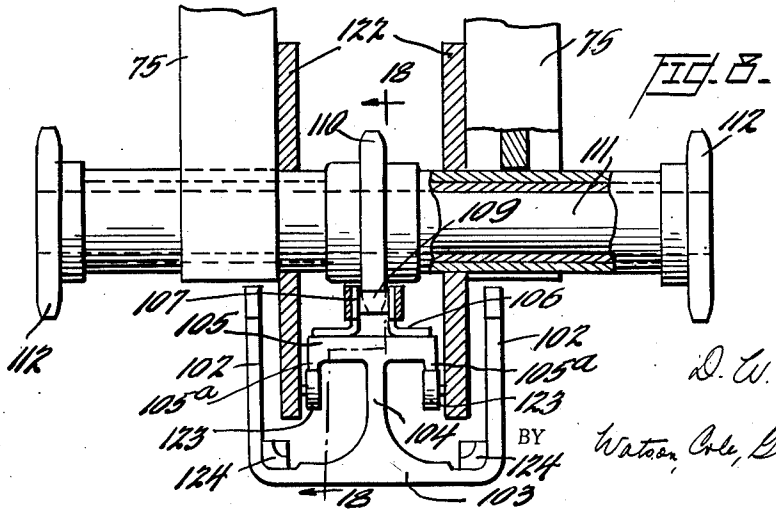


FIG. 8.



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TIE REPLACING MACHINE

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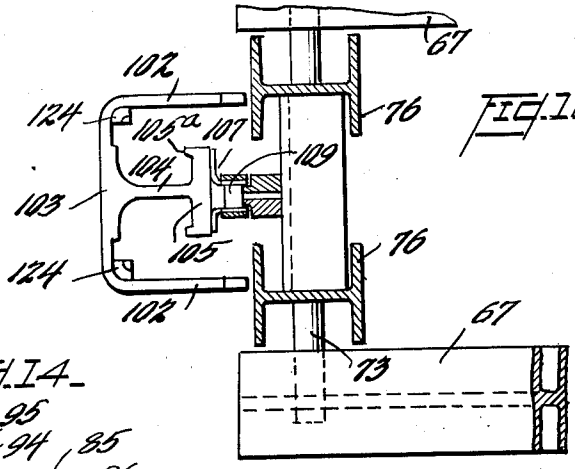


FIG. 10.

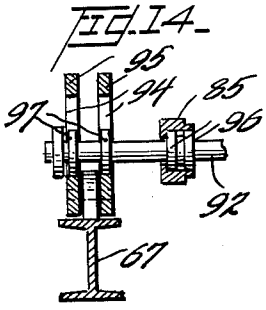


FIG. 14.

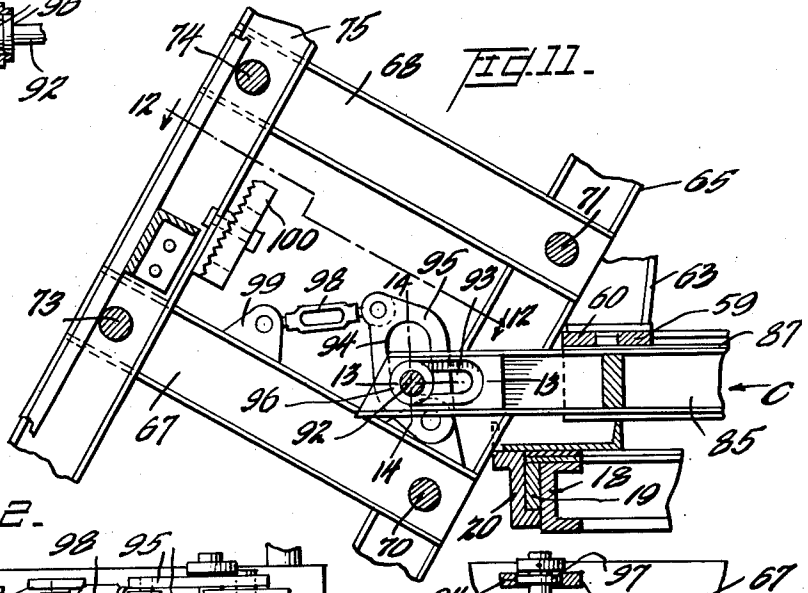


FIG. 11.

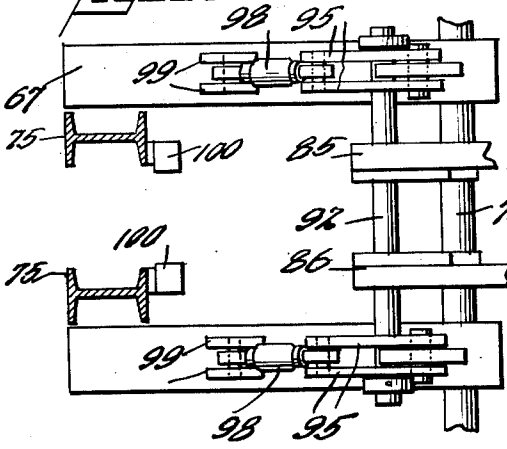


FIG. 12.

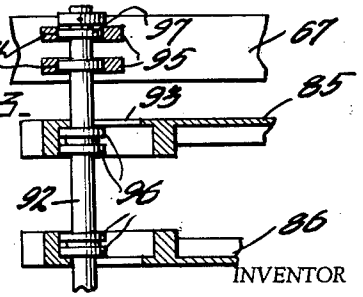


FIG. 13.

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TIE REPLACING MACHINE

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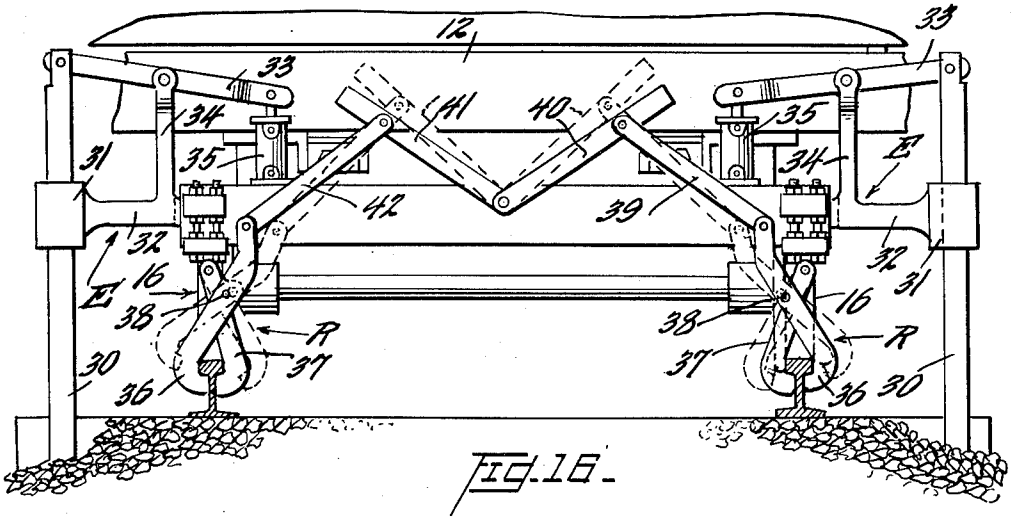


FIG. 16.

