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April 7, 1970

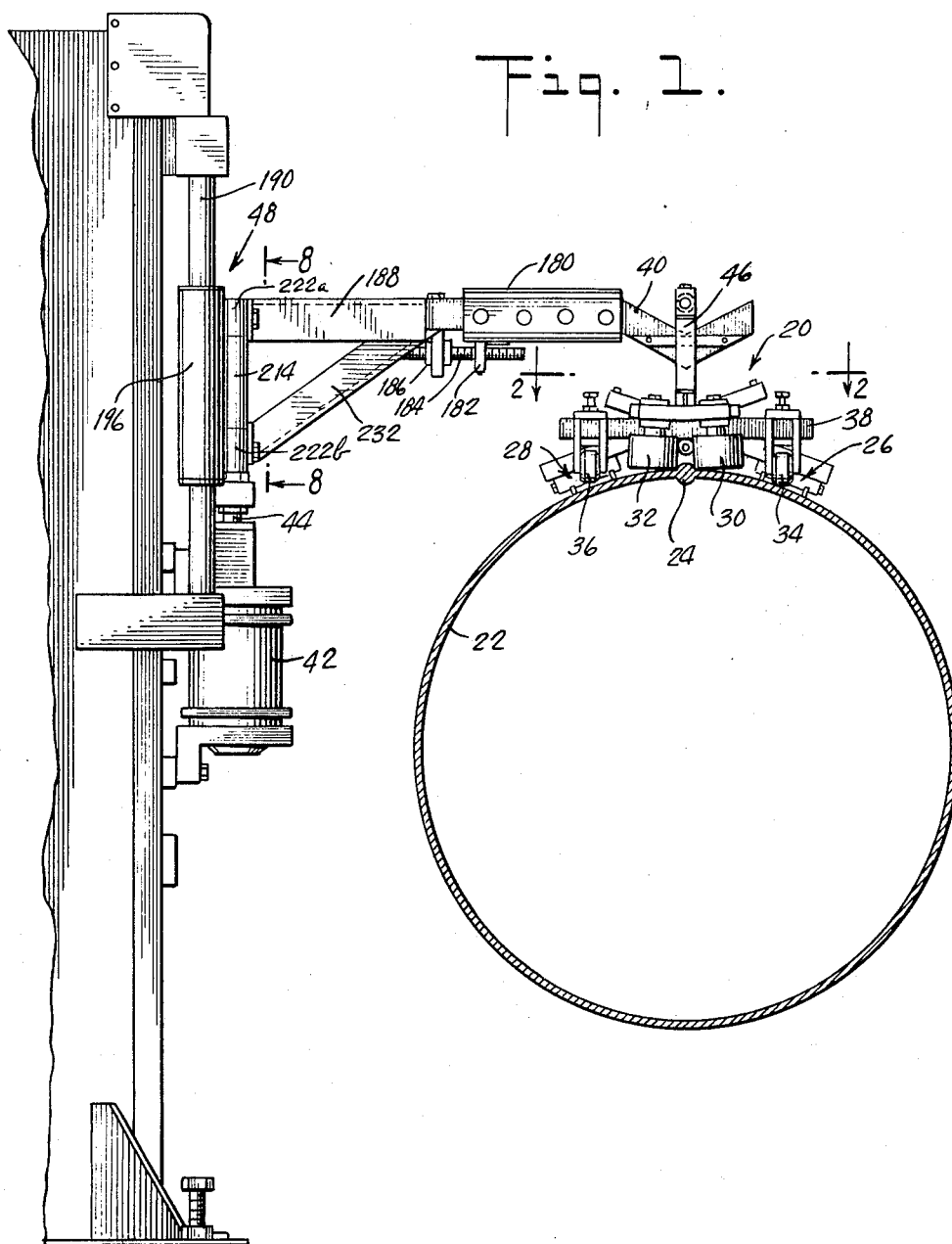
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TRACKING ASSEMBLY FOR ULTRASONIC TRANSDUCERS

Filed Nov. 9, 1967

5 Sheets-Sheet 1



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TRACKING ASSEMBLY FOR ULTRASONIC TRANSDUCERS

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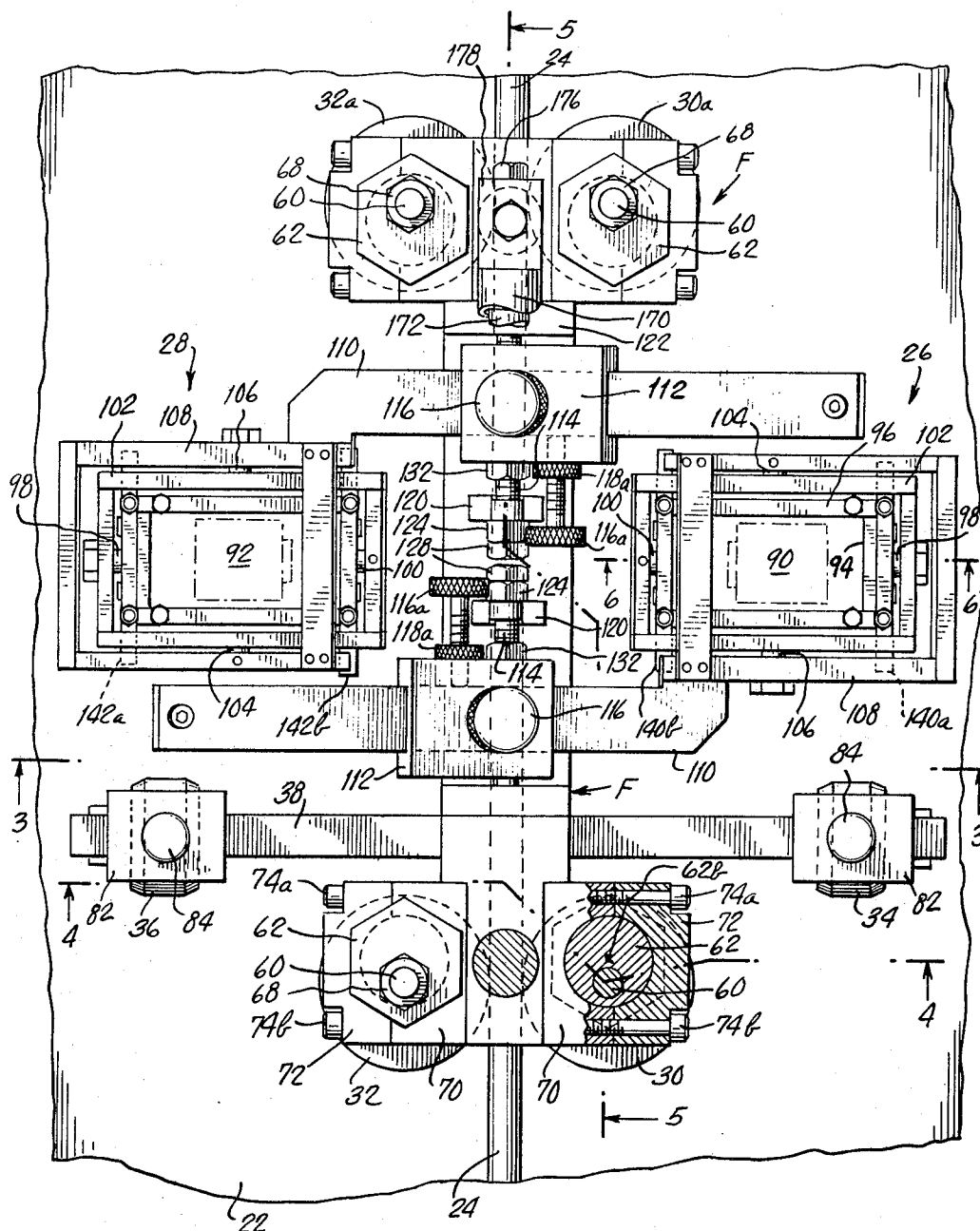


