(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 528 444 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **92116284.8**

(51) Int. Cl.5: **E01B 31/17**

(22) Date of filing: **14.10.88**

This application was filed on 23 - 09 - 1992 as a divisional application to the application mentioned under INID code 60.

(30) Priority: **16.10.87 US 109542**

(43) Date of publication of application:
24.02.93 Bulletin 93/08

(60) Publication number of the earlier application in accordance with Art.76 EPC: **0 395 688**

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

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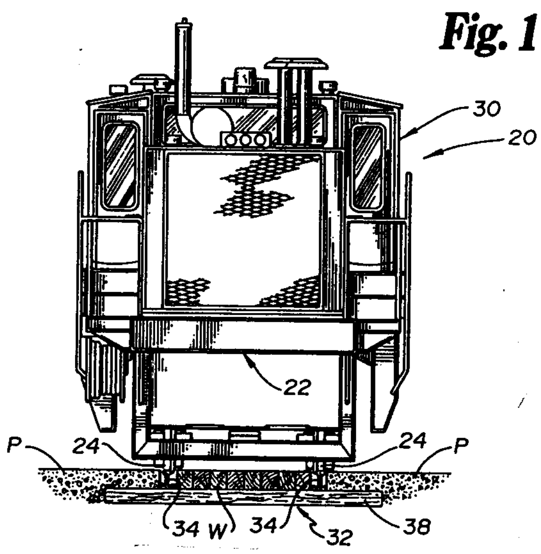
(54) **Rail grinding machine.**

(57) A rail grinding machine (20) especially designed for grinding railroad track rails (34) at railroad track switches and road crossings. Railroad switches and road crossings present particular problems to the rail grinding process. Gaps are necessarily presented in the railroad switches to permit the wheels of a railroad car to cross over one or the other of a set of rails in the switch and at least one of the set of rails in a switch will be curved. An additional problem presented at road crossings as well as at railroad switches is the presence of obstructions close to the railroad. The grinding machine includes an articulated grinding module supporting undercarriage (26) suspended from the grinding machine main frame (22). The undercarriage includes a unique suspension system that allows for lateral shifting and pivoting of the undercarriage independently of the grinding machine main frame. Grinding operations are controlled by sensing the supply pressure of the constant flow hydraulic fluid used to power the individual grinding modules (158), and positioning the grinding modules in grinding abutment with the rails as a function of the supply pressure.

Fig. 1



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Technical Field

This invention relates to machines for maintaining the surfaces of railroad track rails. In particular, it relates to a rail grinding machine especially adapted for grinding rails at railroad track switches and road crossings.

Background Art

Railroad track rails are subject to wear by the passage of trains over the rails. In particular, depressions in the upper surface of a rail may develop such that the railhead presents an undulating, corrugated surface. Moreover, the rail may develop burrs, or otherwise lose its symmetrical profile. Maintenance of smooth running surfaces on railroad track rails is important for reasons of safety, riding comfort, protection of the track, track bed and rolling stock, noise suppression, and reduced maintenance of the track and track bed.

Railroad switches and road crossings present particular problems to the rail grinding process. Gaps are necessarily presented in the railroad switches to permit the wheels of a railroad car to cross over one or the other of a set of rails in the switch, and at least one of the sets of rails in a switch will be curved. An additional problem presented at road crossings as well as at railroad switches, is the presence of obstructions close to the railhead. In short, rail grinding is a demanding, precise process, that even on straight, unobstructed, main line track is technically challenging, and which is particularly difficult at track intersections and road crossings.

The length of track sections at railroad switches and road crossings is typically short. Nevertheless, undulations in the rail surfaces of switches and crossings can impart vibratory motion to rolling stock, that will continue long after the train has passed by the switch or crossing. A railroad grinding machine particularly adapted for grinding the surfaces of railroad track rails at railroad switches and road crossings would accordingly be a decided advantage.

British Publication GB 2 056 345 is exemplary of machines available to grind straight sections of unobstructed track, but which cannot grind in a region of railroad switches and road crossings. The machine has a frame from which a tool carriage is connected. Vertical adjustment is possible as well as horizontal spreading. The entire carriage may also be shifted from side to side. There are vertical guide rollers and lateral guide rollers which interfere with and prevent grinding in regions where there are obstructions along a side of a rail. A tool support has a tool holder for accommodating planing tools and/or grinding tools. The lateral shifting of the carriage and lateral spreading of the sides of the carriage are useful, but do not achieve the more precise positioning that is oftentimes needed in regions of railroad switches and road crossings.

Summary of the Invention

The rail grinding machine in accordance with the present invention is particularly adapted for grinding rail surfaces at railroad track switches and road crossings. A self-propelled, rail mounted main frame includes an articulated, independently rail supported undercarriage. The undercarriage includes a plurality of indepenently movable grinding modules. Motive force is presented to the undercarriage from the main carriage through a unique slide and bracket assembly that transmits motive power to the undercarriage without interfering with the independent suspension of the undercarriage. A unique grinding control system allows for the precise positioning of the grinding modules along the railhead to be ground, notwithstanding the presence of obstructions or gaps at the railhead. The articulated undercarriage, unique suspension, and grinding control system provide the rail grinding machine hereof with the ability to effectively grind the rails of a switch or railroad crossing.

More particularly, the present invention finds from British document GB 2 056 345 a railroad grinding machine having a main frame supported along rails of a railroad track and an undercarriage depending from said main frame, said undercarriage including a first side frame with a first end and an opposed second end, said first side frame being generally aligned along the longitudinal axis of one of said rails, said first side frame having operably coupled thereto at least one grinding module for selectably grinding said one rail, wherein however, the present invention is characterized over the reference in that the undercarriage further includes first side frame shifting means operably coupled to said first side frame first end for selectably laterally shifting said first side frame first end independently of said second end transversely to the longitudinal axis of said one rail.

Brief Description of the Drawings

Fig. 1 is a front elevational view of a railraod grinding machine in accordance with the present invention at a road crossing;

Fig. 2 is a side elevational view of a railroad grinding machine in accordance with the present invention;

Fig. 3 is a multiple sheet drawing, Figs. 3a and 3b, showing a left side elevational view of the grinding machine undercarriage, with the main frame indicated in phantom lines;

Fig. 4 is a multiple sheet drawing, Figs. 4a and 4b, depicting a top plan view of the undercarriage of the rail grinding machine in accordance with the present invention;

Fig. 5 is a sectional view taken along 5-5 of Fig. 4a, with grinding modules removed for clarity;

Fig. 6a is a sectional view taken along the line 6a-6a of Fig. 4a with grinding modules removed for clarity;

Fig. 6b is a sectional view along the line 6b-6b of Fig. 4a, with various parts indicated in phantom lines for clarity;

Fig. 7 is a front elevational view of a grinding module, phantom lines depicting the grinding module in various tilted orientations;

Fig. 8 is a schematic diagram depicting the grinding pressure control circuit for an individual grinding module;

Fig. 9 is a logic diagram for the grinding pressure control circuit;

Fig. 10 is a schematic diagram of a railhead, and a single grinding stone placed along the railhead at different positions;

Fig. 11 is a fragmentary detailed plan view depicting a gimballed pivot pin, taken at the area encircled at 11 in Fig. 4b;

Fig. 12 is a fragmentary detailed perspective view depicting an undercarriage wheel cowling assembly with elements omitted for clarity; and

Fig. 13 is a fragmentary, detailed elevation view of Fig. 6a depicting an alternate position of the cowling assembly and undercarriage side frame.

Detailed Description of the Drawings

Referring to the drawings, the rail grinding machine 20 in accordance with the present invention broadly includes a railroad mounted main frame 22 supported by rail engaging wheels 24, and a grinding undercarriage 26 supported from the main frame 22. An engine compartment 28 and operator's cab 30 are positioned on the main frame 22. The grinding machine 20 is depicted mounted on railroad track 32 comprising parallel rails 34 support on road bed 36 by railroad ties 38. Fig. 1 depicts the rail grinding machine 20 at a road crossing, with the rails 34 at a level below the level of the road pavement p, and wood spacers w extending between the rails 34.

Undercarriage 26 broadly includes forward, middle, and rear vertical slide assemblies 40, 42, 44, and forward, middle, and rear horizontal slide assemblies 46, 48, 50. Undercarriage 26 is divided into a forward section 52 and a rear section 54, with the middle vertical slide assembly 42 and middle horizontal slide assembly 48 pivotally connecting the forward undercarriage section 52 and the rear undercarriage section 54. Forward section right and left side frame assemblies 56a, 58a are supported by, and extend between the forward horizontal slide assembly 46 and the middle horizontal slide assembly 48, and rear section right and left side frames 56b, 58b are supported by and extend between middle horizontal slide assembly 48 and rear horizontal slide assembly 50. The forward and rear vertical slide assemblies 40, 44, forward and rear horizontal slide assemblies 46, 50, and forward and rear side frames 56, 58 are respectively comprised of similar components that are assigned identical numerals in the drawings. Moreover, it is to be understood that although Figs. 6a and 6b, and the below detailed description, are primarily directed to the forward undercarriage section 52, the structure and operation of the rear undercarriage section 54 can be ascertained from the description of the forward assemblies.