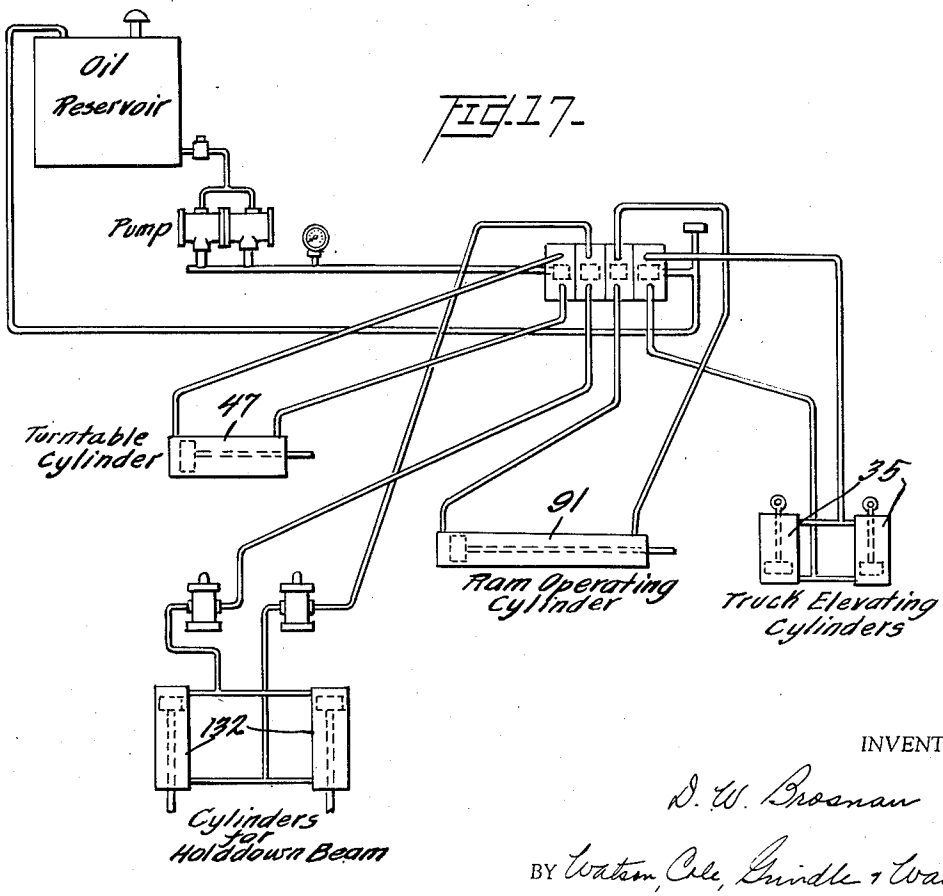


FIG. 17.

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TIE REPLACING MACHINE

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FIG. 18.

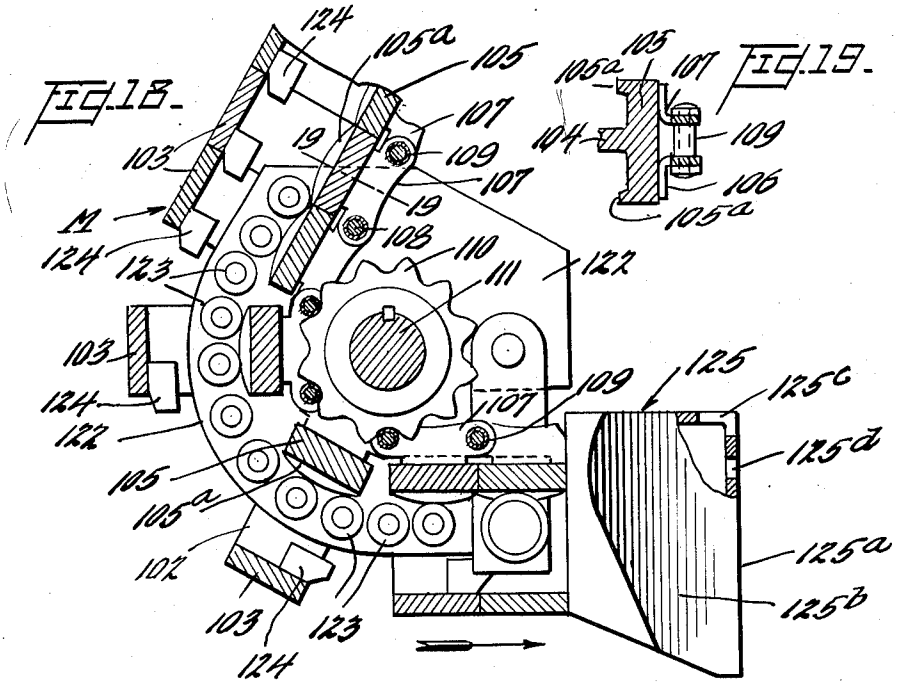


FIG. 19.

FIG. 20.

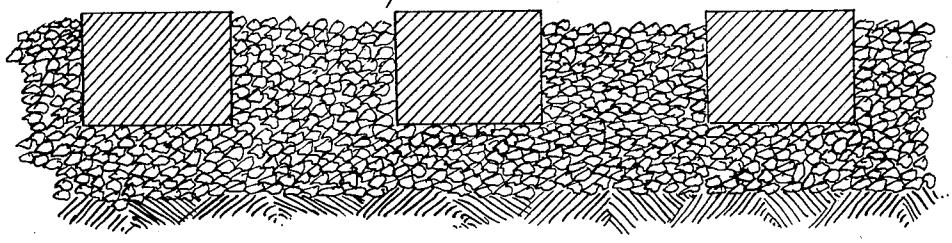
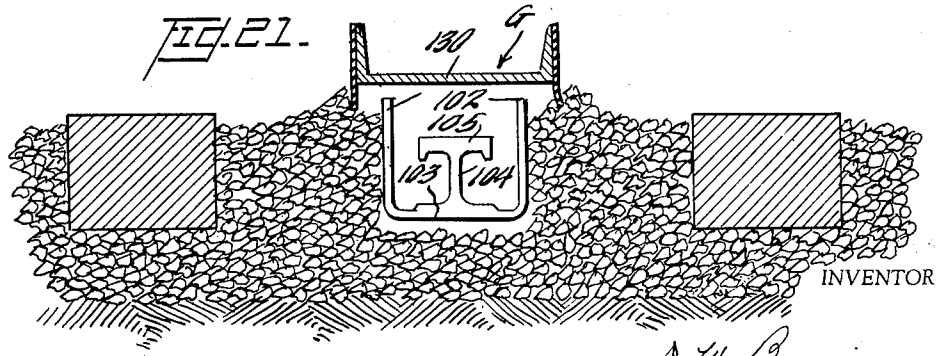


FIG. 21.