Fig. 2.

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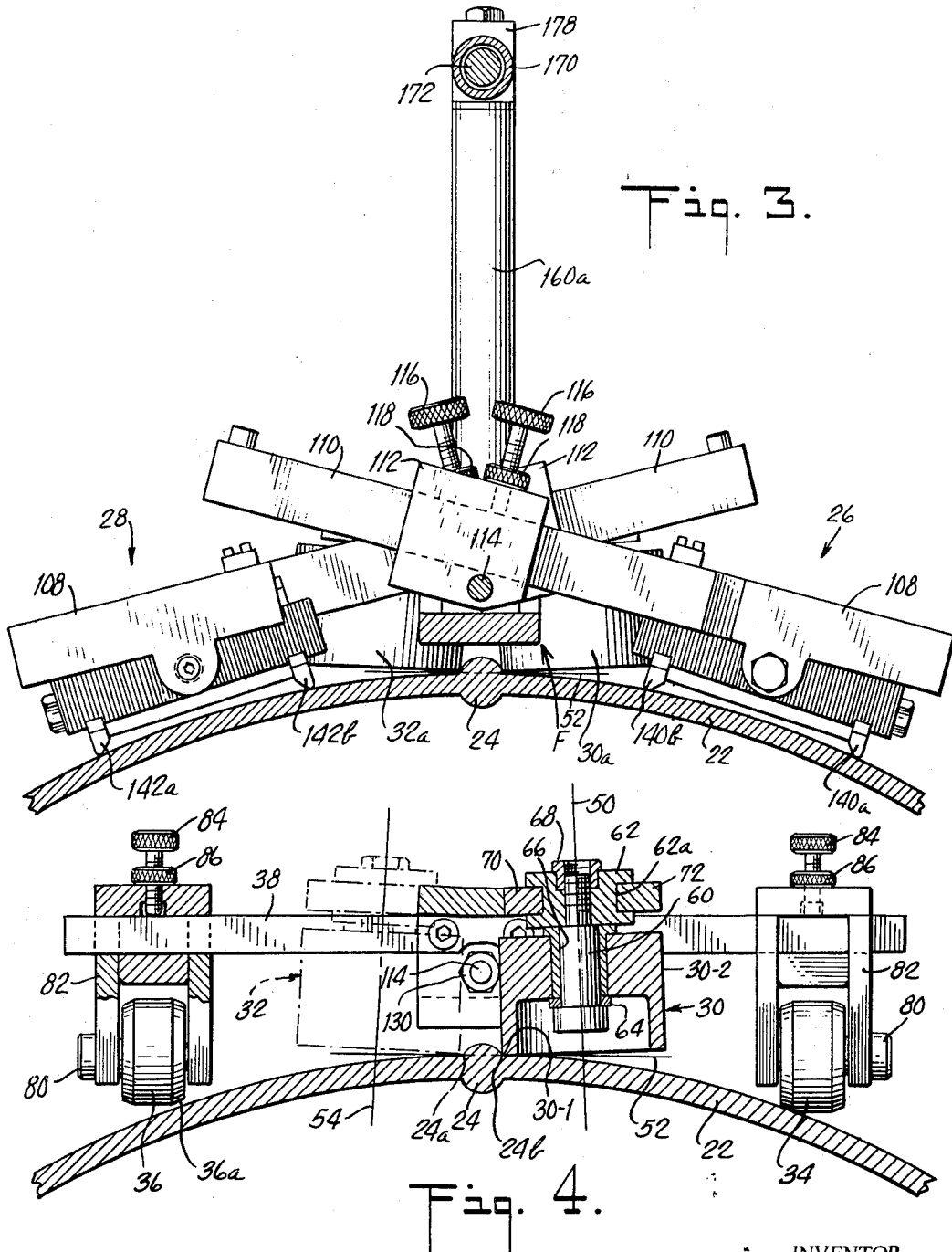
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TRACKING ASSEMBLY FOR ULTRASONIC TRANSDUCERS