Referring to Fig. 6a, forward vertical slide assembly 40 broadly includes vertical slide tube 64 fixedly attached to cross beam 66 of main frame 22, and vertical slide rod 68 shiftably received within vertical slide tube 64. U-shaped slide rod end bracket 70 is fixedly attached to the lower end of vertical slide rod 68. Vertical lift piston and cylinder assembly 72 extends between main frame cross beam 66 and the U-shaped bracket 70. Fore and aft generally triangular support brackets 14, 76 depend downwardly from main frame cross beam 66. Side plate 78 extends between support bracket 74, 76, and is fixedly attached to vertical slide tube 64 by weldments 80, 82.

A carriage retaining latch 84 is pivotally mounted on side plate 78 at pivot pin 79. Latch actuating piston and cylinder assembly 84 extends between a mount 88 on main frame cross beam 66 and the uppermost end of latch 84. U-shaped slide rod end bracket 70 comprises identical U-shaped plates mounted on either side of vertical slide rod 68. Latch rod 90 extends between the two plates of U-shaped bracket 70, in engageable alignment with latch 84.

Referring to Fig. 6a, forward horizontal slide assembly 46 includes horizontal slide rod 92, and right and left horizontal slide tubes 94, 96. The horizontal slide rod 92 is pivotally coupled to vertical slide rod 68 by pivot pin 98 received through U-shaped end bracket 70. The slide tubes 94, 96 each include flange plates 99.

Right and left side frames 56, 58 each comprise an uppermost, fore and aft channel 100 and a plurality of generally equally spaced, downwardly depending grinding module support members 102. Referring to Fig. 2, a pair of upper and lower, horizontal frame elements 104, 106 extend between adjacent grinding module support members 102a, 102b. Referring to Fig. 6a, the flange plates

99 of right and left horizontal slide tubes 94, 96 are attached to the right and left side frames 56, 58, respectively, by brackets 107 received by clevises 108 mounted on upper and lower horizontal frame elements 104, 106 of right and left side frames 56, 58. The brackets 107 are retained within clevises 108 by gimballed pivot pins 109.

Rail engaging undercarriage wheels 114 are rotatably mounted on individual hubs 116. Each hub 116 slideably supports cowling 118. The cowlings 118 are fixedly attached to respective side frames 56, 58. Shifting of each cowling 118 axially along its respective hub 116, therefore, when its associated undercarriage wheel 114 is in engagement with rail 34, will shift the respective side frames 56, 58 to which the cowling 118 is attached laterally relative to the rail 34.

Each hub 116 is fixedly connected to a side frame shifting brace plate 120. A guide rod 122 extends from each brace plate 120. Each cowling 118 includes an aperture 119 for shiftably receiving the guide rod 122 of its associated brace plate 120. A side frame shifting piston and cylinder assembly 124 is carried by each brace plate 120. The piston 125 of each side frame shifting piston and cylinder assembly 124 is fixedly, threadably attached to its associated cowling 118, and the cylinder 126 of each side frame shifting piston and cylinder assembly 124 is fixedly carried by its associated brace plate 120. Referring to the phantom lines of Fig. 3, it will be understood that the guide rods 122 are separate from, but not parallel to, the pistons of the side frame shifting piston and cylinder assemblies 124.

Undercarriage spread assembly 128 extends between opposed, right and left brace plates 120. Spread assembly 128 includes spreading piston and cylinder assembly 130, and connecting rod 132. Undercarriage shifting piston and cylinder assembly 134 extends between bracket 136 mounted on the horizontal slide rod 92 and brace plate 120.

Referring to Fig. 5, the middle vertical slide assembly 42 and the middle horizontal slide assembly 48 are, in most respects, identical to the forward vertical slide assembly 40 and forward horizontal slide assembly 46 described above, and similar components bear identical numerals in the drawings. Note, however, that, side frames 56, 58 are connected to the middle horizontal slide rod 92 in a different manner, to be described in detail below, and that the horizontal slide rod 92 is captured at its outermost ends by brackets 138 depending downwardly from main frame 22.

More particularly, the horizontal slide rod 92 or middle horizontal slide rod 48 shiftably supports frame support collars 140. The frame support collars 140 include fore and aft, opposed, side frame receiving clevises 142. The side frame downwardly depending support members 102c adjacent the middle horizontal slide assembly 48 include apertured brackets 144 received within the frame support collar clevises 142 and retained by gimballed pivot pins 146. The gimballed pivot pins 146 are similar in construction to gimballed pivot pins 109.

The horizontal slide rod 92 of the middle horizontal slide assembly 48 supports main frame, power receiving, interface assemblies 148 that are slidably received within main frame brackets 138. Each interface assembly 148 includes a plurality of radially extending mounting plates 150 carried by a mounting collar 152. Front and rear interface panels 154 are carried by the support plates 150, and include friction bearing members 156.

Individual grinding modules 158 are supported by opposed pivotal mounts 160, 162 carried by adjacent downwardly depending module support members 102 of side frames 56, 58. The grinding modules 158 include base 164 fixedly carried by the pivotal module supports 160, 162, and grinding assemblies 166 mounted for up and down shifting relative to the base 164. The grinding module base 164 includes upwardly extending support sleeve 168 through which the grinding assemblies 166 are shiftably received. A module lift piston and cylinder assembly 170 extends between the grinding module base 164 and the grinding assembly 166 of each grinding module 158. A module tilt piston and cylinder assembly 172 extends between each pivotal module support 160 and a respective support bracket 174. The support brackets 174 are mounted on side frame module support members 102.

A pressure control system 175 for positioning individual grinding assemblies 166 against the railhead 34 with the appropriate grinding force is depicted in schematic form in Fig. 8. The system broadly includes the grinding assembly 166, grinding assembly vertical position sensing and control system 176 and hydraulic fluid flow sensing and control system 178.

The vertical positioning sensing and control system 176 includes rheostat 180 mounted on module lift piston and cylinder assembly 170. As depicted in Fig. 8, the piston 182 of lift piston and cylinder assembly 170 includes an electrical contact 183. The position of the piston 182 inside the cylinder 184 of lift piston and cylinder assembly 170 is electrically detected by the rheostat 180. The grinding assembly vertical positioning sensing and control circuitry 176 further includes servo amp 186, flow control servo valve 188 and variable displacement pump 190.

Hydraulic fluid flow sensing and control system 178 is connected to orbit motor 192 of grinding assembly 166. The hydraulic fluid flow control system 178 includes constant displacement gear pump 194 and fluid pressure sensor 196. Computer 198 provides logic control for the pressure control system 174, and reservoir 200 provides a source of hydraulic fluid for the pressure control system 174.

Referring to Fig. 12, cowling 118 includes opposed, field side and gauge side pillow blocks 202, 204 and correcting side plates 206, 208. Threaded aperture 210 in pillow block 204 receives the piston of side frame shifting piston and cylinder assembly 124.

Referring to Fig. 11, the gimballed pivot pin 109 includes straight pin 212 received through ball joint 214. The ball joint 214 is rotatably received within bracket 107. Cotter pin 216 retains the straight pin 109 within clevis 108.

In operation, the undercarriage 26 is maintained in a raised and locked position when transporting the grinding machine 20 to a portion of railroad track to be ground. In particular, each of the vertical lift piston and cylinder assemblies 72 for the forward, middle and rear vertical slide assemblies are retracted, lifting the entire undercarriage 26 off of the rails 34. The undercarriage 26 is maintained in a raised position by engagement of latch 84 with latch rod 90 of the U-shaped brackets 70.

Upon arrival at a portion of track to be ground, latch 84 is disengaged from U-shaped bracket 70 to permit the lowering of the undercarriage 26. The piston and cylinder assemblies 130 of spread assemblies 128 are slightly retracted such that the distance between opposed undercarriage wheels 114 is less than the distance between opposed rails 34. Once the undercarriage 26 has been lowered to a position where the undercarriage wheels 34 are nearly to the level of the top of the rails 34, the piston and cylinder assembly 130 of spread assemblyd 128 is extended, thereby pushing the undercarriage wheels 34 outwardly until the flanges of the undercarriage wheels 114 come into contact with the gauge side of the railhead of rails 34. The piston and cylinder of piston and cylinder assembly 130 of spread assembly 128 are thereupon fixed in relative position such that the undercarriage wheels 114 are rigidly maintained in contact with the rails 34.

The above described procedure for positioning the undercarriage wheels 114 into carriage supporting contact with rails 34 assumes that the undercarriage wheels 114 are basically centered about their respective horizontal slide assemblies, and that the portion of track which the undercarriage 26 is being lowered onto is generally straight. The shift piston and cylinder assembly 134 is employed to shift the undercarriage assembly 26 into engaging alignment with the rails 34 when either of the above two assumed conditions are not met. In particular, with reference to Figs. 5 or 6a, extension or retraction of wheel base shifting piston and cylinder assembly 134, while at the same time maintaining the piston and cylinder of spread piston and cylinder assembly 130 in fixed relative position, will shift undercarriage 26 to the left or right respectively along horizontal slide rod 92. Since there is an individually actuated wheel base shifting piston and cylinder assembly 130 associated with each of the forward, middle and rear horizontal slide assemblies 46, 48, 50, the undercarriage 26 can be easily manipulated for set down of the undercarriage 26 on a curved portion of the railroad track. The pivotal connection of the side frames 56, 58 to the middle horizontal slide assembly 48 permits articulation of the undercarriage 26 for positioning of the undercarriage 26 along a curved track. The gimballed pivot pins 109, 146 contribute to the flexibility of the undercarriage 26.