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FIG. 22.

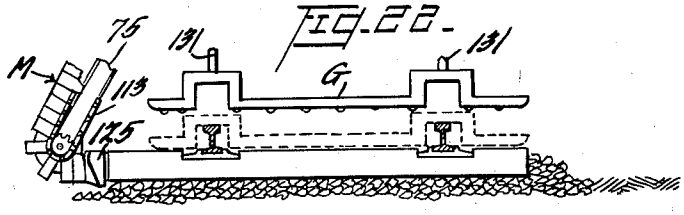


FIG. 29.

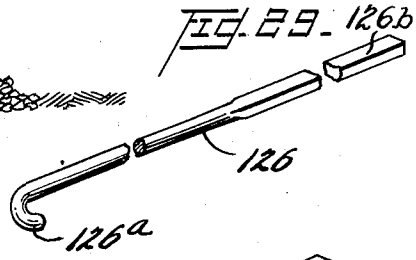


FIG. 23.

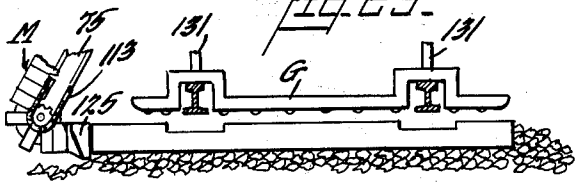


FIG. 30.

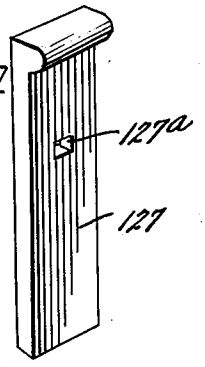


FIG. 24.

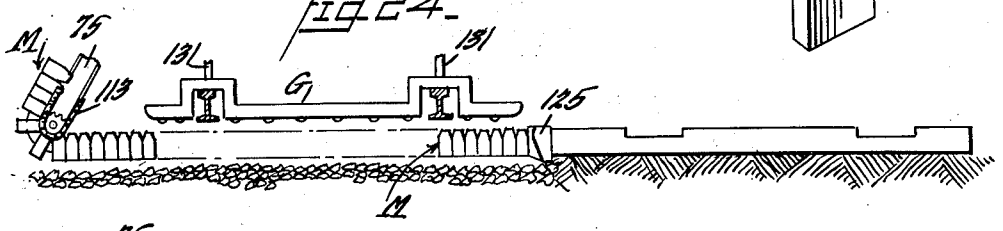


FIG. 25.

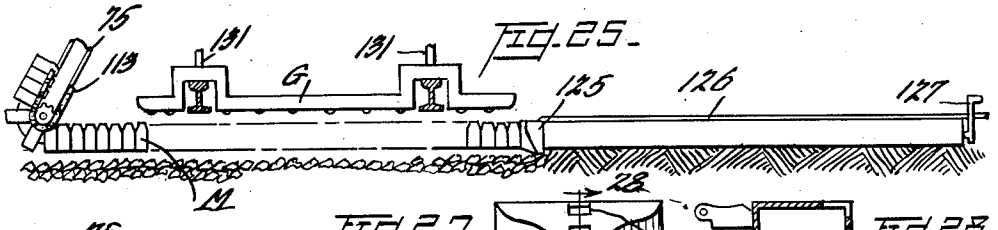


FIG. 27.

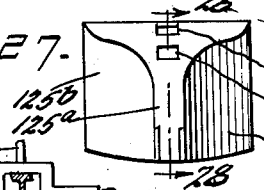


FIG. 28.

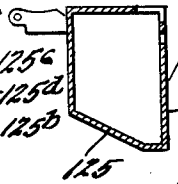


FIG. 26.

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United States Patent Office 2,786,426 Patented Mar. 26, 1957

2,786,426

TIE REPLACING MACHINE

Dennis William Brosnan, Washington, D. C.

Application January 28, 1953, Serial No. 333,668

20 Claims. (Cl. 104—9)

The present invention relates to a method of and machine for repairing railroad track structures, particularly to a method of and machine for withdrawing from a railroad track structure a defective or worn cross tie and inserting in its place a new or more perfect tie.

The railroad trackway structure now currently in common use almost without exception comprises, in addition to the graded roadbed, a shallow layer of pervious material, a substantial quantity of ballast superposed upon this material and which is generally in the form of broken or crushed rock, transversely disposed wooden ties, rather closely spaced, steel rails in parallel, and fastening means by which the rails are attached to the ties over which they pass. In constructing a railroad track structure new ties are employed, these being preferably subjected to a preservative treatment calculated to prolong their lives. Theoretically all of these ties will need replacement after a certain period of time has elapsed but, as is well known to those engaged in track maintenance, the several wooden ties will, for a number of reasons, have varying lengths of useful life, certain of them failing sooner than expected and others maintaining their structural integrity for much longer periods of time than originally thought possible. Hence it is necessary, in maintaining a railroad track structure in condition to function satisfactorily, to replace an individual tie wherever there may be a tie failure, at odd intervals along the trackway. Heretofore this operation has been a purely hand or manually performed operation, the conventional railroad track gang with the aid of manually operated tools, unloosening and removing the fastenings by means of which the rail is secured to the defective tie and forcing the tie longitudinally from its seat in the ballast, an operation which, when accomplished with manually operated tools, requires much manual effort and the expenditure of a considerable amount of time by a substantial group of workers.

It has been suggested that the labor of removing an individual tie from a railroad roadbed may be reduced with the aid of power driven instrumentalities of various kinds and to some extent such instrumentalities have been placed in operation. The devices of this character which have been provided heretofore have, however, been of such character as to effect no very substantial saving in labor costs and, for the most part, have been destructive to the tie removed. In many instances it is not desirable to destroy the tie being removed inasmuch as it may be usefully employed for a further period of time if not further damaged by the act of removal. In any event, for one reason or another, the various mechanical aids which have heretofore been proposed for the accomplishment of the tie removal and replacement operations have not met with popular favor and the cost of making repairs of this character has constantly remained high and the time of replacement lengthy.

The present invention has for its object the provision of a method and machine for the removal of defective

railway ties from railroad track constructions wholly by mechanically applied power and a further objective is to provide a method and apparatus which not only can effect the rapid removal of a defective tie in minimum time and at lowest possible cost but the immediate replacement of that tie with another, the act of replacement being a sequel to the act of removal and accomplished without adding appreciably to the time or cost of effecting tie removal alone.