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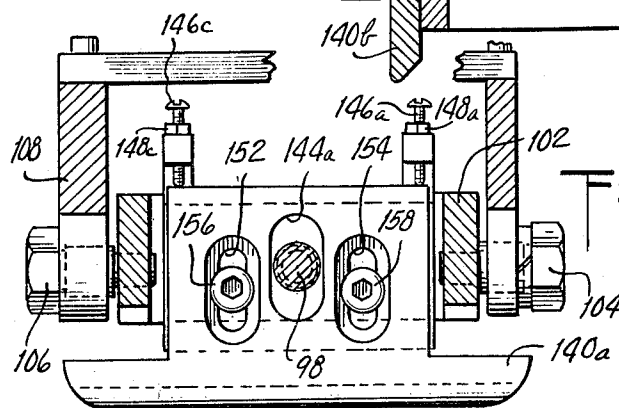
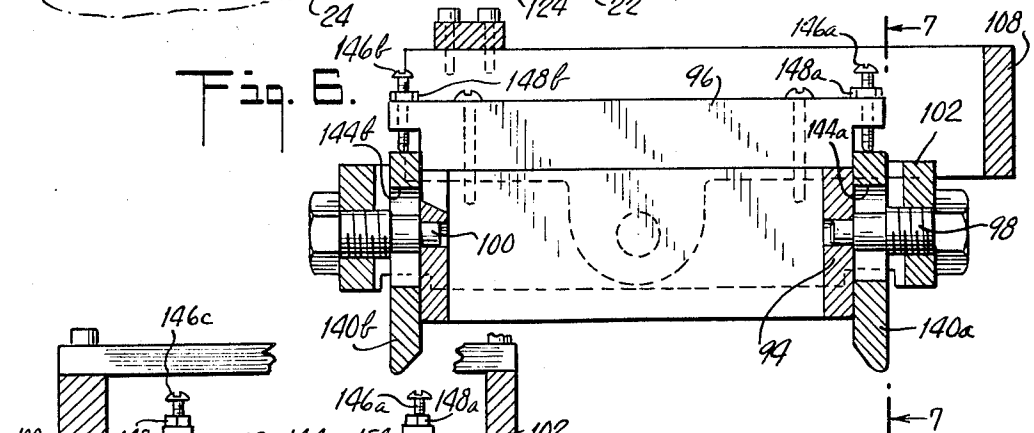
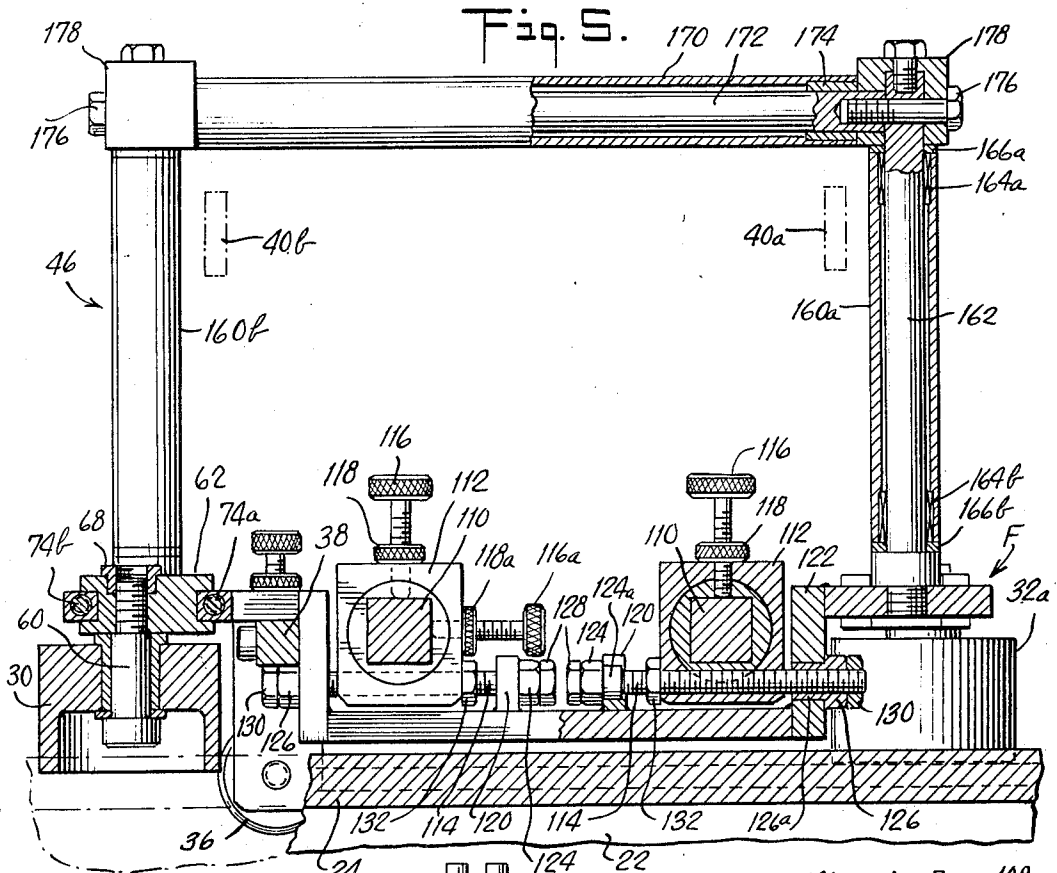
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TRACKING ASSEMBLY FOR ULTRASONIC TRANSDUCERS

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5 Sheets-Sheet 4



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TRACKING ASSEMBLY FOR ULTRASONIC TRANSDUCERS

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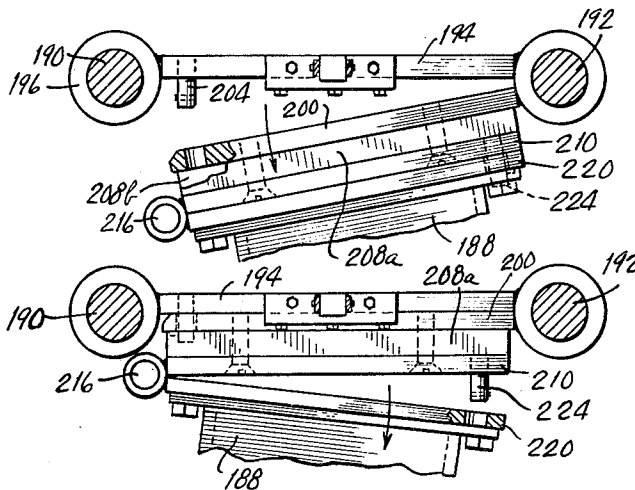
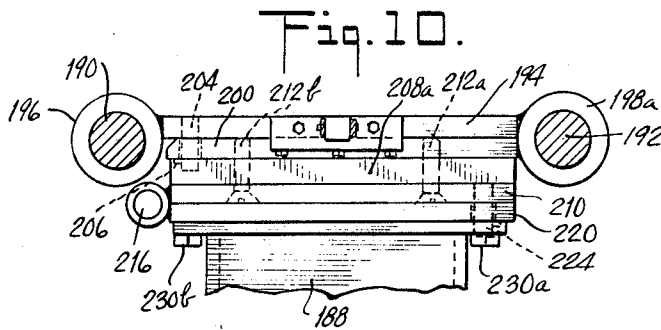
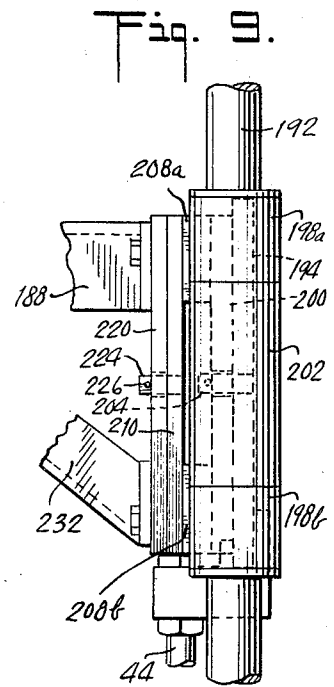
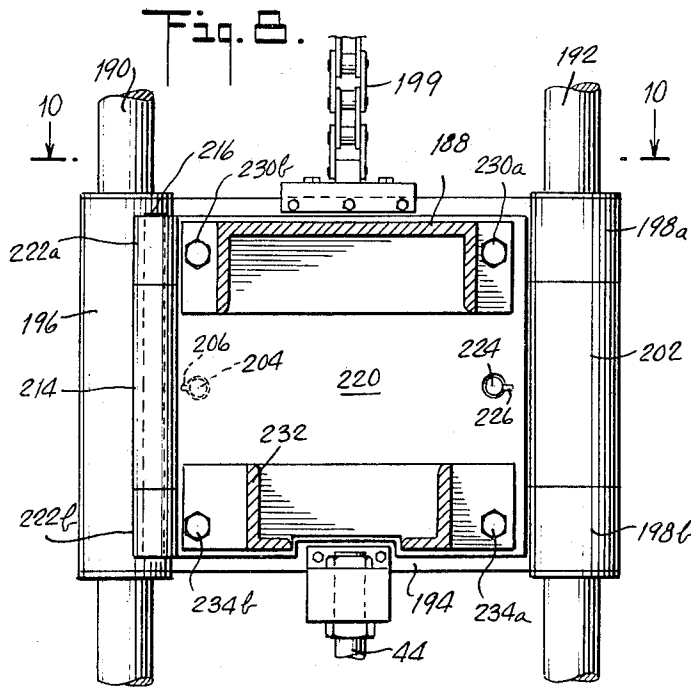


