73-639 SR SEARCH ROOM
OR 3,371,524
X 3706 V

March 5, 1968 J. T. WLOSZEK 3,371,524

APPARATUS FOR POSITIONING A SEARCH UNIT

Filed Oct. 15, 1964 6 Sheets-Sheet 1

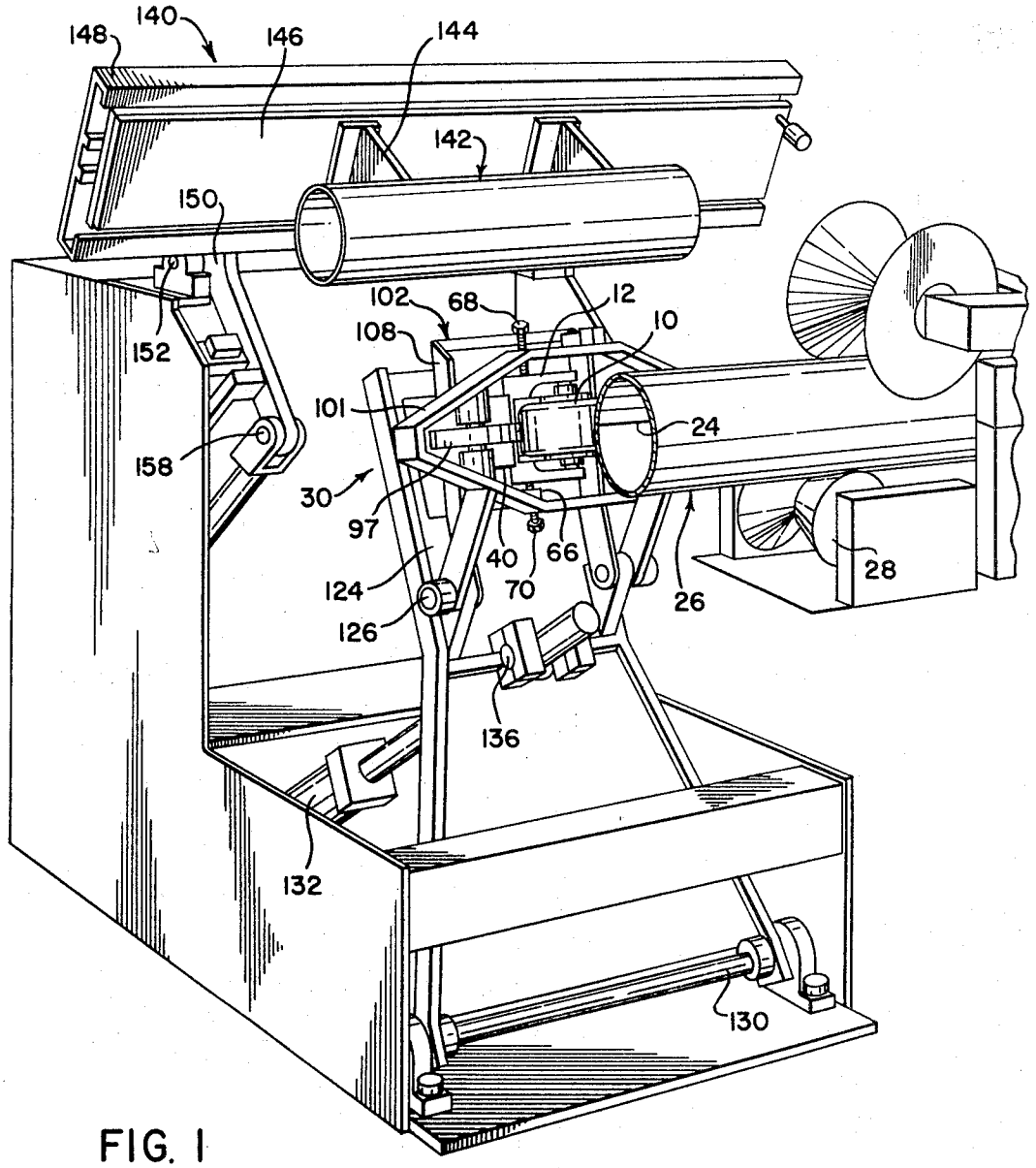


FIG. 1

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APPARATUS FOR POSITIONING A SEARCH UNIT

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FIG. 2
(PRIOR ART)