In order that the apparatus provided may be most conveniently brought into position to act upon a defective tie it is mounted upon a wheeled truck which may be moved from point to point along a trackway and precisely positioned in desired relationship to any tie to be removed. A primary consideration from the standpoint of railroad operation is that the apparatus to be so employed shall be operable to remove a defective tie from one trackway of a double tracked roadbed without interrupting or endangering the flow of traffic over the second or parallel track.

An important member or part of the machine consists in a novel work engaging member which is adapted to engage the end of a railroad tie, exert thrust as a column axially of the tie to effect its displacement, such member being likewise flexible so that it may be deflected upwardly to a storage space above the body of the truck, caused to move longitudinally downwardly when called into action until its leading end reaches a point opposite the end of the tie to be removed, and then advanced transversely of the roadbed and axially of the tie, pushing the tie before it, the active reach of the work member, which is that portion intermediate the tie and the power applying means, being disposed rectilinearly and acting as a column. The columnar action of the work member is continued until the tie has been completely ejected from the track structure. Thereafter the active reach of the work member comprises an element to which one end of the replacement tie is attached and which functions as a tension member to pull the replacement tie into the position formerly occupied by that tie which has just been ejected.

Means is employed in association with the work member for guiding the active reach of that member in its tie ejecting stroke and which maintains free of loose ballast the space from which the defective tie has just been ejected, this in order that the replacement tie may be drawn into that space freely and easily. The invention includes many additional features of novelty which, taken together, render the apparatus highly effective in operation and well adapted to accomplish its primary purposes, i. e. to reduce labor costs by the elimination of the major part of the manual effort now expended in accomplishing tie replacements, to decrease the time required to effect a tie replacement so that the apparatus may efficiently function on a busy section of track where no repair machine can remain for any lengthy period of time, and to greatly decrease costs by the substitution of an easily controlled machine for a substantial group of laborers. One embodiment of the invention is disclosed in the accompanying drawings, this embodiment being a preferred form. It will be appreciated by those skilled in the art that, in certain of its aspects, the invention is subject to substantial modification in mechanical detail, without departure in function or result from that embodiment which has been selected for disclosure by way of example.

In the drawings:

Figure 1 is an elevation of the improved apparatus as it is seen from one side of a railroad track construction, its flexible work member being shown in operative position and ready to eject a tie when activated;

Figure 2 is a top plan view of the apparatus, certain of its parts having been omitted and other parts broken away in order that certain major features of the supporting truck may be observed;

Figure 3 is an end elevation of the apparatus, as seen from a point on the trackway, the tie ejecting work member being shown in position to eject a tie;

Figure 3A is a generally similar view showing the work member supporting means in a different position of adjustment;

Figure 4 is a section on line **4—4** of Figure 1;

Figure 5 is a section on line **5—5** of Figure 4;

Figure 6 is a section on line **6—6** of Figure 4;

Figure 7 is an end elevation of portion of the machine shown in Figure 3 with the tie ejecting work member and its support in raised or inoperative position, this being the position to which it is moved when the supporting truck is to be advanced along the trackway;

Figure 8 is a section on line **8—8** of Figure 7;

Figure 9 is a section on line **9—9** of Figure 7;

Figure 10 is a section on line **10—10** of Figure 7;

Figure 11 is a view showing certain movable elements of the mechanism for raising and lowering the work member supporting frame;

Figure 12 is a section on line **12—12** of Figure 11;

Figure 13 is a section on line **13—13** of Figure 11;

Figure 14 is a section on line **14—14** of Figure 11;

Figure 15 is a section on line **15—15** of Figure 2;

Figure 16 is an end elevation of the lower portion of the wheeled truck employed, showing ground or ballast engaging elements and the mechanism utilized for preventing lifting of the wheels from the rails of the trackway when the ground engaging elements are activated;

Figure 17 is a schematic view of the fluid transmitting system for providing several of the operating cylinders or rams of the mechanism with motive fluid;

Figure 18 is a section on line **18—18** of Figure 8;

Figure 19 is a section on line **19—19** of Figure 18;

Figures 20 and 21 are, respectively, longitudinal sections through a roadbed showing, in cross section, several railroad ties, the central tie being shown to have been replaced, in Figure 21, by the work member of the apparatus;

Figures 22 through 26 inclusive are of diagrammatic character, illustrative of the sequence of operations performed by the work member of the mechanism in ejecting a defective tie and drawing a fresh tie into the position formerly occupied by the defective tie;

Figure 27 is a front elevation of a plow-like member which constitutes the leading end of the active reach of the work member of the mechanism;

Figure 28 is a section on line **28—28** of Figure 27;

Figure 29 is a perspective view of a tension rod utilized as an attachment to the work member and which functions, when equipped with a tie engaging means, to secure the replacement tie to the work member so that the tie is drawn into the roadbed when th ework member is retracted;

Figure 30 is a perspective view of a tie end engaging plate which is utilized in association with the tension rod of Figure 29; and

Figure 31 is a section on line **31—31** of Figure 1.

The apparatus illustrated in the drawings, and which constitutes a preferred embodiment of the invention, comprises two main structural assemblies the first of which is the truck or mobile support generally indicated at T and the second of which is a carriage structure mounted on the truck and indicated generally at C, the carriage being mounted for limited movement of rotation about a vertical axis located centrally of the truck.

The mobile support or truck T is preferably of conventional character having a rectilinear frame which includes the side frame members **10** and **11**, the transverse end members **12** and **13**, axles **14** and **15**, and wheels **16**. The truck frame also includes longitudinally extending parallel supporting beams **17** which are the principal bearers for a power plant such as an internal combustion engine B which provides the power for advancing the apparatus along the trackway. A generally circular channel member **18** is supported upon the truck side frame members **10** and **11** and a track **19** is rigidly affixed to the outwardly facing cylindrical surface of this arcuate channel member **18**. The generally circular means comprising members **18** and **19** constitutes a support for the carriage which permits it to be adjusted angularly to a limited extent about a vertical axis, the carriage being provided with track engaging arcuate members **20** the inner faces of which closely engage the arcuate outer faces of the members **19** of the arcuate track and members **20** having inturned flanges **20***a* slidably engaging the undersurfaces of members **19**, the effect of this construction being to positively lock the carriage C to the mobile support, while permitting its free rotation about the vertical axis of the circular trackway.

The truck T also carries a mechanism for elevating the truck relatively to the ballast of the trackway when desired, this mechanism being generally indicated at E, E, a device for clamping the truck frame to the rails of the trackway structure, which device is located at one end of the truck and is generally indicated at R, and the power means, generally indicated at A, for adjusting the carriage angularly about its vertical axis of rotation. Mounted upon the truck will likewise be suitable mechanism for transmitting the driving power developed in the power plant B to the axle **15**. This means may be of any conventional character but can with advantage be constructed as shown in Figure 2 of the drawings, including a sprocket **21** mounted upon axle **15**, a chain **22** connecting sprocket **21** to a smaller sprocket **23** which is connected to the power plant B through a change-speed mechanism enclosed in housing **24**. A control shaft entering housing **24** is indicated at **25** and movements of this shaft may be effected by applying manual power to an operating handle **26** which is operatively connected to shaft **25** as by means of suitable sprockets or pulleys and the chain or belt **27**.