Fig. 11.

Fig. 12.

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TRACKING ASSEMBLY FOR ULTRASONIC TRANSDUCERS

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18 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for mounting a testing transducer, such as an ultrasonic transducer, in a fixed position with respect to an elongated ridge on the surface of a workpiece, such as a weld bead. A carriage assembly rides on the workpiece and has rollers mounted on both sides of the ridge for tracking the ridge. The tracking rollers are mounted for rotation about axes which are positioned on opposite sides of the ridge substantially at right angles to a plane which includes both side edges of the ridge at the base of the ridge. The axes are normally given a slight tilt. The testing transducer is typically positioned at one side of the ridge, held in place by a gimbal support which may be adjusted toward and away from the ridge as well as in a direction along the ridge. A set of outrigger rollers is included for balancing the assembly, only one of the rollers engaging the workpiece at any time. A hinge plate support is employed for carrying the carriage assembly, employing shear pins which are sheared in the event of jamming of the assembly preventing relative movement between the assembly and workpiece, allowing the assembly to rotate away from the ridge under inspection. The pins may be removed manually to swing the carriage assembly away from the ridge for servicing the assembly.

BACKGROUND OF THE INVENTION

This invention relates to testing apparatus, and more particularly to apparatus for testing the weld bead of fusion welded pipe.

Pipe is often formed by means of fusion welding, so that the finished pipe includes a weld bead along the length thereof. During the course of manufacture, it is necessary to test the bead to determine if there are flaws therein. The copending application of Gerald R. Coy, Ser. No. 379,255, filed June 30, 1964, for Testing Assembly for Testing a Weld Bead or the Like, discloses a tracking assembly for tracking a weld bead and positioning testing transducers on opposite sides of the weld bead. That assembly employs tracking rollers positioned on opposite sides of the weld bead which engage the weld bead so that, as relative movement takes place between the pipe and the carriage assembly, the tracking rollers of the assembly maintain the assembly (and hence the testing transducers) in a fixed position with respect to the weld bead. The tracking rollers of that assembly are mounted so as to rotate about an axis which is substantially parallel to the plane which includes both side edges of the weld bead at the base of the weld bead. It has been found that there may be a tendency of such rollers to ride up on the weld bead.

The present invention is directed to a carriage assembly such as that disclosed in the Coy application, including tracking rollers which eliminate the possibility of their riding up on the weld bead. Specifically, the rollers are mounted on opposite sides of a ridge on the surface of a workpiece to be tracked (e.g., a weld bead) and engage the ridge, and are mounted for rotation about axes positioned on opposite sides of the ridge substantially at

right angles to the plane which includes both side edges of the ridge at the base of the ridge. The rollers have edges thereof which engage the side edges of the ridge, and a point on the engaging edge of each roller travels substantially in the plane of the side edges of the ridge as the roller rotates. Since a point on the engaging edge of the roller travels substantially in the plane of the side edges of the ridge as the roller rotates, there is no tendency of the roller to ride up on the ridge.

The present invention also involves a simplified mounting of the testing transducers on either side of the ridge or weld bead under test. In particular, each transducer is mounted in a gimbal mounting connected to a gimbal holder which includes a rod or similar element adjustably carried in a sleeve block. The sleeve block is mounted over the ridge or weld bead under test by a threaded stud on the carriage assembly which is rotated to adjust the position of the sleeve block along the ridge. In this fashion the two transducers on both sides of the ridge may be adjusted in a direction aligned with the ridge so as to assume the proper position with respect to each other. Additionally the gimbal holder rod is adjustably carried in the sleeve block, as noted above, so as to permit simple adjustment of the gimbal assembly toward and away from the ridge.

The invention also involves a hinge plate arrangement which carries the carriage assembly during the tracking operation. In the event that the carriage assembly is jammed and relative movement between the workpiece under test and carriage assembly is prevented, a shear pin is sheared permitting the hinge plate assembly to swing, thereby to swing the carriage assembly away from the ridge under inspection.

Additionally a set of outrigger rollers is employed for balancing the testing assembly. The rollers are positioned on opposite sides of the ridge, and only one of the rollers engages the workpiece at any time. The carriage assembly is balanced on the workpiece with the outrigger rollers alternately contacting the workpiece to maintain balance. In the apparatus disclosed in the Coy application, an outrigger assembly is employed in which both outrigger rollers contact the workpiece at the same time. The arrangement of the present invention, in which only one outrigger roller contacts the workpiece at any time, prevents the assembly from being raised away from the workpiece due to minor variations in the workpiece surface.

It is thus an object of the present invention to provide a mounting assembly for a testing member used to test weld bead or the like, such that the testing member is accurately positioned with respect to the weld bead.