Each end of each individual side frame 56, 58, together with the grinding modules 158 supported on individual side frames 56, 58 can be shifted laterally across the rails 34 by extension and retraction of the side frame shifting piston and cylinder assemblies 124. Referring to Figs. 5 or 6a, with the undercarriage wheels 114 positioned in engaging contact with rails 34 by the spread assembly 128, brace plate 120 is fixed in lateral position relative to the rail 34. Extension of the associated side frame shifting piston and cylinder assembly 124 will accordingly shift cowling 118 axially along the hub 116, such as is depicted in Fig. 13. The side frames 56, 58 are fixedly attached to respective cowlings 118, and are accordingly shifted relative to the undercarriage wheel 114 and the rail 34 with which the wheel 114 is engaged.

Referring to Fig. 7, the tilt angle of each individual grinding module 158 can be adjusted by the extension or retraction of module tilt piston and cylinder assembly 172. As shown in phantom lines in Fig. 7, extension of the module tilt piston and cylinder assembly 172 tilts the grinding module 158 to the right, and retraction of the tilt piston and cylinder assembly 172 tilts the grinding module 158 to the left.

The grinding stone of each grinding module 158 is brought into grinding contact with rail 34, once the undercarriage 26 is in engagement with the rails 34, by extension of the associated module lift piston and cylinder assembly 170. The amount of metal ground from a rail 34 during a single pass of the grinding stone of the grinding module 158 along the rail 34 is a function of the speed of rotation of the stone and the amount of force with which the stone is held into contact with the rail 34.

The ability to lift each individual grinding module with the piston and cylinder assembly 170, with the ability to tilt each grinding module 158 with the tilt piston and cylinder assembly 172, along with the ability to laterally shift each end of each side frame 56, 58 with the side frame shifting piston and cylinder assemblies 124, allows the individual grinding modules 158 to be brought into contact with the rail 34 in a variety of angles and alignments, permitting great flexibility in controlling the grinding operation along curves and around obstructions. It will also be appreciated that, because of the single pivot mount of each horizontal slide assembly 46, 48, 50 to its respective vertical slide assembly, the undercarriage 26 will self-align itself parallel to the plane of the track road bed, independently of the orientation of the main frame to the road bed. This is especially significant in banked curves, where the self-aligning, parallel orientation of the undercarriage 26 to the road bed permits the precise and accurate profile grinding of the railheads. The alignment of the undercarriage to the road bed independently of the orientation of the main frame 22 is maintained, notwithstanding the requirement to provide motive force to the undercarriage 26 from the main frame 22, by transmission of motive force to the undercarriage 26 solely through brackets 138. The brackets 138 provide fore and aft motive forces to the horizontal slide rod 92 of middle horizontal slide assembly 48. Up and down and right and left shifting of the power receiving interface assemblies 148 within the brackets 138 is freely allowed.

Operation of the module pressure control system 174 can be understood with reference to Figs. 8-10. Fig. 10 schematically shows a railhead having corrugations with peaks P and valleys V along its surface. It will be appreciated by those skilled in the art that the corrugations depicted in Fig. 10 are grossly exaggerated; in practice, corrugations as small as six-hundredths of an inch can cause damage to rolling stock, and therefore must be ground smooth. The corrugations are removed by grinding metal away from the peaks in the corrugation, and by not grinding away metal in the valleys of the corrugations.

Referring to Fig. 8, the grinding stone is pushed into grinding abutment with the rail 34 by the extension of grinding module lift piston and cylinder assembly 170. The stone is rotated at a constant number of revolutions per minute by orbit motor 192. Orbit motor 192 is in turn rotated by the application of a constant flow of hydraulic fluid to the motor by constant displacement gear pump 194. As will be appreciated, maintaining a constant rate of flow of fluid through the motor 192 requires an increase in the pressure of the fluid delivered to the orbit motor 192 as the force with which the grinding stone is brought into contact with rail 34 increases.

Referring to Fig. 10, a grinding stone S is schematicly depicted in a number of sequential positions as the stone S moves along a rail 34. At position A, the grinding stone is grinding on the front side of a peak P of a corrugation. As the stone S travels from point A to point B, the pressure of the hydraulic fluid delivered to orbit motor 192 to maintain a constant flow of fluid (and thereby a constant rotational speed of the orbit motor 192), will increase. The pressure of the hydraulic fluid will increase because the stone S is held at the same elevation by the module lift piston and cylinder assembly 170 as the grinding stone S is urged across the upward slope of the corrugation peak. The module lift piston and cylinder assembly 170 will maintain the elevation of the grinding stone S until a maximum acceptable pressure is exceeded. Once the maximum acceptable pressure is exceeded, the elevation of the grinding stone S is incrementally raised until the pressure drops to an acceptable level. It will be appreciated that if the pressure of the hydraulic fluid were allowed to exceed an acceptable minimum, excessive stone wear, hydraulic line failure, and general stress of the grinding system would occur.

The grinding stone S is depicted in position B as being at the top of the corrugation peak P. As the grinding stone is urged forward along the downward slope of the corrugation peak, the pressure of the hydraulic supply fluid to orbit motor 192 will drop. It is not desirable to grind in the low spot, or valley V of the corrugation, since grinding in the valley V of the corrugation will only accentuate, rather than smooth out, the corrugation. The grinding stone S is therefore held in elevation by the grinding module tilt piston and cylinder assembly 172 until the stone S has traveled a predetermined length L, and arrives at location C in Fig. 10. The length L is set to be less than the peak to peak wavelength of the corrugations. Alternatively, when grinding across a gap in the rail 34 provided by a cross over point in a switch, the distance L can be preset to a distance just longer than the length of the longest expected gap.

After the grinding stone S has traveled the predetermined length L, the grinding module tilt piston and cylinder assembly 172 will lower the stone S at a predetermined rate. The descent of the stone will continue until the stone comes into contact with the rail 34, at location D, for instance. The pressure of the hydraulic fluid supplied to orbit motor 192 will again increase as the grinding stone S travels along the rising slope of the second peak P in the corrugation. When the pressure of the hydraulic fluid reaches a predetermined maximum (at location E), the stone S will again incrementally adjust upwardly to relieve the pressure to a point below the maximum acceptable pressure.

Fig. 9 is a flow diagram that depicts the logic process executed by computer 198 to accomplish the above described positioning of the grinding stone S. At block 202, the pressure of the hydraulic fluid supplied to orbit motor 192 is determined at fluid pressure sensor 196. The actual pressure of the fluid is compared to a minimum desired pressure at block 204. If the pressure of the hydraulic fluid is not below the minimum desired pressure, program flow is directed to block 206 where the actual pressure is compared against a maximum desired fluid pressure. If the actual pressure is not greater than a predetermined maximum, program flow is again directed to block 202 where the actual pressure is again determined, and the comparison loop of the actual pressure to the minimum and maximum desired pressures is again entered.

When the actual pressure of the hydraulic fluid delivered to orbit motor 192 drops below the desired minimum pressure, program flow is directed to block 208. At block 208, the program determines whether the most recent below minimum pressure reading is the first or a subsequent below minimum pressure reading in a consecutive series of readings. In particular, program flow is directed to block 210 if the below pressure reading is the first in the series of readings, where a "below pressure" flag is set to indicate that a first below pressure reading has been made. The program, at block 210, also begins counting off a delay distance that corresponds to the distance L in Fig. 10 through which the grinding stone S is maintained in elevation before the stone is allowed to descend. Program flow is directed from block 210 back to block 202 where another pressure reading is obtained from the fluid sensor 196.

When the pressure reading provided by fluid pressure sensor 196 is a second or subsequent below pressure reading in a series of readings, the "below pressure" flag will have already been set at block 210, and program flow will proceed from block 208 to block 212. At block 212, the program will determine whether the delay distance L has been transited by the grinding stone. If the delay distance L has not been covered by the grinding stone S, the program flow will proceed from block 212 to block 202 where another reading of the fluid pressure is obtained. When the delay distance L has in fact been covered, the program flow is directed from block 212 to block 214 where it is determined how far the most recent actual pressure reading was below the desired minimum pressure. The computer will then determine a downward distance through which the stone S should travel, depending on how far below the desired minimum pressure the most recent actual pressure reading was. The magnitude of the downward distance is greater the greater the actual pressure is below the minimum desired pressure. Program flow is next directed from block 214 to block 216 where the computer outputs a signal to servo amp 186 which results in servo valve 188 being operated to lower the grinding module lift piston and cylinder assembly 170.

Program flow is next redirected from block 216 to block 202 where another pressure reading of the hydraulic fluid delivered to the orbit motor 192 is taken. When the pressure of the hydraulic fluid is above the predetermined desired minimum pressure, but is also above the predetermined maximum pressure, the program flow is directed from block 204 to block 206, and subsequently to block 218. At block 218 the program determines how far above the desired maximum pressure the actual pressure is and computes a distance through which the grinding stone needs to be lifted to relieve the pressure. The magnitude of the distance the stone is to be lifted becomes greater as the amount the actual pressure is above the maximum desired pressure becomes greater. Program flow is next directed to block 220 where a grinding module lift signal is provided to servo amp 186, resulting in the actuation of servo valve 188 to raise the grinding module lift piston and cylinder assembly 170. The program flow is next directed from block 220 to block 222 where the "below pressure" flag previously set at program block 210 is turned off. The program then cycles again to block 202 where yet another reading of pressure of the hydraulic fluid delivered orbit motor 192 is taken, and the logic cycle begins again.