The truck elevating mechanism E, E may be of any suitable character but is shown in the drawings to include two ground engaging rods **30** which, when in operative position, are disposed vertically and at their midpoints extend through channel guides **31** which are mounted upon suitable bracket members **32** springing from the frame of the truck. The upper end of each ground engaging member **30** is pivotally attached to a rocker **33** mounted upon a fixed bracket **34** for rocking movement about a horizontal axis, the inner end of each rocker **33** being suitably connected to a piston or plunger working in a vertically disposed hydraulic cylinder **35**. Admission of fluid into the bottom of the cylinders **35** simultaneously will cause the ground engaging members **30** to press downwardly against the ballast which their lower ends engage and to cause the truck to move upwardly relatively to the roadbed ballast. The truck, or at least that end thereof upon which the lifting mechanism E, E is mounted, will be lifted from the rails by such action of the lifting mechanism unless means such as that indicated generally at R is employed. This holds the truck wheels against the rails and thus causes the rails to move upwardly with the truck upon energization of the lifting mechanism.

The mechanism generally indicated at R comprises rail engaging tong members **36** and **37** pivotally connected together at **38**, the lower ends of these tongs being inturned so that they may be moved into contact with the opposite faces of the rail web directly under the head of the rail, as shown in Figure 16. The upper end of each member **37** is pivotally hung from the truck frame and the upper ends of members **36** are interconnected by a system of

levers 39, 40, 41 and 42 which, when manipulated manually by an attendant at a time when the ground engaging members 30 are bearing no load, will either cause the tong members 36 and 37 to operatively engage a rail or to disengage the rail, as desired. With the tongs in the positions in which they are shown in Figure 16, and with the further application of downward pressure to the upper ends of the ground engaging members 30, the truck and the rails upon which it is mounted are simultaneously lifted. The amount of lift need not be great, the purpose being to permit removal of the tie plates and to make certain that the base of each rail is above the level of the upper surface of the tie to be removed, despite any extensive cutting of the tie by the rail plates. The tie is thus definitely freed from the rails in such manner that it may be ejected longitudinally from the trackway by the means to be hereinafter described.

When the apparatus is being moved from place to place the ground engaging members 30 will be swung upwardly about their pivotal points of attachment to the rockers 33 and the tongs will be disengaged from the rails and caused to occupy the approximate positions in which they are illustrated in dotted lines in Figure 16.

The power means generally indicated at A, previously referred to, is most clearly to be seen in Figures 2 and 15. This comprises a horizontal support 44 mounted for pivotal movement upon the block 45 about the vertical axis of the pivot bolt 46, bolt 46 passing through aligned apertures in support 44 and block 45. Upon the pivotally mounted support 44 is fixed the hydraulic cylinder 47 the piston of which is connected by a rod 48 and pivot pin 49 to a bracket 50 integral with or attached to the carriage C. It will be understood that by admitting superior fluid pressure into one end or the other of the hydraulic cylinder 47, and causing the piston therein to move longitudinally of the cylinder, the entire carriage C may be adjusted angularly about the vertical axis of the circular trackway previously described, which axis passes through the point 51 in Figure 2. This adjustment is effected when necessary to bring the tie ejecting work member into precise alignment with the tie to be ejected from the trackway, this ability to adjust the carriage for this purpose being essential inasmuch as the ties of a railroad roadbed make many different angles with the rails and the application of an ejecting force to the end of a cross tie to be ejected, at a substantial angle to the axis of the tie, would, of course, tend to urge the tie to a greater angularity and interfere with its ejection, as will hereinafter be made clear.

The carriage C supports the tie ejecting mechanism, which mechanism includes a second power plant, generally indicated at P in Figure 3, the flexible elongated work member generally indicated at M in this and other figures, the storage rack for the work member M, including its stationary portion SM and its vertically adjustable section SV, and the horizontally extending vertically adjustable work member guide G, all four of which instrumentalities are brought into operation to perform a tie ejecting function when the apparatus as an entirety has been moved into position with the axis of rotation of the carriage C over that tie and the longitudinal axis of the tie is disposed in the vertical plane of the work member.

The rotatable carriage is formed of structural members and considerable latitude may be permitted in its construction. In the form shown it has a generally rectangular base frame comprising two parallel longitudinally extending side frame members 53 and 54 and a suitable number of transverse connecting members such as indicated at 55, 56, 57, 58, 59 and 60. The power plant P is mounted upon this platform toward one end thereof and may comprise an internal combustion engine of conventional character with its usual controls, including the gear box 61. At the other end of the carriage, and also located in part above the engine, is the storage rack for

the elongated work performing member M, this storage rack comprising two portions, a stationary portion SM which is generally horizontal and is permanently supported in the position in which it is shown in Figure 3 by means of upright structural members 62 and 63 and diagonal members 64 and 65 all united by welding or suitable securing devices into a rigid structural frame, and the adjustable portion SV of the storage rack which may be moved by means hereinafter to be fully described from the position in which it is shown in Figure 3 through the intermediate position in which it is shown in Figure 3A to its uppermost position in which it is shown in Figure 7, this vertical adjustment being effected to elevate the tie ejecting mechanism when not in use so that it will clear all track obstructions in moving from point to point along the trackway.

In order that this vertical adjustment of the movable portion SV of the work member storage rack may be effected it is mounted upon three pairs of pivoted arms or links, disposed in parallel planes, clearly to be observed in Figures 1, 3 and 7. The lower pair of parallel supporting members, which are preferably short sections of structural character such as I-beams, are indicated at 66, 66, the intermediate pair at 67, 67 and the uppermost pair at 68, 68, the corresponding inner ends of the members of each pair being rotatably supported upon fixed shafts or axles 69, 70 and 71 respectively, and the outer ends being mounted upon axles or shafts 72, 73 and 74. Axles 69, 70 and 71 are disposed in parallelism and the ends thereof are fixed in suitable apertures in the parallel inclined structural members 65 of the frame of the carriage. As will be apparent from an inspection of the figures referred to, the movable section SV of the work member storage rack, which section includes the two channel members 75, will in each of the successive positions which it occupies in its vertical movements of adjustment, assume a position parallel to the plane in which the axes of the shafts 69, 70 and 71 are disposed, and, in its upward and downward movement, will not be projected laterally away from the track structure to any appreciable extent, the arrangement being such that no portion of the apparatus at any time, even during vertical adjustment of the movable portion of the rack, will extend beyond the lateral limits of a single track structure.