BRIEF DESCRIPTION OF DRAWINGS

The following detailed description should be read in conjunction with the appended drawings, in which:

FIG. 1 is a front view of a tracking assembly for tracking a weld bead in accordance with the invention.

FIG. 2 is a plan view of part of the apparatus shown in FIG. 1, drawn to a larger scale than that used in FIG. 1 and looking in the direction of the arrows 2—2 of FIG. 1.

FIGS. 3, 4, 5 and 6 are sectional views showing parts of the apparatus of FIG. 2, taken respectively along section lines 3—3, 4—4, 5—5 and 6—6 of FIG. 2.

FIG. 7 is a sectional view of the apparatus shown in FIG. 6, taken along the section line 7—7 of FIG. 6.

FIG. 8 is a view of part of the apparatus shown in FIG. 1, looking in the direction of the arrows 8—8 of FIG. 1 and drawn to a larger scale than that used in FIG. 1.

FIG. 9 is a side view of the apparatus shown in FIG. 8.

3

FIG. 10 is a sectional view of the apparatus shown in FIG. 8, taken along the section line 10—10 of FIG. 8.

FIGS. 11 and 12 are views similar to that of FIG. 10 showing the operation of a hinge plate mechanism in accordance with the invention.

DETAILED DESCRIPTION

Referring to FIG. 1, a carriage assembly 20, in accordance with the invention, is shown positioned with respect to a pipe 22 which is fusion welded to produce a longitudinal weld bead 24 to be tested for flaws. The weld bead constitutes an elongated ridge on workpiece 22. The assembly 20 is adapted to ride on the pipe 22 which is moved beneath the assembly by any suitable track and drive arrangement (not shown). Alternatively, the mounting assembly 20 could be moved over the pipe which would be maintained stationary. In any event, the assembly 20 and pipe 22 are given relative movement. During such movement two ultrasonic testing transducers, positioned on both sides of the weld bead 24 and carried in gimbal mountings 26 and 28, generate ultrasonic waves which are reflected within the pipe 22 and weld bead 24. The transducers may advantageously form a part of the testing arrangement described in United States Patent No. 3,248,222 and are employed to detect flaws within the weld bead.

The carriage assembly includes tracking rollers 30 and 32 which are positioned on opposite sides of the weld bead 24 and which engage the side edges of the weld bead at the base of the weld bead. Tracking rollers 30 and 32 are mounted for rotation about axes which are substantially vertical in FIG. 1. The axes are positioned on both sides of the weld bead and are substantially perpendicular to the plane which includes the side edges of the weld bead at the base of the weld bead. The axes may be given a slight tilt so that each is not exactly vertical or perpendicular to the plane. It has been found that such tilt aids in tracking.

A pair of outrigger rollers 34 and 36 carried at opposite ends of an outrigger arm 38 are employed to balance the assembly. Only one of the rollers rides on the surface of the pipe 22 at any time, thereby preventing the carriage assembly from being raised away from the pipe 22 due to minor variations in the surface of the pipe.

The testing arrangement includes a V-shaped lift bar mechanism 40 which is adapted to raise and lower the carriage assembly away from the pipe 22 by the action of an air cylinder 42 operating through a piston rod 44 connected to a plate (not shown in FIG. 1) that is coupled to the lift bar mechanism.

The carriage assembly includes an upstanding portion 46 which laterally engages the lift bar mechanism 40 to be retained in position so as to permit the pipe 22 to move under the carriage assembly. In the event that there is a jamming of the carriage assembly due to an imperfection in the pipe, for example, which prevents relative movement between the pipe and the carriage assembly, a hinge plate arrangement 48 (not shown) in detail in FIG. 1 but described in detail later) is employed which permits the carriage assembly to be swung away from the weld bead under test, thereby preventing damage to the assembly.

TRACKING ROLLERS

The details of the tracking rollers are shown in FIGS. 2, 3 and 4. As shown in FIG. 2, two sets of tracking rollers are employed: a front set 30 and 32, which are visible in FIG. 1; and a rear set 30a and 32a shown in FIG. 2. FIG. 4 shows the tracking roller 30 in detail. The roller 30 is mounted for rotation about an axis 50 which is substantially perpendicular to a plane 52 which includes side edges 24a and 24b of weld bead 24 at the base of the weld bead. The roller 32 is similarly mounted for rotation about an axis 54 which is substantially perpendicular to the plane 52. Advantageously the axes 50

4

and 54 are inclined slightly toward each other above the weld bead 24, each forming an angle of approximately 88° with the plane 52.

Since the tracking rollers all rotate about axes which are substantially perpendicular to the plane 52, it will be noted that a point on the contacting edge of the roller (e.g., a point on roller edge 30-1 in FIG. 4) travels substantially in the plane 52 of the weld bead side edges 24a and 24b. Taking the roller 30 as an example, it includes a side surface 30-2, which is substantially perpendicular to the plane 52 of the weld bead side edges. The lower edge 30-1 of the surface 30-2 contacts the edge 24b of the weld bead. Because a point on the contacting edge 30-1 of the roller travels in a plane that includes the edges 24a and 24b of the weld bead, any climbing of the roller up on the weld bead during tracking is effectively prevented. It has been found that the slight tilt given to the axes of rotation of the tracking rollers aids substantially in the tracking operation, maintaining the tracking rollers on the edges of the weld bead.

Each tracking roller is mounted by a screw 60 to a tracking wheel mount 62. As shown in FIG. 3, the roller 30 rotates about the screw 60 as an axis by virtue of a thrust bearing 64 and a flange bearing 66. A nut 68 engages the threaded end of screw 60 maintaining the screw in place.

As shown in FIG. 2, screw 60, constituting a tracking wheel axle, passes through the tracking wheel mount 62 in eccentric relation with respect to axis 62b of the tracking wheel mount. Referring to FIGS. 2 and 4 together, the tracking wheel mount 62 includes a circular groove 62a which is engaged by a flanged part 70 of the frame F of the carriage assembly and by a clamp 72. The frame flange 70 and clamp 72 are held together by screws 74a and 74b. If the screws 74a and 74b are loosened, the tracking wheel mount 62 may be rotated, thereby (because of the eccentric relation of the tracking wheel axle 60 with respect to the axis 62b of the tracking wheel mount 62) to move the tracking wheel 30 toward and away from the weld bead 24. In this fashion all tracking wheels are adjusted at the beginning of a testing operation to provide the proper spacing between adjacent wheels (so as to ride along the edges of the weld bead as discussed above) and the screws 74a and 74b are then tightened, thereby to tighten the clamp 72 against the frame flange 70 and to maintain the tracking wheel axle 60 in fixed position.