Claims

1. A railroad grinding machine (20) having a main frame (22) supported along rails (34) of a railroad track (32) and an articulated undercarriage (26) depending from said main frame, said undercarriage including forward and rear undercarriage sections (52, 54) each with wheels (114) adapted for engaging said track, said undercarriage further including means (48, 142, 144, 146) for operably pivotally coupling said forward and rear undercarriage sections, said forward and rear undercarriage sections each having operably coupled thereto at least one grinding module (158) for grinding at least one of said rails, said machine being characterized in having means (70, 98) for pivotally suspending said articulated undercarriage from said main frame about an axis substantially parallel with said tracks wherein said undercarriage is adapted for conforming to the plane defined by said railroad tracks independent of the positioning of said main frame on said railroad tracks.

2. The invention as claimed in claim 1, including means (40, 42, 44) operably coupling said main frame and said undercarriage for selectively raising and lowering said undercarriage between lowered, rail engaging and raised, rail clearing positions.

3. The invention as claimed in claim 2 including means (134) operably coupling said main frame and said undercarriage for selectively, laterally shifting said undercarriage transversely to the longitudinal axis of said railroad track, independent of the position of said main frame on said railroad track.

4. The invention as claimed in claim 3, said forward and aft undercarriage sections (52, 54) each including a right side frame (56) and an opposed left side frame (58), each of said side frames being generally aligned along the longitudinal axis of a corresponding one of said rails, said means (134) for laterally shifting said undercarriage including means (124) operably coupled to each of said right and left side frames for transversely shifting each of said opposed right and left side frames transversely across the corresponding one of said rails independently of the side frame opposed to the side frame being shifted.

5. The invention as claimed in claim 1, said means (70, 98) for pivotally suspending said articulated undercarriage from said main frame comprising a bracket (70) depending from said main frame and a rod (98) operably coupled to said undercarriage slidably received within said bracket.