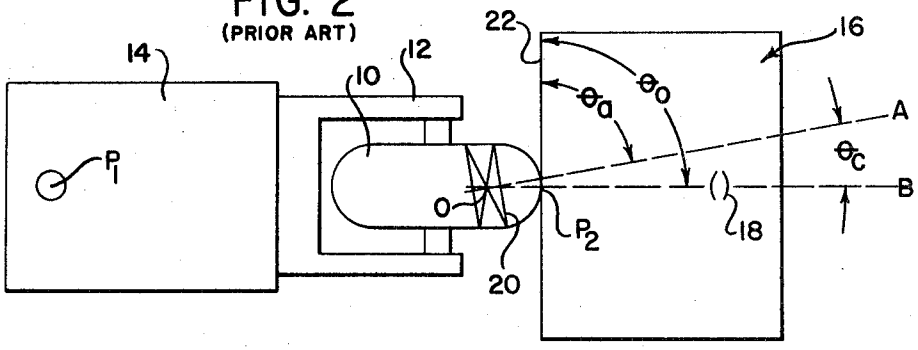


FIG. 3
(PRIOR ART)

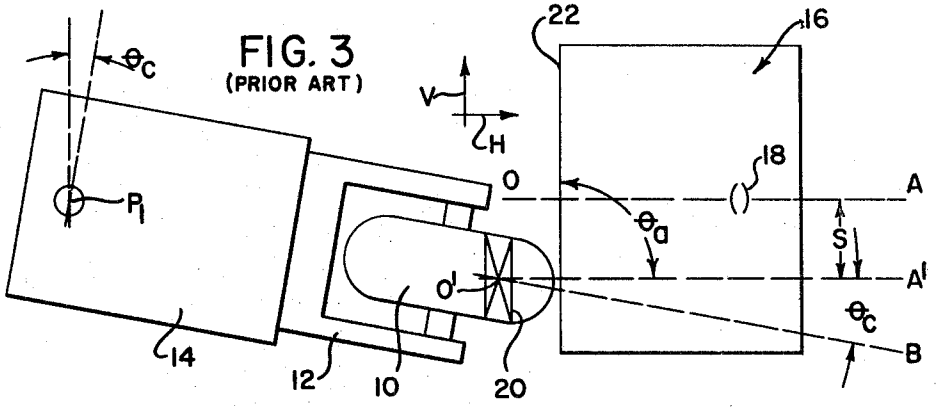
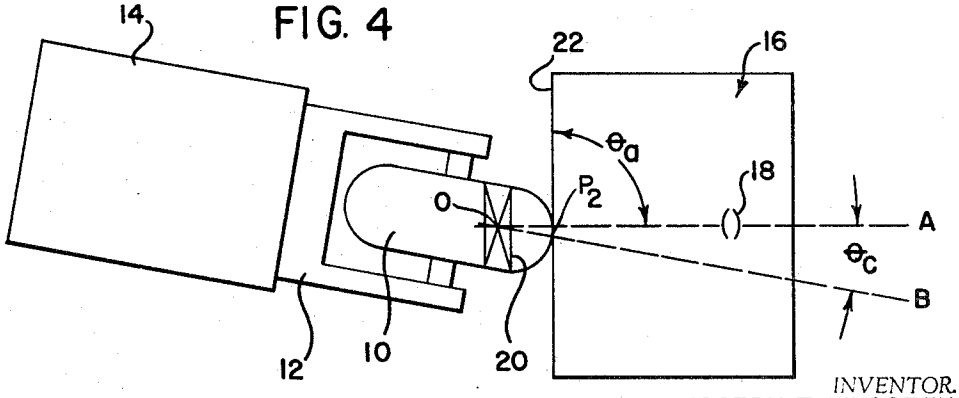