BALANCING ROLLERS

A single pair of outrigger rollers 34 and 36 is employed as described generally above in connection with FIG. 1. These are shown in detail in FIG. 4 and are carried at the ends of outrigger arm 38. Taking the roller 36 as an example, it includes a beveled inner edge 36a to better enable the roller to roll along the surface of pipe 22. The roller 36 is mounted by a screw 80 (serving as an axle) for rotation in a roller housing 82 carried by the outrigger arm 38. The roller housing 82 is slidable along the outrigger arm and is maintained in fixed position on the arm by a thumb screw 84 which, after being tightened, is maintained in place by a check nut 86.

The two outrigger rollers 34 and 36 are adjusted along the outrigger arm 38 so that, for the object under test, only one of the rollers rides on the surface of the workpiece at any time. The carriage assembly is thus allowed to balance on the workpiece, with position maintained by the tracking rollers 30, 32 and 30a, 32a and with balance maintained by contact between the workpiece and one of the outrigger rollers 34 and 36. The contact may alternate often between rollers during a test. Since both outrigger rollers do not ride on the surface of the pipe at the same time, imperfections in the surface of the pipe can be tolerated, and both rollers will not ride up on imperfections. In this fashion the carriage assembly is prevented from being raised away from the weld bead.

TRANSDUCER MOUNTING

The gimbal mountings 26 and 28 shown in FIG. 1 mount the testing transducers as shown in detail in FIG. 2. A pair of transducers 90 and 92 is positioned on both sides of the weld bead 24, as shown diagrammatically in FIG. 2. Each gimbal mounting includes a transducer holder 94 that carries the transducer and that is mounted in a first frame 96. The frame 96 is pivotally suspended by screw pivots 98 and 100 within a second frame 102 that is in turn pivotally suspended by screw pivots 104 and 106 within a frame 108 constituting a gimbal holder. The pivots 98 and 100 are along a first axis and the pivots 104 and 106 are along a second axis perpendicular to the first axis. The perpendicular axes thereby provide a gimbal mounting for the transducer to permit the transducer to be oriented properly against the surface of the workpiece.

Each gimbal holder 108 includes a rod-like extension 110 which extends through a slot in an associated sleeve block 112. As shown in FIGS. 2 and 3, the rod 110 extends over the weld bead 24, through the sleeve block 112. The sleeve block, supporting the rod 110, is in turn supported by a stud 114. The stud 114 is positioned above the weld bead 24 as shown in FIGS. 2 and 3. The sleeve block 112 includes thumb screws 116 and 116a which extend into the sleeve block and engage the rod 110. The thumb screws 116 and 116a are loosened and the rod 110 moved within the sleeve block until the transducer is positioned at the proper lateral distance away from the weld bead 24. The thumb screws are then tightened to bear against the rod 110 and to fix its position with respect to the sleeve block 112. Check nuts 118 and 118a are then tightened against the sleeve block to secure the rod 110 in this fixed position. This procedure is followed for both transducers 90 and 92.

Each sleeve block 112 is mounted on the associated threaded stud 114 as shown in FIG. 5. The stud is supported in parts 120 and 122 of the main carriage assembly frame F. Nuts 124 and 126 are employed for support, each of which has a sleeve (124a and 126a) which serves as a bearing so that the stud and nuts may freely rotate within the frame parts 120 and 122. A pair of jam nuts 128 and 130 at the ends of the stud are threaded into tight engagement with the bearing nuts 124 and 126 after the bearing nuts have been adjusted to permit smooth rotation of the stud assembly within the frame parts 120 and 122. A further jam nut 132 bears against the sleeve block 112 to fix the sleeve block with respect to the stud 114.

By this mounting of sleeve block on stud, the sleeve block and stud are free to rotate together. In this fashion the gimbal holder 108 shown in FIG. 3 (since it is connected to the sleeve block 112 by the rod 110) may pivot about the axis of the stud 114 so that the transducer assembly 26 is positioned against the surface of the pipe 22. The weight of the gimbal mounting and transducers maintains the transducer against the pipe. Regardless of imperfections on the pipe, the transducer will always ride in position because of the free pivoting action of the sleeve block 112 and associated stud 114.

It will be noted from FIG. 2 that the two transducers 90 and 92 are mounted opposite each other on opposite sides of the weld bead 24. In order to align the transducers in a direction along the weld bead, the jam nuts 132 are loosened against the sleeve blocks 112. The studs 114 are then rotated, and since they are threaded through the sleeve blocks 112, each sleeve block moves along its stud in one direction or the other depending upon the direction of rotation of the stud. The stud 114 is rotated until the corresponding sleeve block is properly positioned (the movement of the transducer is parallel to the direction of elongation of the weld bead). When the two transducers are properly aligned, the jam nuts 132 are tightened against the sleeve blocks.

The distance of the transducers 90 and 92 away from the surface of the pipe under inspection is controlled by wear shoes 140a, 140b, and 142a, 142b (FIG. 3). The wear shoes 140a and 140b are shown in detail in FIG. 6. They are connected to the transducer holder 94 as shown and include openings 144a and 144b, through which the pivots 98 and 100 respectively pass. The openings are much larger than the diameter of the pivots to allow for sufficient adjustment of the wear shoes toward and away from the pipe under inspection. The top surfaces of the wear shoes bear against set screws 146a and 146b shown in FIG. 6 (as well as against two other set screws, not shown in this figure) which are threaded through portions of frame piece 96. The screws are adjusted and then tightened by nuts 148a and 148b for proper positioning of the wear shoes.

One of the wear shoes (shoe 140a) is shown in FIG. 7; all wear shoes are the same. Two adjustment screws 146a and 146c are employed as shown. The wear shoe is slotted as at 152 and 154; screws 156 and 158 pass through the slots and are secured into the transducer holder 94. The screws 156 and 158 are loosened, and the wear shoe 140a is adjusted upwardly or downwardly, as the case may be, by adjustment of the set screws 146a and 146c, until the transducer carried by the holder 94 is positioned the proper distance from the pipe. The set screws 146a and 146c are then locked in position by nuts 148a and 148c. Next the screws 156 and 158 are tightened, fixing the position of the wear shoe.