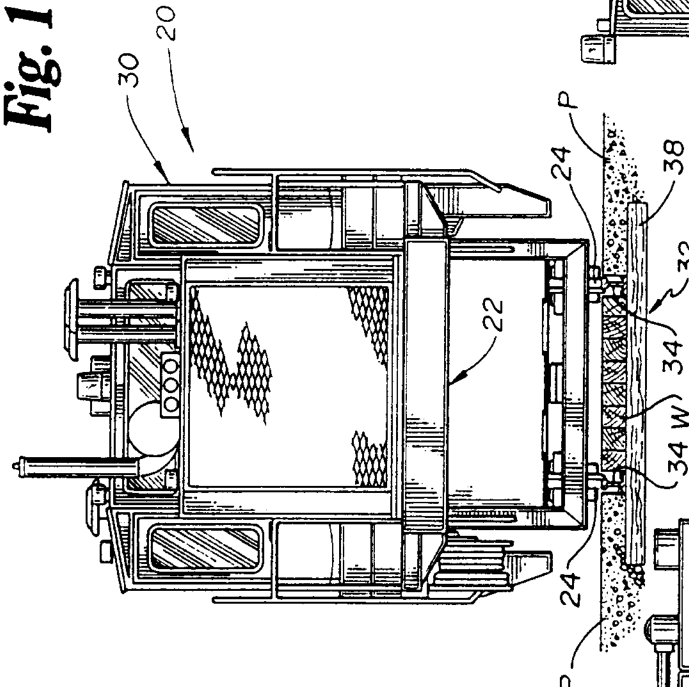

Fig. 1

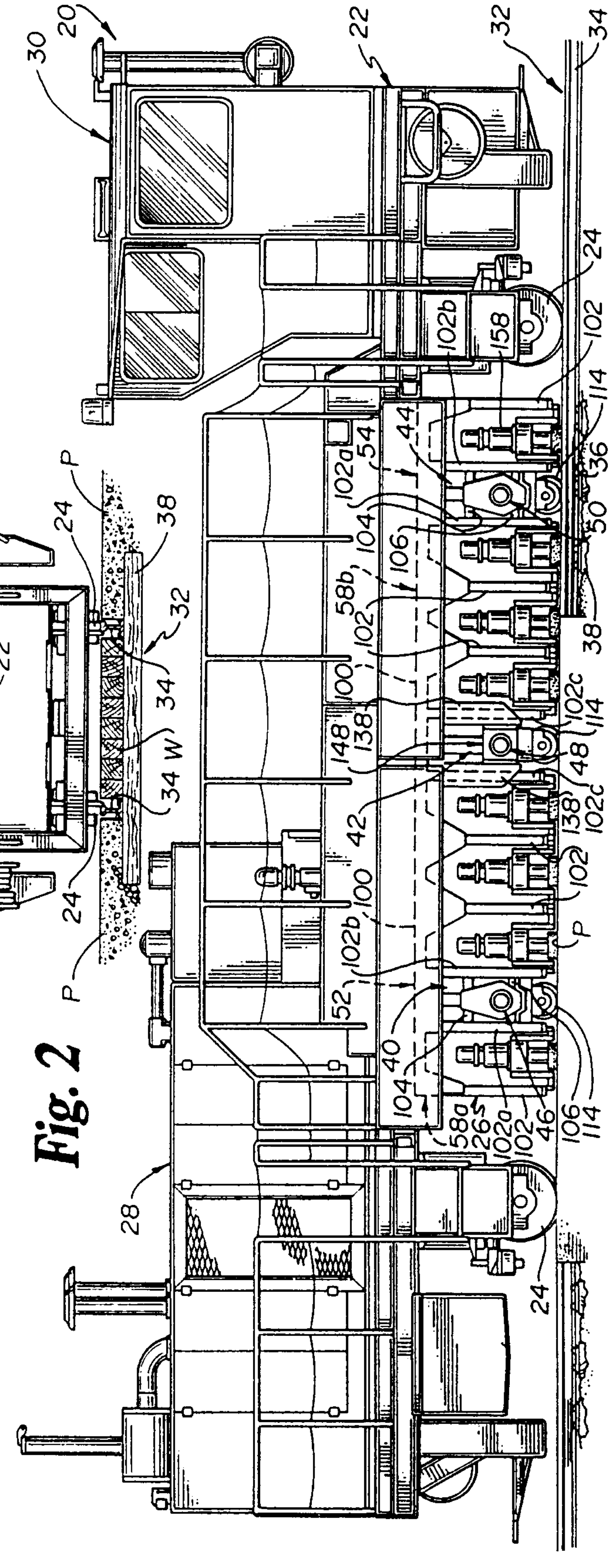

Fig. 2

Fig. 3a

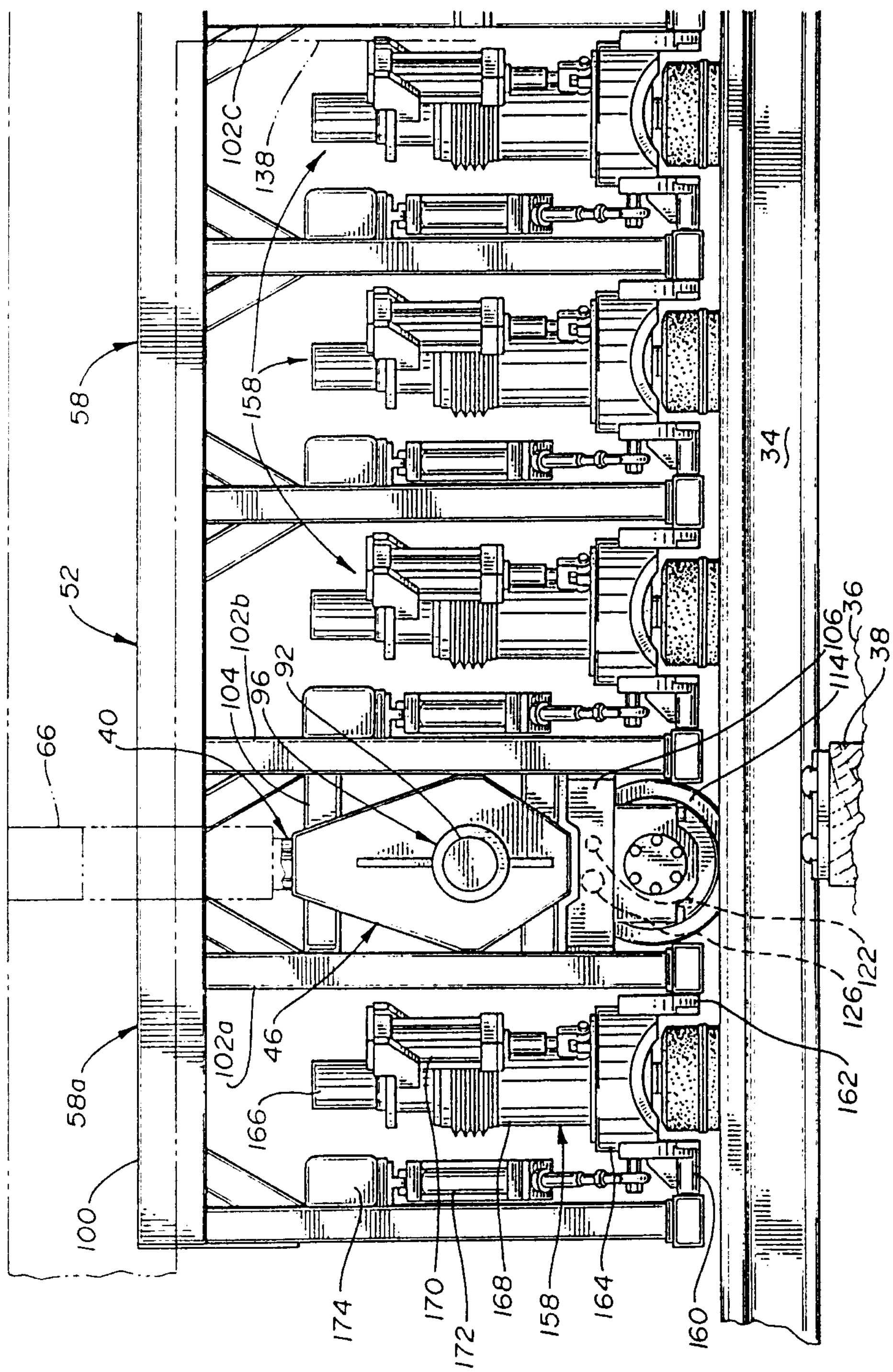
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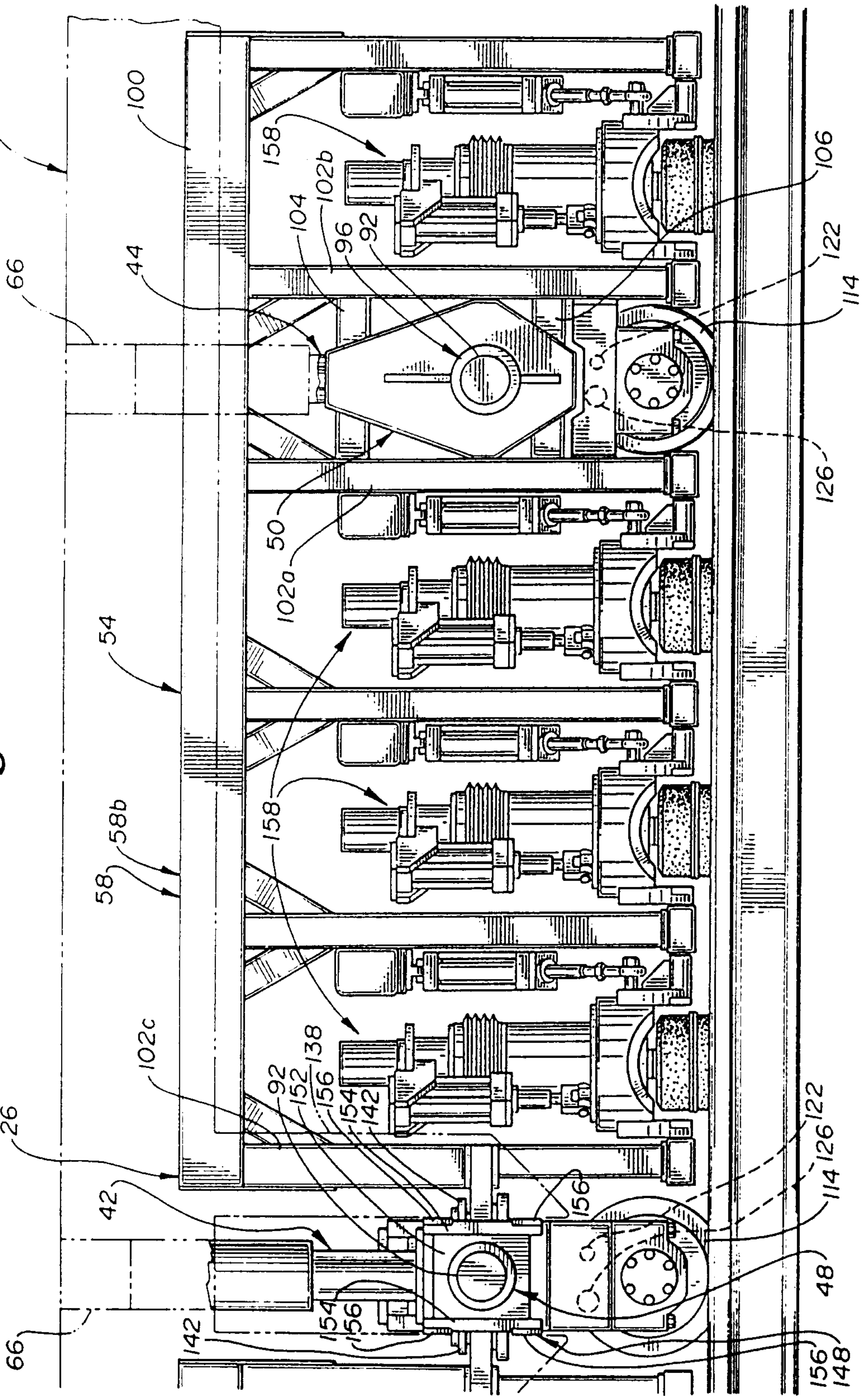
Fig. 3b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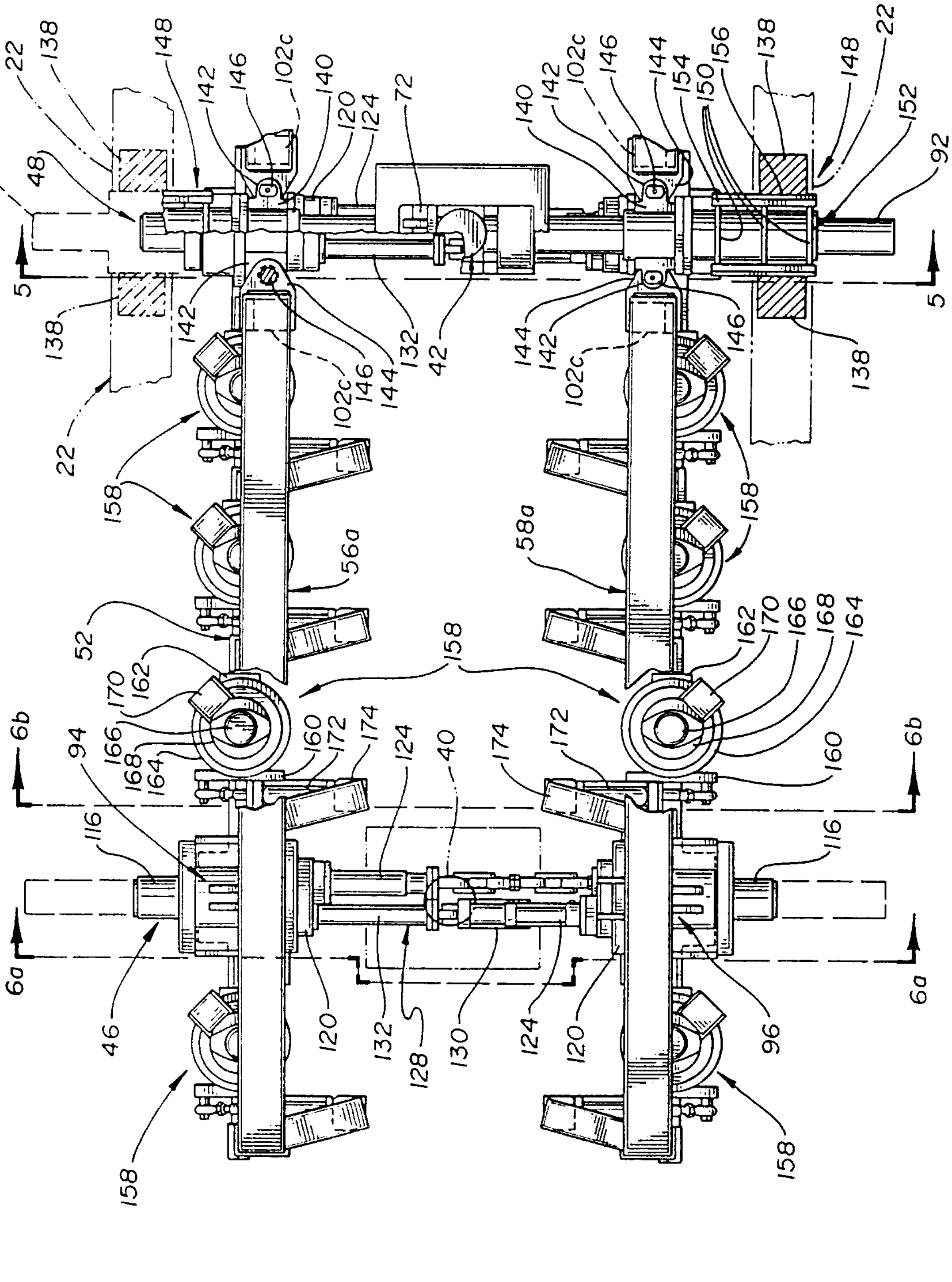
148

Fig. 4a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56a
58a
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6b
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116
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6a
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130
96