When in its uppermost position section SV of the storage rack will be in close proximity to the horizontally extending frame member 76 affixed to vertical frame member 63 whereas, when this adjustable portion of the storage rack is in its lowermost position, as shown in Figure 3, its upper end is spaced a substantial distance from the structural member 76. In order that the elongated flexible work member M shall be adequately supported in both the uppermost and lowermost positions of adjustment of section SV of the storage rack two bridging members 80 and 81 are provided, the adjacent ends of which are connected by links 82 and the remote ends of which are pivoted or connected by links to the structural members 76 and adjustable storage rack section SV respectively. Thus the supporting members 80 and 81, which are coplanar when the mechanism is in operative position as shown in Figure 3, will fold relatively to each other as the adjustable section SV of the storage rack is elevated, first passing through intermediate positions, as shown in Figure 3A, for example, and finally reaching parallelism as shown in Figure 7. The elongated flexible work member M is so constructed that it will bridge, because of its inherent resistance to flexure in one direction, the gap in the support (see Figure 3A) which temporarily exists during the period of vertical adjustment of the storage rack section SV, for reasons which will be made clear when the details of construction of the elongated work member are described.

For the purpose of vertically adjusting portion SV of the storage rack a hydraulically operated plunger is employed, this plunger being indicated at 84 in the draw-

ings. It will be seen to include two parallel horizontally extending slides 85 and 86 supported in guide members 87 and 88 respectively, these guide members being fixed in position on the horizontal frame members of the carriage. That end of each slide which is remote from the work member M is connected to a piston rod 89 upon which is mounted piston 90 adapted to reciprocate in cylinder 91 under the influence of liquid introduced into the cylinder ends under varying pressures, movement of the piston 90 in one direction retracting the slides 85 and 86 and in the other direction causing these slides to advance. The means for attaching the leading ends of slides 85 and 86 to the vertically adjustable portion SV of the storage rack is most clearly illustrated in Figures 11, 12, 13 and 14 of the drawings, this mechanism including a cross rod 92 working in elongated slots 93 formed in the slides, the outer ends of the cross rod 92 extending through elongated apertures 94 formed in rockers 95. Cross bar 92 is encircled by roller bearings 96 which move in elongated countersunk recesses generally similar to but somewhat larger than slots 93 formed in the thickened ends of the slides and rod 92 is likewise provided with roller bearings 97 which work in the elongated apertures formed in the rocker members 95. The lower ends of rockers 95 are mounted upon fixed pivots whereas the outer ends are connected by adjustable turnbuckles 98 to brackets 99 mounted upon links 67 respectively.

It will be understood therefore that, if the plunger comprising slides 85 and 86 is moved away from the section SV the rockers 95 shown in Figure 11 will move in a clockwise direction, the cross rod 92 moving away from the axis of rock of the rocker members as the rockers are rotated, the link 67 being also rotated in a clockwise direction about cross rod 70, continuance of this motion to the limit of movement of the plunger causing the three sets of links 66, 67 and 68, which always occupy parallel planes, to assume the positions in which they are shown in Figure 7. Reverse movement of the plunger will cause the rockers 95 to rotate about their lower pivotal axes in counterclockwise direction, rocking the links 66, 67 and 68 downwardly about their fixed axes until section SV occupies the position in which it is shown in Figure 3. When this occurs section SV is locked in its lowermost position by the end portions of the slides, which end portions are projected into positions (Figure 4) in which they directly overlie blocks 100, mounted upon the movable section SV for adjustment longitudinally thereof. Upward motion of the section SV will be blocked by contact of stop members 100 against the undersides of slide members 85 and 86 until these slides are retracted, thus preventing accidental upward swinging movement of the section SV during the operation of the apparatus.

The elongated work member, transversely flexible in one direction only, to which frequent reference has been made in the foregoing description, comprises an elongated series of identical sections pivotally connected together, the member as an entirety being positioned upon the storage rack which has been described except when it is in operation in ejecting a tie and in drawing into position a replacement tie. The details of construction of the work member may be most clearly perceived from an inspection of Figures 8, 9, 18 and 19. Each section includes parallel sides 102, connecting web 103, a central web 104 disposed parallel to the sides 102, this central web terminating in a transversely extending generally flat portion 105 having downturned terminal flanges 105*a* (Figure 8), all of the elements so far mentioned being preferably formed as portions of an integral structure, as by a casting operation.

Projecting upwardly from the flat face of the transversely extending portion 105 of each of the sections are the two spaced parallel webs of angle members 106 and 107, these webs being connected by two spaced parallel horizontal bolts or rivets 108 each of which is encircled by an anti-friction roller 109.

As will be seen from an inspection of Figure 18, each cross bolt 108 passes through aligned apertures in the adjacent ends of adjacent bracket members 106 and 107, thus constituting a pivotal connection between the two sections of the work member M. In other words, each section, the transverse faces of which are parallel, is pivotally connected to the sections on either side by two of the transversely extending bolt members 108 and the entire series of similar sections thus formed into a continuous member which may flex about a transverse axis to one side of said member, as shown in Figure 18, but cannot otherwise flex. Thus the member may, when the parallel faces of the several sections are in contact, be utilized as a column to transmit thrust and may also be used when so disposed to transmit pulling force. It will be clear that the work member is so constructed that it may transmit thrust as a column in larger degree than it may transmit pulling or tension forces, having been particularly designed to exert heavy thrust against the end of a tie to dislodge it from a roadbed and requiring substantially less strength in tension for the purpose of drawing a replacement tie into a previously established space in the roadbed.

Driving force is applied to the work member at the junction between its active reach, which is the horizontal reach, and the inactive reach, which is that reach of the member which extends upwardly and is supported by the storage rack. The force applying member comprises a pinion 110 which is designed to receive a bolt in alternate interdental spaces, as shown in Figure 18, pinion 110 being fixed upon driving shaft 111 which is rotatably supported in suitable bearings formed in the lower ends of the parallel structural members 75 of the vertically adjustable section SV of the storage rack. Upon the end of shaft 111 are fixed sprockets 112 which are at all times connected by chains 113 to sprockets 114 fixed upon shaft 115 mounted in suitable bearings formed in the upper ends of the parallel structural members 75. Shaft 115 is in turn driven by means of sprockets 116 mounted thereon, and connecting chains 117, from sprockets 118 mounted upon a drive shaft rotatably supported in bearings formed in the inclined structural members 65, which are at all times maintained in fixed position in the carriage. The arrangement is such that, notwithstanding arcuate movement of each portion of the adjustable section SV of the storage rack, as it is vertically moved, this driving connection is maintained, the axis of shaft 115 describing a circular path about the axis of sprocket 118, which axis is fixed. It will be observed that chain take-up devices 120 and 121 are provided for taking up any looseness which may occur in the lower chain 113 and similar devices may be provided in association with the chain 117.