CARRIAGE ACTUATION

As noted above with respect to FIG. 1, this embodiment of the invention provides for the positioning of the carriage assembly over the weld bead, with relative movement between the weld bead and carriage assembly provided for by movement of the pipe underneath the carriage assembly. This operation is representative; if desired, the carriage assembly could be moved over the pipe, the pipe being kept stationary. However, in practice the carriage assembly is typically positioned after the welding station (not shown) that forms the weld bead in the pipe, in order to test the weld bead. It is most advantageous in such a case to maintain the carriage assembly fixed and to test the pipe as it is produced and passes under the carriage assembly. The details of positioning the carriage assembly are disclosed fully in the Coy application referred to above. However, they will be repeated here for completeness.

The V-shaped lift bar mechanism 40 shown in FIG. 1 includes two parts, 40a and 40b, shown in FIG. 5. These parts bear against tubes 160a and 160b, respectively, in the carriage assembly, which tubes form parts of the upstanding carriage assembly portion 46 briefly mentioned in connection with FIG. 1. The tubes 160a and 160b are constructed in the same fashion, and the mounting of the tube 160a will be explained in detail.

The tube 160a is mounted for free rotation about a shaft 162 that is mounted on the carriage assembly frame F. Needle bearings 164a and 164b as well as thrust bearings 166a and 166b provide for rotation of the tube about the shaft. As the pipe 22 is moved underneath the carriage assembly, one of the parts 40a and 40b of the V-shaped arm assembly 40 bears against the associated one of tubes 160a and 160b to maintain the carriage assembly in fixed position. The carriage assembly is free to move laterally with respect to the weld bead, under the action of the tracking rollers following a weld bead that is not exactly straight, since the tubes 160a and 160b are free to rotate.

A similar freely rotatable tube 170 is positioned at the top of the carriage assembly supported by a shaft 172 and a bearing assembly, only one of which is shown (bearing 174) in FIG. 5. The shaft 172 is joined to the shaft 162 by a screw 176 and cap 178. When the carriage assembly is raised or lowered by the raising or lowering

of the lift bar mechanism 40 through the action of the air cylinder 42, shown in FIG. 1, the tube 170 rotates freely so that it is always carried in the bottom of the V of the V-shaped lift bar mechanism. This provides for the simple positioning of the carriage assembly over the weld bead; the lift bar is lowered during tracking.

Lateral adjustment of the lift bar mechanism 40 is provided for, as shown in FIG. 1. The mechanism includes a plate 180 which carries a nut 182. Adjustment screw 184 is threaded through the nut and is supported by a bushing 186. The adjustment screw is rotated, causing the nut 182 and plate 180 to move laterally with respect to the weld bead, thereby moving the lift bar 40 which slides within a slide bracket 188.

HINGE PLATE MECHANISM

As described above in FIG. 1, the invention includes a hinge plate mechanism 48 permitting the carriage assembly to be swung away from the weld bead 24. This mechanism is shown in FIGS. 8 to 12.

Referring to FIG. 8, a pair of slide rods 190 and 192 are included for providing up-and-down movement of the carriage assembly as occasioned by the air cylinder 42 acting through the cylinder rod 44. The cylinder rod is connected to a plate 194 that is connected to a cylindrical sleeve 196 which slides along the rod 190 and a pair of cylindrical sleeves 198a and 198b which are spaced vertically along the rod 192 and are free to slide along the rod. A chain 199 is connected to a counterweight (not shown) to raise the carriage assembly in the event of a failure in the pneumatic system. A second plate 200 (FIG. 10) is attached to a sleeve 202 positioned between the sleeves 198a and 198b which also slides along the rod 192. The plates 194 and 200 serve respectively as rear and front hinge plates of a first hinge plate assembly. The plate 200 is free to pivot about the rod 192 by virtue of sleeve 202. However, the plates 194 and 200 are maintained in abutting relationship, as shown in FIG. 10, by a pin 204 which is fastened to the plate 194 and which extends through the plate 200, in association with a shear pin 206 which passes through the pin 204 to maintain the two plates against each other.

A set of spacer plates 208a and 208b (see FIGS. 9 and 10) are positioned against the front hinge plate 200, and against these two spacer plates there is positioned another hinge plate 210. The hinge plate 210, the spacer plates 208a and 208b, and the hinge plate 200 are all secured together in a sandwich relationship by screws 212a and 212b. The hinge plate 210 is also attached to a cylindrical sleeve 214 (FIG. 8) which encircles a rod 216 positioned alongside the rod 190. A final hinge plate 220 is positioned against the hinge plate 210. The hinge plate 220 is secured to two sleeves 222a and 222b positioned respectively above and below the sleeve 214. The rod 216 also passes through the sleeves 222a and 222b. The plates 210 and 220 constitute respectively rear and front hinge plates of a second hinge plate assembly. These two hinge plates are secured in abutting relationship by a pin 224 which is attached to the rear hinge plate 210 and which passes through the front hinge plate 220, in association with a shear pin 226 which passes through the pin 224 to maintain the two hinge plates closed together.

Slide bracket 188 is secured to the front hinge plate 220 by bolts 230a and 230b. Similarly a support bracket 232 (see also FIG. 1) providing support for the slide bracket 188 is also secured to the front hinge plate 220 by bolts 234a and 234b.

The rear and front hinge plates 194 and 200 provide for the pivoting of the carriage assembly away from the weld bead in one direction, and the rear and front hinge plates 210 and 220 provide for the pivoting of the carriage assembly away from the weld bead in the other direction as follows: If the shear pin 206 is removed or sheared off, the front hinge plate 200 is free to pivot about the shaft 192, as shown in FIG. 11, carrying the other

hinge assembly with it and swinging the slide bracket 188. The entire carriage assembly is thereby pivoted in a counterclockwise direction looking downwardly upon the carriage assembly. The shear pin 206 will be sheared automatically in the event that there is a jamming of the carriage assembly which prevents relative movement between the carriage assembly and the pipe under inspection with the pipe moving from left to right in FIG. 5. Since the pipe is continuously moving underneath the carriage assembly, the carriage assembly is swung away from the weld bead after the shear pin 206 is sheared, thereby preventing damage to the carriage assembly.

In the same fashion, with the pipe moving from right to left in FIG. 5, any jamming between pipe and carriage assembly will cause the shear pin 226 to be sheared, permitting the front hinge plate 220 to move away from the rear hinge plate 210 of the other hinge plate assembly (as shown in FIG. 12) with the front hinge plate 220 swinging about the rod 216, thereby to swing the carriage assembly free of the weld bead. Of course, the shear pins 206 and 226 may be manually removed at any time that it is desired to service the carriage assembly, in which case the carriage assembly can be swung in either direction away from the weld bead in order to provide for easy servicing.