Fig. 4b

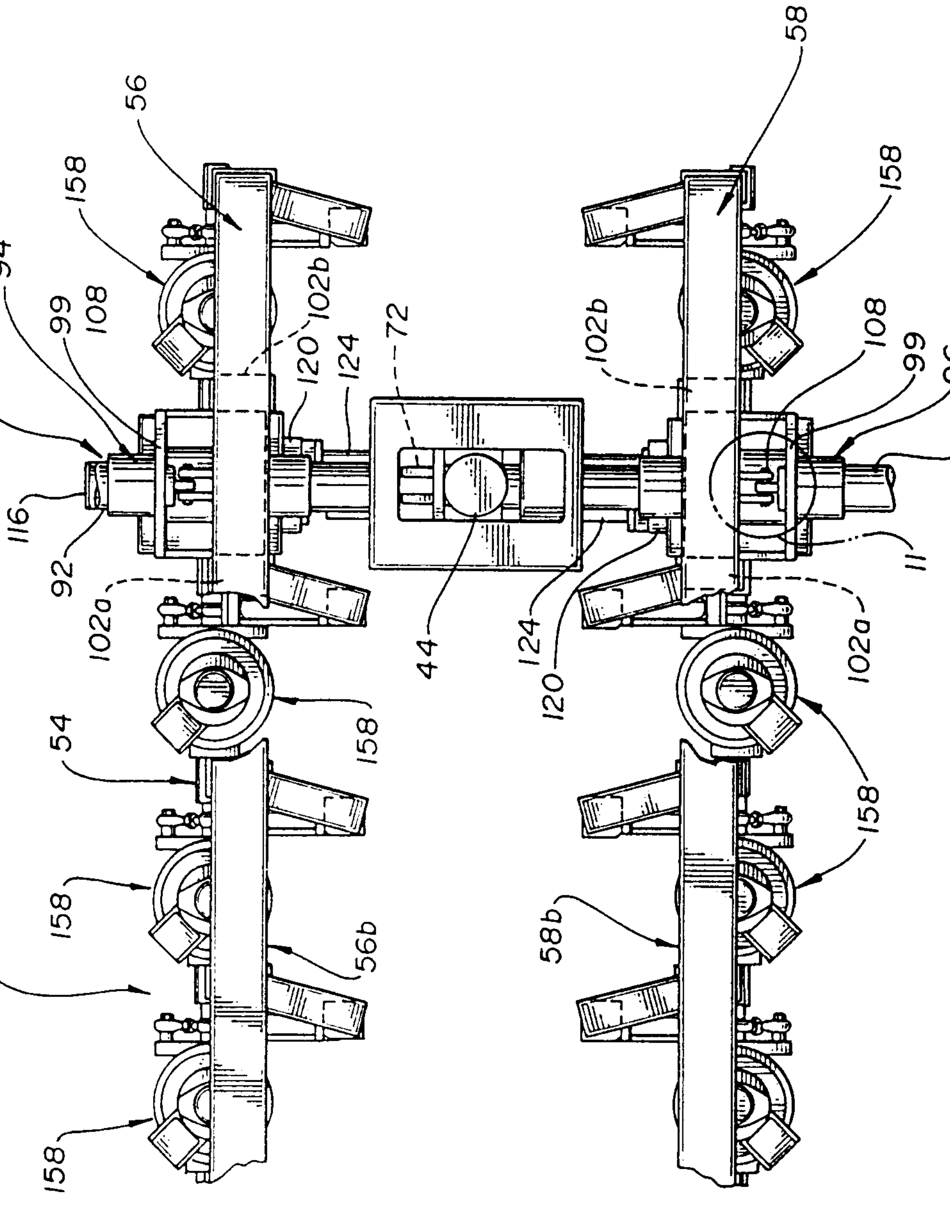
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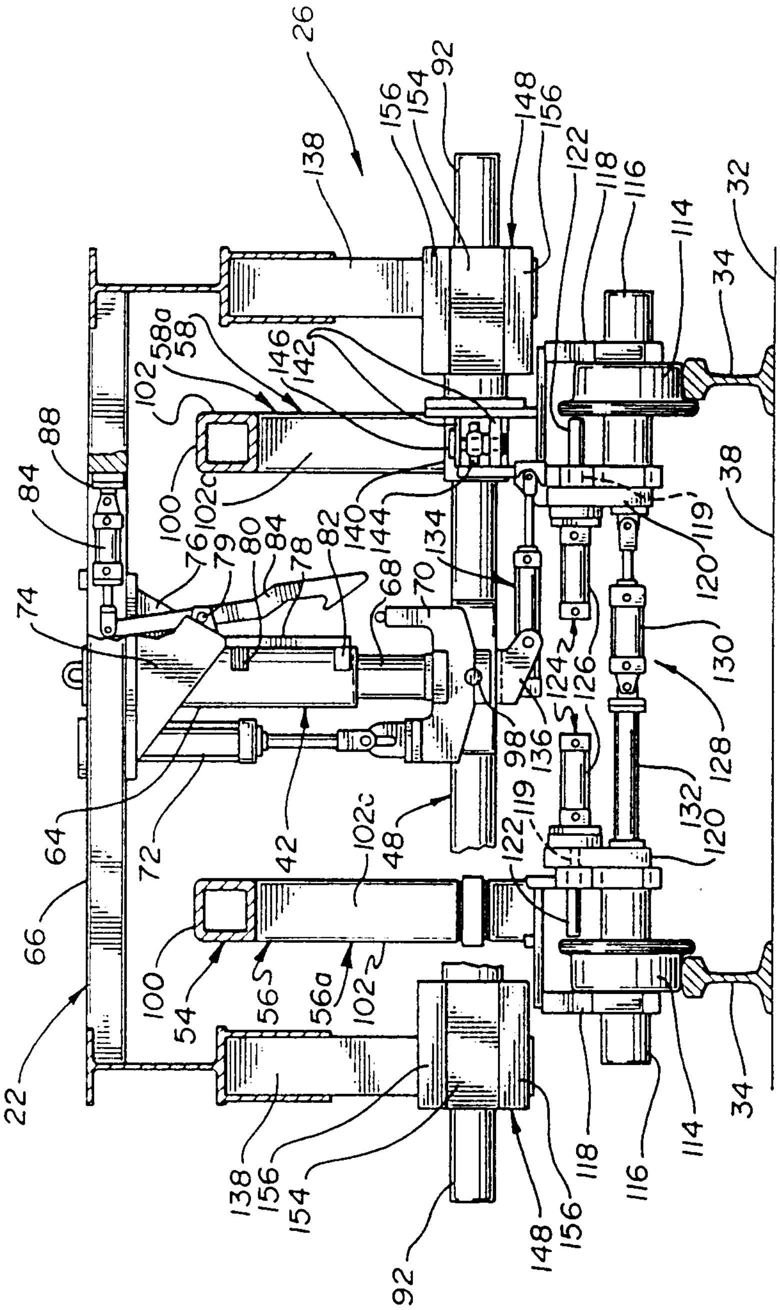
Fig. 5



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56a

Fig. 6a

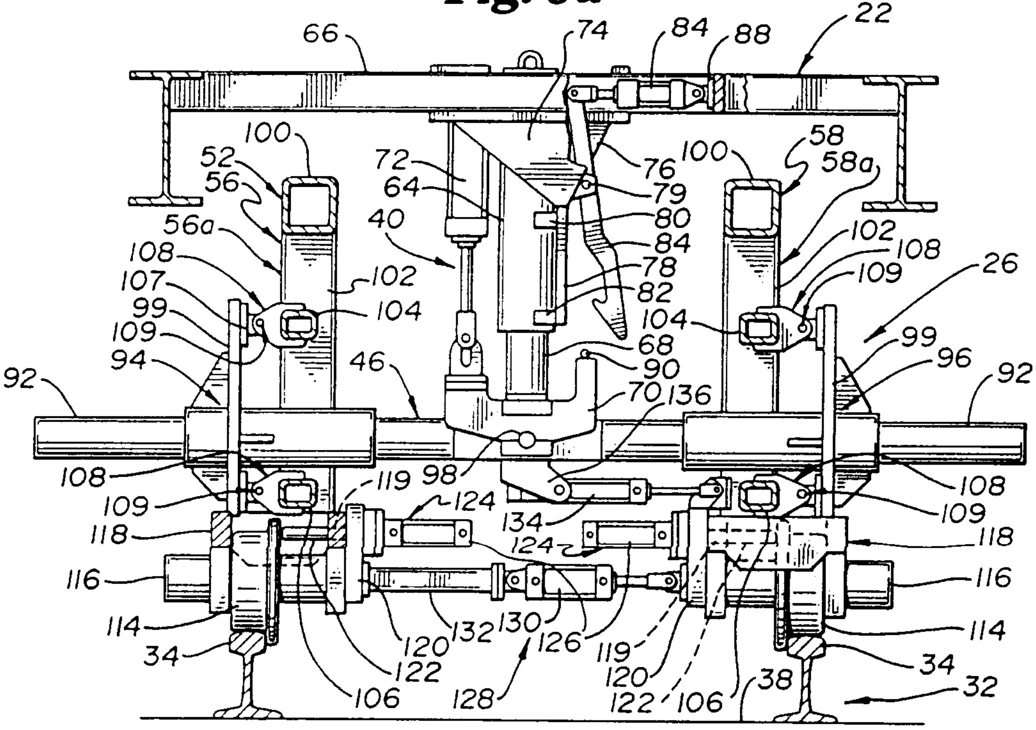
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Fig. 6b