Shaft 111 passes through parallel gusset plates 122 rigidly affixed to the lower end of structural members 75 respectively, and each of these gusset plates is provided with a circular series of anti-friction rollers 123. These rollers function to guide the work member along a circular path centered on the axis of shaft 111 and to maintain the successive bolts 108 in close interlocking engagement with pinion 110 during the time that each is so circularly moving. It will be observed from an inspection of Figure 18 that the flanges 105*a* previously referred to are longitudinally arcuate and that the curved edge surfaces of these flanges comprise roller engaging surfaces, the arrangement being such that successive sections of the work member pass smoothly along the series of supporting rollers during the movement of the work member in either direction and during the time that driving force is being imparted to the work member by the sprocket 110. As each section of the work member concludes its arcuate movement about the axis of shaft 111 (assuming that the work member is being advanced in the direction of the

arrow A in Figure 18), its leading face will fully engage the rearwardly directed face of the immediately preceding section, which is then moving tangentially to the arc of its previous travel and in a generally horizontal direction. Thus each two successive sections form a solid column extending in a horizontal direction along the active reach of the work member and successive sections add themselves to the rear of this column as the column is extended horizontally upon its working stroke.

To be assured that each successive section is in full register with the one which precedes it alignment members **124** are provided, these being located at the inside corners of each section, at the junction of the side walls **102** and the transverse web **103**, and projecting forwardly so as to guide the section into full register with that section which has immediately preceded it, as the sections come together, the protruding ends of members **124** being beveled or wedge-shaped for this purpose.

To the forward face of the leading section is secured a head **125** having a central flat tie end engaging surface **125***a* and rearwardly and outwardly sloping faces **125***b*, so shaped as to deflect laterally ballast particles which the head may engage and clear the way for the active reach of the work member which follows. The head is also provided with apertures **125***c* and **125***d* which will receive the end of a tension rod utilized to attach a replacement tie to the head **125** to be drawn into position upon the return stroke of the work member. Assuming that the apparatus has been positioned as shown in Figure 3, with the work member disposed in a vertical plane which includes the axis of the tie by suitably adjusting the carriage, and further assuming that the rail attachment means shown in Figure 16 has been utilized to secure the truck to the rails, and that the elevating members **30** have been actuated to lift the rails, and further assuming that the rail plates and spikes have been removed, the work member is ready for use.

The power plant P is connected to the drive shaft **111** through the sprocket and chain mechanism previously described, the pinion **110** is rotated, and the head is caused to advance against the end of the tie (Figure 23), the motion being continued until the tie has been completely ejected (Figure 24), from its former position in the roadbed structure. The defective tie is then removed and a replacement tie is aligned with the active reach (horizontal reach) of the work member, the hooked end **126***a* of the tension rod **126** then passed through apertures **125***c* and **125***d* of the head, the tie end engagement plate **127** affixed (Figure 25), by passing the squared end **126***b* of the tension rod through the rectangular aperture **127***a* formed for its reception in the plate **127**, and the operation of drawing into position the replacement tie may then proceed, the work member being retracted until it occupies substantially its original position (Figure 26) and there being brought to a halt. The tension rod and plate **127** may then be removed, the tie plates placed in position and the rails lowered onto the tie plates, this to be followed by the conventional spiking or the attaching of rail securing devices of various kinds.

It is highly to be desired that, in its working movements, the active reach of the work member be guided by means above the same so that it may not accidentally move upwardly upon making contact with a hard spot in the ballast so as to cause the leading end, i. e. the plow **125**, to strike a rail. To eliminate this possibility a guide means is provided, which means is illustrated in Figures 4 and 6 of the drawings, likewise in the diagrammatic Figures 22 through 26 inclusive. This guide comprises essentially a generally horizontal channel member **130** which is attached to the lower ends of vertically disposed rods **131** which project upwardly into hydraulic cylinders **132**, containing plungers to which the rod ends are attached. By introducing fluids under pressure into these cylinders the channel member **130** may be elevated or depressed. This channel is transversely slotted at a number of points and carries a plurality of anti-friction rollers **133** the lower surfaces of which are disposed below the lower surface of the channel so as to be in position to engage the upper surface of the plow **125** and to guide that plow in its horizontal movement upon its thrusting and pulling strokes respectively. The channel **130** is likewise recessed for the reception of the rails and stops are provided to make contact with the upper surfaces of the rails for the purpose of limiting the downward movement of the guide means so that the undersurfaces of the rollers **133** will be only slightly below the undersurfaces of the rails when the guide is in operative position. These stop members are indicated at **135** and they may be varied in thickness to compensate for variations in rail height.

To the oppositely facing vertical faces of the flanges of the channel member **130** are secured stiff rubber sheets the lower margins of which project downwardly beyond the undersurfaces of the anti-friction rollers. It is the function of each of these laterally flexible guard members to yield when subjected to pressure of the ballast laterally deflected by the plow and to prevent the return of these deflected particles into the space from which a tie may have been ejected. It will be appreciated that a tie replacement operation may not conveniently be accomplished in the event that ballast originally deflected by the plow should fall back into the space vacated by the tie and further that the operation of the work member would be impeded and the work member damaged and eventually destroyed if hard particles of ballast could find their way into the open top of its active reach as the active reach moves along a horizontal path transversely of the track structure and through the ballast. By the means described the work member may be operated freely and rapidly to accomplish both its tie ejection and tie replacement functions, all without the possibility of ballast entering the trough-like extended work member.

Various means may be provided for supplying motive fluid to the several cylinders illustrated and described, for the purpose of actuating the pistons in those cylinders and effecting the movements of the operating parts of the mechanism. One such hydraulic system is illustrated in Figure 17, which is a diagrammatic view. The oil reservoir is so marked and the pump illustrated is of the constantly operating type, the valve box being so constructed that oil under pressure will return to the reservoir in a constant stream when not otherwise being employed. The valve box also may be of conventional character including a plurality of valves, one for each operating instrumentality or ram. It will be understood that air pressure may be employed to actuate the several servomechanisms or, in certain cases, electrical current may be the motive fluid.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In a machine for repairing railroad track structures, in combination, a transversely flexible, elongated work member, extensible rectilinearly to transmit thrust as a column and movable longitudinally along a curvilinear path when flexed transversely, said work member having a leading end, and generally horizontally disposed means overlying the leading end of said member to maintain it rectilinear and guide it along a generally horizontal rectilinear path as it advances.

2. In a machine for repairing railroad track structures, in combination, a wheeled truck, an elongated work member mounted on the truck, said member being transversely flexible, and extensible rectilinearly to transmit thrust as a column and movable longitudinally along a curvilinear path when flexed transversely, said work member having a leading end, means for guiding said member along sequential curvilinear and rectilinear paths as it moves longitudinally, said means including a generally horizontally disposed means overlying the leading end of said member to maintain it rectilinear and guide it along a generally horizontal rectilinear path as it advances.