SUMMARY

A carriage assembly has been provided for tracking a weld bead or the like involving unique tracking roller and balancing roller arrangements, advantageous mounting of transducers for easy transducer adjustment, and advantageous mounting of the entire carriage assembly to permit the carriage assembly to be swung away from the weld bead under test in the event of jamming between weld bead and carriage assembly or as required for servicing. The invention should be taken to be defined by the following claims.

I claim:

1. In apparatus for positioning a testing member with respect to an elongated ridge on the surface of a workpiece, including a carriage assembly for mounting the testing member in an operating position, said carriage assembly having a pair of tracking rollers mounted on opposite sides of the ridge and engaging the ridge so as to accurately position the testing member with respect to the ridge as relative movement is occasioned between the workpiece and the carriage assembly, the improvement wherein the rollers are mounted rotation about axes positioned on opposite sides of the ridge substantially at right angles to a plane which includes both side edges of the ridge at the base of the ridge.

2. Apparatus as defined in claim 1, wherein said rollers have edges thereof which engage the side edges of the ridge, a point on the engaging edge of each roller traveling substantially in said plane of said side edges of said ridge as the roller rotates.

3. Apparatus as defined in claim 1, wherein said rollers have sides which are substantially perpendicular to said plane of said side edges of said ridge.

4. Apparatus as defined in claim 1, wherein said axes of roller rotation are inclined slightly toward each other.

5. Apparatus as defined in claim 1, wherein said axes of roller rotation form an angle of about 88° with respect to said plane of said side edges of said ridge.

6. Apparatus as defined in claim 1, wherein said rollers are adjustably mounted so as to permit the spacing of the rollers from each other to be varied in order to accommodate ridges of different sizes.

7. Apparatus as defined in claim 6 wherein said rollers rotate about axes, and the adjustment mechanism for each roller comprises a collar and an axle holder mounted for rotation within the collar, said axle being connected to said axle holder in an eccentric relation with respect to the axis of rotation of said axle holder so that rotation

of said axle holder within the collar causes said axle to move toward and away from said ridge.

8. Apparatus as defined in claim 1, including an outrigger arm connected to the carriage assembly mounting another pair of rollers on opposite sides of the ridge and spaced a greater distance apart than said tracking rollers in order to prevent tipping of the assembly, said other rollers being mounted so that only one of said rollers is in contact with the workpiece at any time.

9. Apparatus as defined in claim 1, including means mounting the carriage assembly for movement about an axis away from the elongated ridge.

10. Apparatus as defined in claim 1, including means responsive to relative movement between carriage assembly and workpiece for moving the carriage assembly away from the elongated ridge if such relative movement ceases while the workpiece or carriage assembly is moving.

11. Apparatus as defined in claim 1, including a hinge plate assembly that carries the carriage assembly, the hinge plate assembly including a hinge plate mounted for rotation about an axis and maintained in fixed position by a shear pin, jamming of the carriage assembly preventing relative movement between the workpiece and the carriage assembly causing a shearing of the shear pin, permitting the hinge plate to rotate about its axis and move the carriage assembly away from the ridge so as to prevent damage to the carriage assembly.

12. Apparatus as defined in claim 11, including a second hinge plate mounted for rotation about a second axis and maintained in fixed position by a second shear pin, jamming of the carriage assembly preventing relative movement between the workpiece and the carriage assembly in one direction causing a shearing of one of the shear pins, permitting the associated one of the hinge plates to rotate about its axis and move the carriage assembly away from the ridge so as to prevent damage of the carriage assembly, and jamming of the carriage assembly preventing relative movement between the workpiece and the carriage assembly in the other direction causing a shearing of the other shear pin, permitting its associated hinge plate to rotate about its axis and move the carriage assembly away from the ridge so as to prevent damage to the carriage assembly.

13. Apparatus as defined in claim 1, wherein said carriage assembly includes a threaded stud substantially aligned with said elongated ridge, a sleeve block engaging the threaded stud so that rotation of the stud causes movement of the sleeve block in a direction aligned with the ridge, and a transducer holder coupled to the sleeve block for positioning the transducer with respect to the ridge.

14. Apparatus as defined in claim 13, wherein the transducer holder extends transversely away from the ridge and includes an arm engaged by the sleeve block permitting relative movement with respect to the sleeve block so as to permit adjustment of the distance between the transducer and ridge.

15. Apparatus as defined in claim 1, wherein the carriage assembly is mounted on a welded pipe including a weld bead thereon which constitutes the elongated ridge and wherein the carriage assembly rides over the weld bead with the tracking rollers mounted on opposite sides

of the weld bead, with each tracking roller being rotatable about an axis which is substantially vertical.

16. In apparatus for positioning a testing member with respect to an elongated element, including a carriage assembly for mounting the testing member in an operating position, said carriage assembly including tracking rollers for tracking the elongated element, the improvement wherein the carriage assembly is mounted by a hinge plate assembly, the hinge plate assembly including a hinge plate mounted for rotation about an axis and maintained in fixed position by a shear pin, jamming of the carriage assembly preventing relative movement between the elongated element and the carriage assembly causing a shearing of the shear pin, permitting the hinge plate to rotate about its axis and move the carriage assembly away from the elongated element so as to prevent damage to the carriage assembly.

17. Apparatus as defined in claim 16, including a second hinge plate mounted for rotation about a second axis and maintained in fixed position by a second shear pin, jamming of the carriage assembly preventing relative movement between the elongated element and the carriage assembly in one direction causing a shearing of one of the shear pins, permitting the associated one of the hinge plates to rotate about its axis and move the carriage assembly away from the elongated element so as to prevent damage to the carriage assembly, and jamming of the carriage assembly preventing relative movement between the elongated element and the carriage assembly in the other direction causing a shearing of the other shear pin, permitting its associated hinge plate to rotate about its axis and move the carriage assembly away from the elongated element so as to prevent damage to the carriage assembly.

18. In apparatus for positioning a testing member with respect to an elongated ridge on the surface of a workpiece, including a carriage assembly for mounting the testing member in an operating position, said carriage assembly having a pair of tracking rollers mounted on opposite sides of the ridge and engaging the ridge so as to accurately position the testing member with respect to the ridge as relative movement is occasioned between the workpiece and the carriage assembly, and an outrigger arm connected to the carriage assembly mounting another pair of rollers on opposite sides of the ridge and spaced a greater distance apart than said tracking rollers in order to prevent tipping of the assembly, the improvement wherein said other rollers are mounted so that only one of these rollers is in contact with the workpiece at any time.

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JAMES J. GILL, Primary Examiner

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