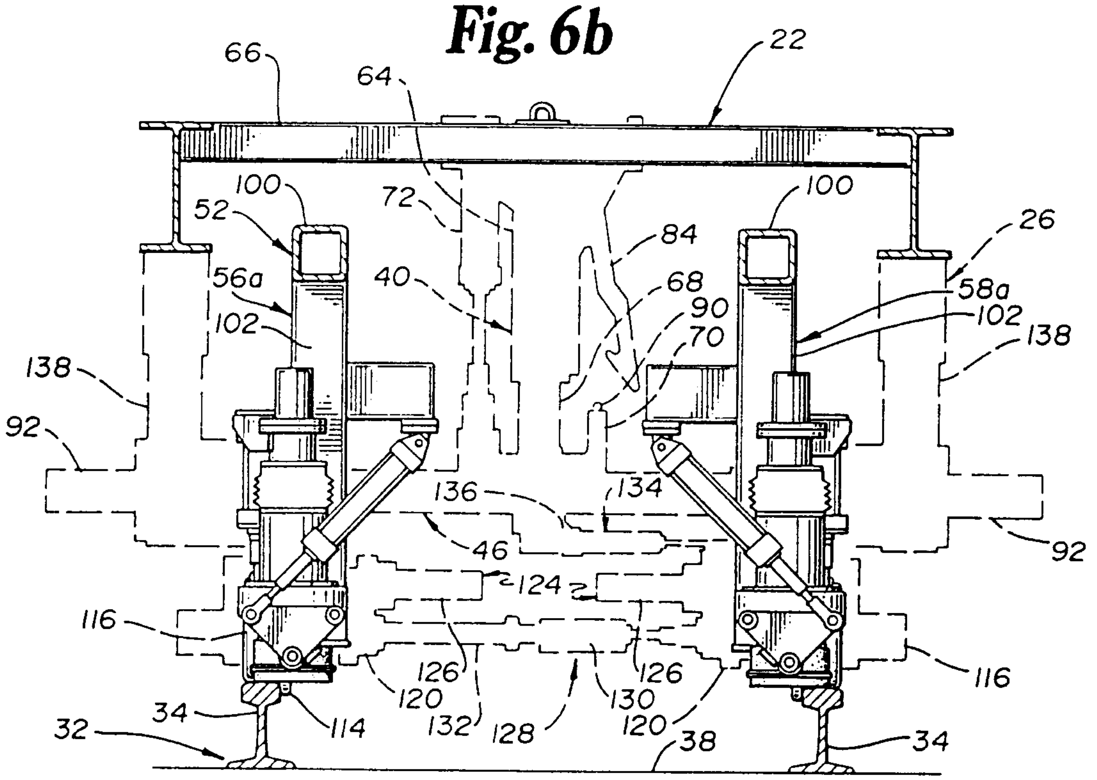
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Fig. 7

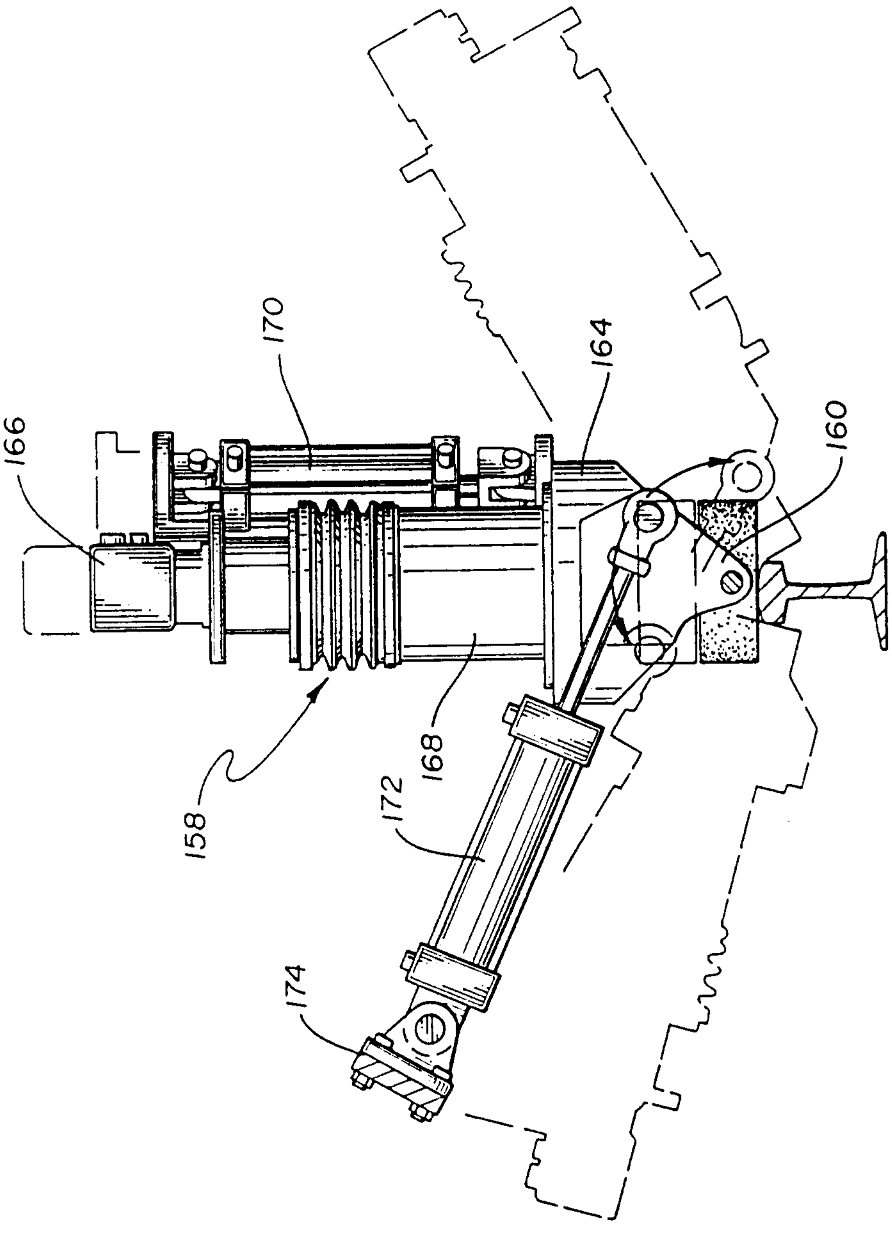
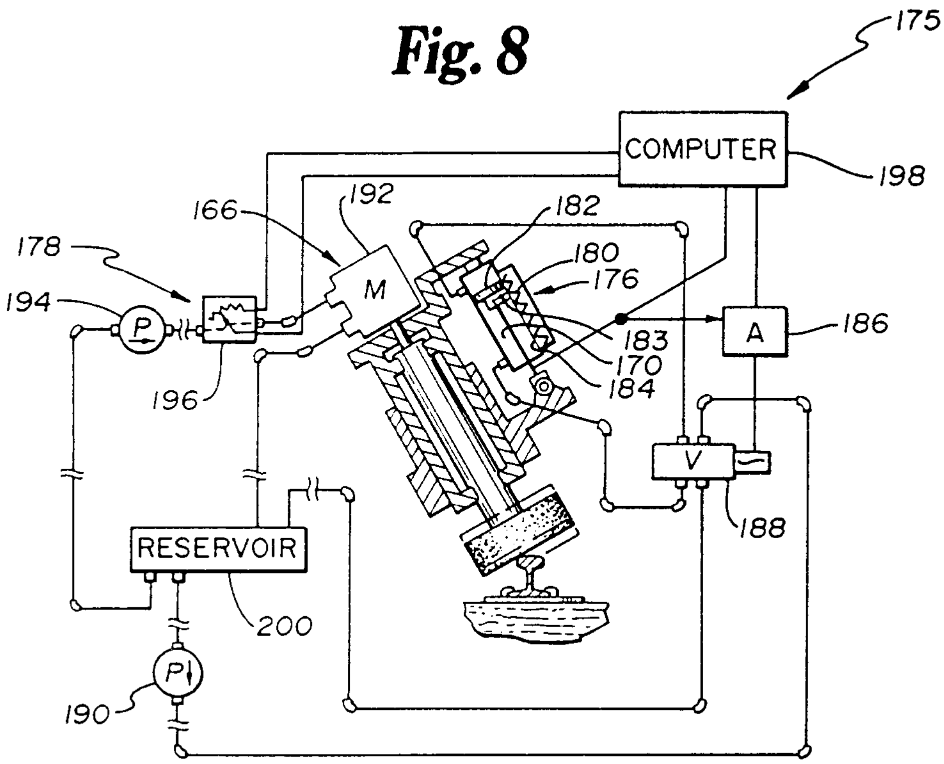


Fig. 8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P
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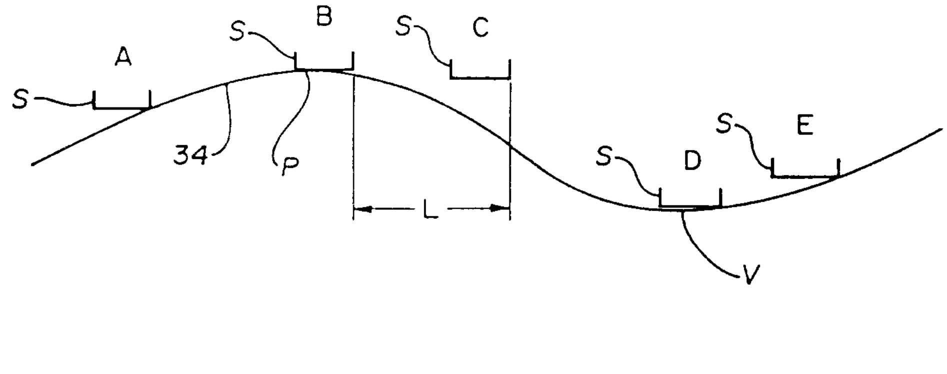
Fig. 10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D
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E
V