3. In a machine for repairing railroad track structures, in combination, a transversely flexible, elongated work member, extensible rectilinearly to transmit thrust as a column and movable longitudinally along a curvilinear path when flexed transversely, said work member having a leading end, means for guiding said member along sequential curvilinear and rectilinear paths as it moves longitudinally, said guiding means including a generally horizontally disposed means overlying the leading end of said member to maintain it rectilinear and guide it along a generally horizontal rectilinear path as it advances, and means for imparting driving force to said member as it passes along said curvilinear path.

4. In a machine for repairing railroad track structures, in combination, a transversely flexible, elongated work member, extensible rectilinearly to transmit thrust as a column and movable longitudinally along a curvilinear path when flexed transversely, said work member having a leading end, means for advancing and retracting said member longitudinally, and means for guiding the leading end thereof along a rectilinear path as it advances, said first mentioned means being spaced along the work member from said last mentioned means so that the active portions of the work member engage said means successively.

5. In a machine for repairing railroad track structures, in combination, guide means adapted to be positioned transversely to a railroad trackway and to present, when so positioned, downwardly facing guide surfaces disposed in a substantially horizontal plane below the rails, a transversely flexible, elongated work member, extensible rectilinearly to transmit thrust as a column and movable longitudinally along a curvilinear path when flexed transversely, said work member having a leading end, means for applying power to said work member to advance said leading end longitudinally transversely of the trackway beneath and in contact with said guide means and thereafter retracting the same, and a second guide for causing said work member to move along a curvilinear path, said second guide deflecting successive lengths of the work member upwardly as said member issues from beneath said first guide.

6. In a machine for repairing railroad track structures, in combination, a vehicle movable along the trackway to a selected operating station, and mechanism mounted thereon for applying force to one end of a railway tie forming part of that trackway and ejecting the same longitudinally from the trackway, said mechanism including a transversely flexible, elongated work member extensible rectilinearly to transmit thrust as a column and movable longitudinally along a curved path when flexed transversely, said work member having a leading end, driving means engaging said work member to thrust said leading end against one end of a tie forming part of that trackway for the purpose of longitudinally ejecting the tie, and means for guiding the leading end of said member as it moves transversely of the trackway to confine it to a path of movement beneath the rails.

7. In a machine for repairing railroad track structures, in combination, a vehicle movable along the trackway to a selected operating station, and mechanism mounted thereon for thrusting against one end of a railway tie forming part of that trackway and ejecting the same longitudinally from the trackway, said mechanism including an elongated work member transversely flexible to one side only and extensible rectilinearly to transmit thrust as a column, means for storing said member above the trackway and within the lateral limits of a single track structure, power means for longitudinally advancing and retracting said member, and guide means for directing one end of said member along a rectilinear path extending transversely of the trackway and beneath the rails and disposed on the side of the member to which it is otherwise free to flex.

8. In a machine for repairing railroad track structures,

in combination, a vehicle movable along the trackway to a selected operating station, and mechanism mounted thereon for thrusting against one end of a railway tie forming part of that trackway and ejecting the same longitudinally from the trackway, said mechanism including an elongated work member transversely flexible to one side only and extensible rectilinearly to transmit thrust as a column, means for storing said member above the trackway and within the lateral limits of a single track structure, power means for longitudinally advancing and retracting said member, guide means for directing the leading end of said member along a rectilinear path of movement extending transversely of the trackway and beneath the rails, said guide means being disposed on the side of said member in which it is otherwise free to flex, and power devices for vertically adjusting the storage and guide means.

9. In an apparatus of the type described, in combination, a wheeled truck, a flexible work member any portion of which is adapted to exert pushing or pulling forces when disposed in a straight line and subjected to an axially applied force, a power driven element rotatably mounted on the truck for rotation in either direction about an axis, means for guiding said member in a circular path about the axis of said element and maintaining a minor portion thereof in operative engagement with said element, the active reach of said work member extending from said element in a generally horizontal direction and the inactive reach extending upwardly therefrom, a storage rack above the said element for receiving and supporting the inactive reach of that member, and a guide for constraining the active reach to movement along a generally horizontal path beneath said truck.

10. The combination set forth in claim 9 in which the active reach of said member is provided, at its end, with a plow member or head to engage the end surface of a railroad tie and the immediately adjacent ballast when the work member is caused to eject a railroad tie endwise from a track.

11. The combination set forth in claim 9 in which said element and guide means are supported upon said storage rack and in which the storage rack is vertically adjustable to raise and lower the element, guide means, work member and rack.

12. The combination set forth in claim 9 in which means is provided for mounting the storage rack upon the truck for movement in a generally vertical direction along an arcuate path all portions thereof being disposed at all times within the lateral confines of a single trackway.

13. The combination set forth in claim 9 in which a tension member is detachably connected to the free end of the active reach of said work member, said tension member being provided with means for engaging a railroad tie so that the work member may be employed to pull a tie into position.

14. A machine for repairing roadbeds as claimed in claim 7 comprising, in combination, a frame mounted upon the vehicle for pivotal movement about a vertical axis, means for adjusting the position of the frame about said axis, said mechanism being mounted on said frame.

15. A machine for repairing railroad roadbed structures as claimed in claim 2 comprising, in combination, means associated with the truck for engaging the roadbed and elevating the truck relatively to the roadbed, and means associated with the truck for gripping the rails to prevent disengagement of the wheels therefrom as the truck is elevated.

16. Apparatus for repairing a railroad roadbed structure comprising, in combination, a work member adapted to be applied to the end of a tie, means imparting to said work member a forward and return stroke axially of the tie to eject the tie from the roadbed and to occupy the space in the ballast from which the ejected tie has vacated on said forward stroke, and means for attaching to the end of the work member a replacement tie to be drawn

into the space just vacated by the work member on said return stroke.

17. The apparatus set forth in claim 16 in which the tie engaging end of the work member is larger in cross section than any tie to be ejected, and means is provided for retaining ballast laterally displaced.

18. Apparatus for longitudinally ejecting a railroad tie from a railroad roadbed, including, in combination, a work member to be aligned with the tie, said work member comprising a series of pivotally interconnected generally U-shaped members together forming a substantially hollow thrust member with open top, the tie engaging terminal member thereof being formed as a plow so as to laterally deflect ballast, and means permitting the lateral flow of ballast under influence of the plow-like terminal member and preventing its return.

19. The combination set forth in claim 18 in which said last mentioned means comprises a horizontally extending support member to be disposed parallel to and above the tie, and flexible guards depending therefrom, said guards yielding to the pressure of plow driven ballast particles and thereafter acting to prevent reverse movement of ballast particles which have passed the same.

20. The combination set forth in claim 18 in which each U-shaped member is provided with devices for bringing it into precise register with the adjacent member when said members are brought into axial alignment.

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