Fig. 9

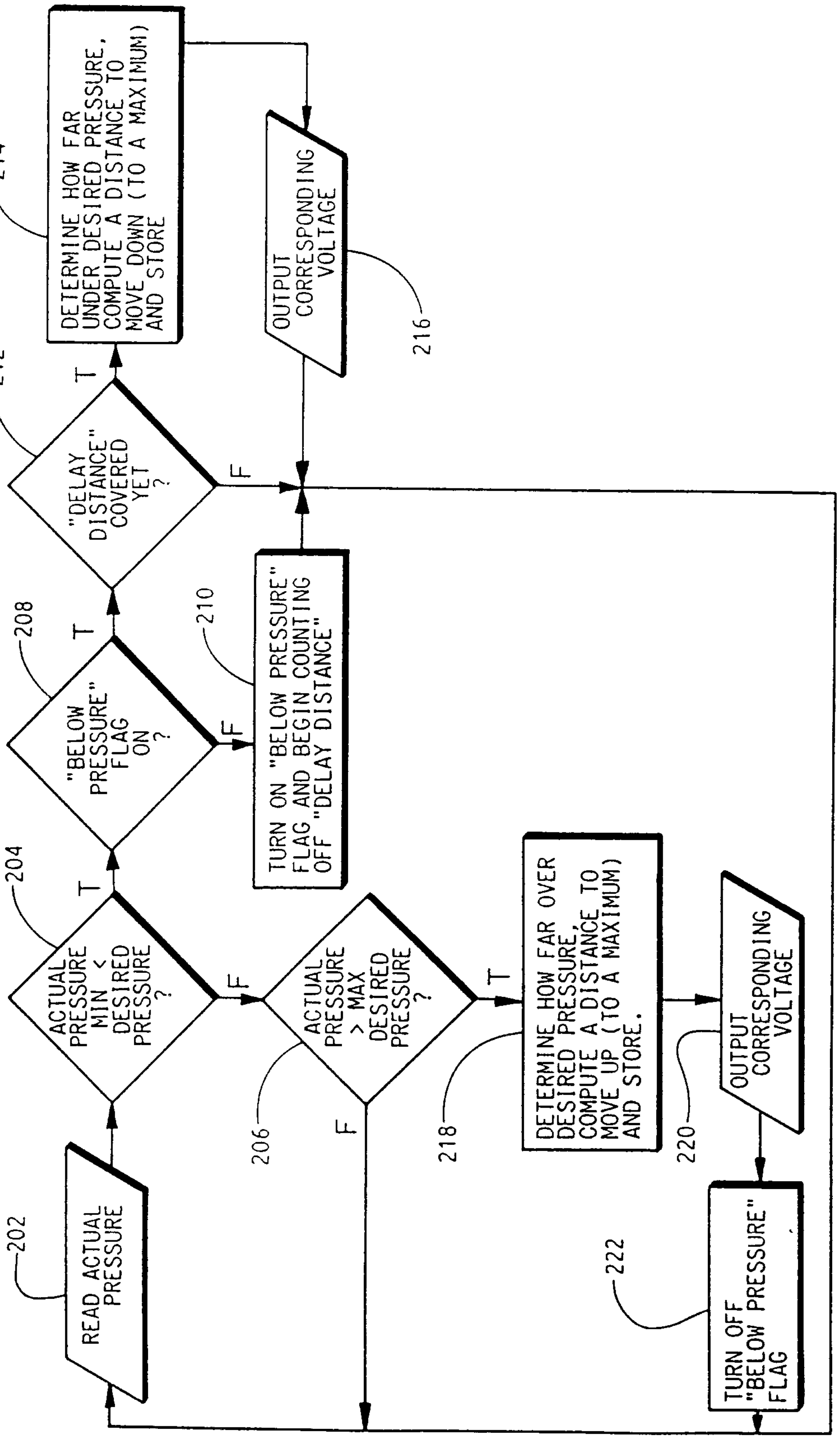

202
READ ACTUAL PRESSURE
204
ACTUAL PRESSURE MIN < DESIRED PRESSURE ?
206
ACTUAL PRESSURE > MAX DESIRED PRESS. ?
208
"BELOW PRESSURE" FLAG ON ?
210
TURN ON "BELOW PRESSURE" FLAG AND BEGIN COUNTING OFF "DELAY DISTANCE"
212
"DELAY DISTANCE" COVERED YET ?
214
DETERMINE HOW FAR UNDER DESIRED PRESSURE, COMPUTE A DISTANCE TO MOVE DOWN (TO A MAXIMUM) AND STORE
216
OUTPUT CORRESPONDING VOLTAGE
218
DETERMINE HOW FAR OVER DESIRED PRESSURE, COMPUTE A DISTANCE TO MOVE UP (TO A MAXIMUM) AND STORE.
220
OUTPUT CORRESPONDING VOLTAGE
222
TURN OFF "BELOW PRESSURE" FLAG
T
F

Fig. 12

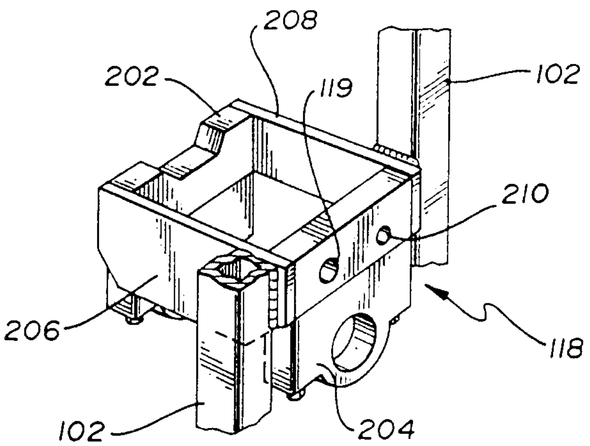


Fig. 11

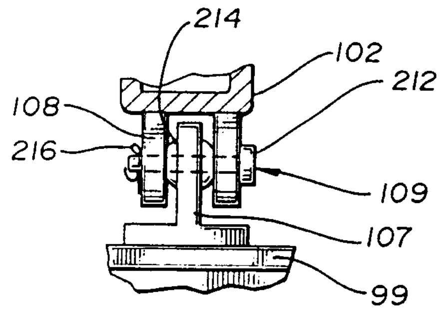
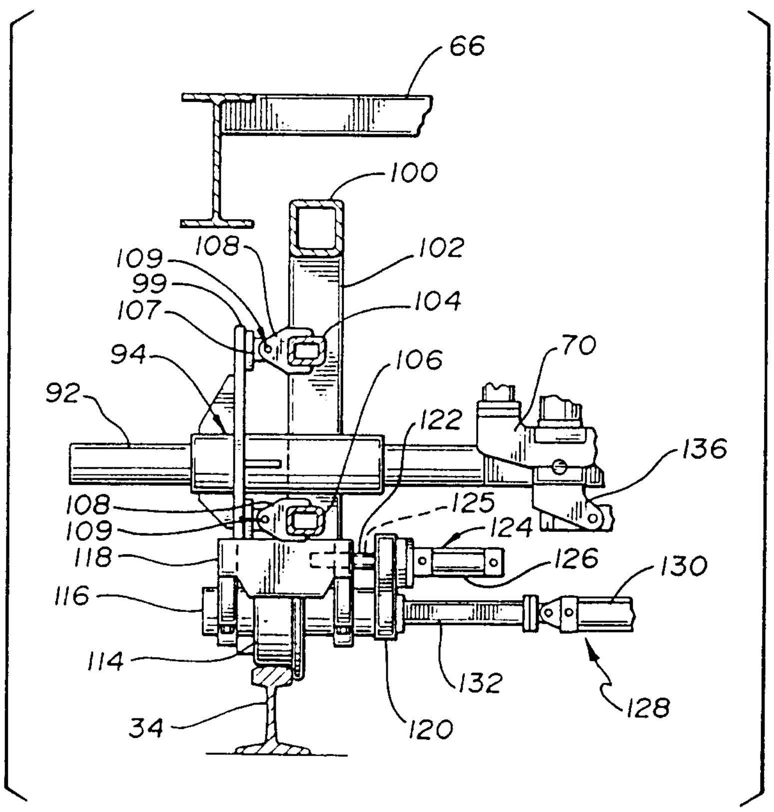


Fig. 13



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 11 6284

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	CH-A-616 186 (LES FILS D'AUGUSTE SCHEUCHZER) * page 2, right column, line 5 - line 13 * * page 2, right column, line 22 - line 40; figures 2,3 * ---	1,2	E01B31/17
A	GB-A-2 056 345 (PLASSER) ---		
A	GB-A-2 014 067 (PLASSER) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			E01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19 NOVEMBER 1992	BELLINGACCI F.

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L : document cited for other reasons

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