FIG. 4



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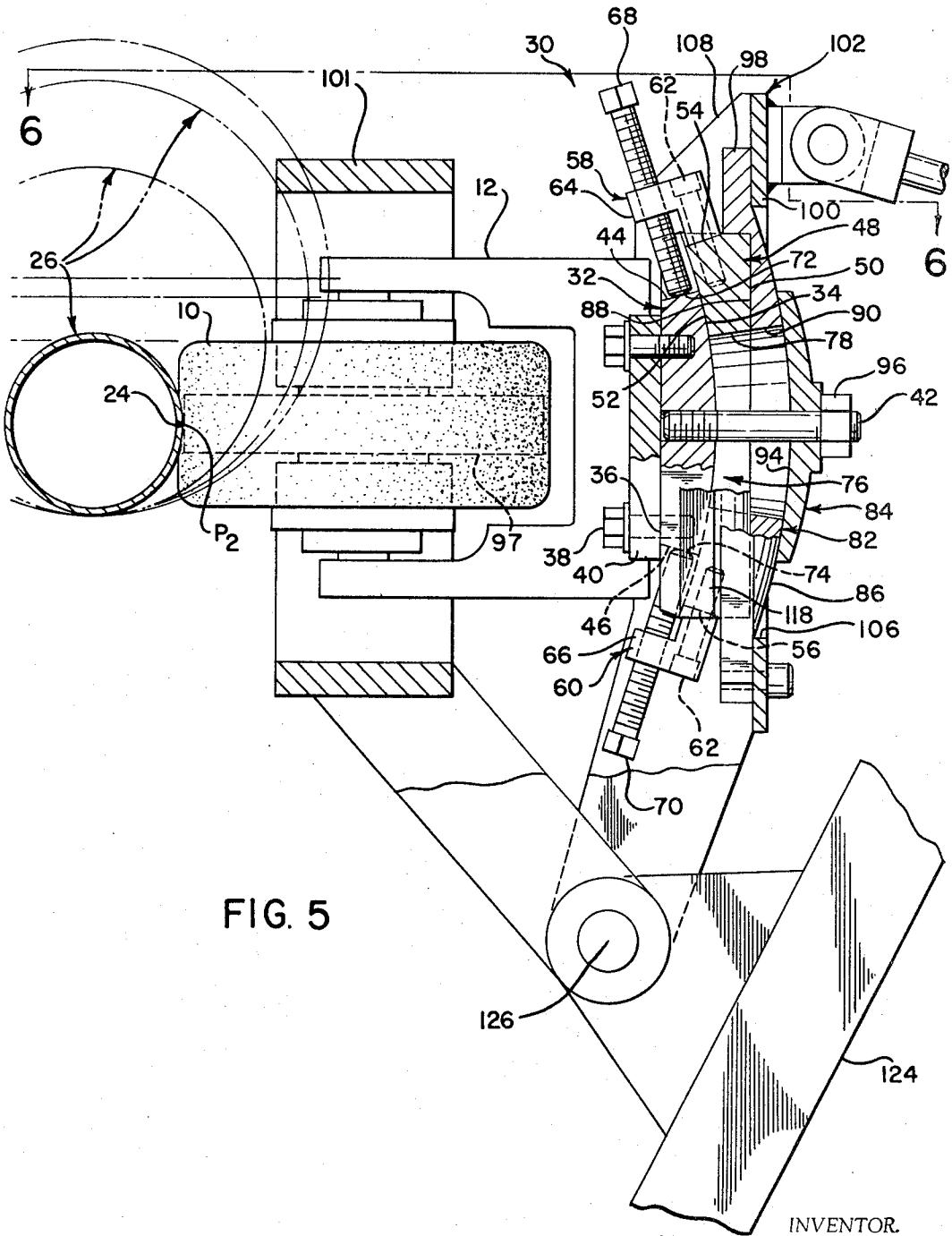


FIG. 5

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APPARATUS FOR POSITIONING A SEARCH UNIT

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FIG. 7

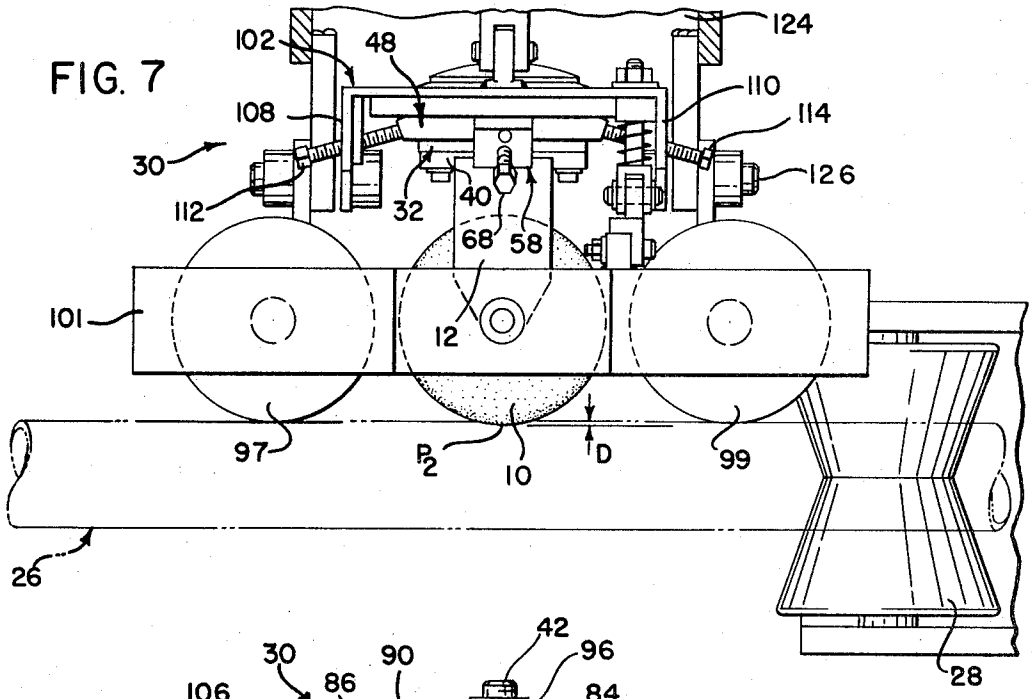
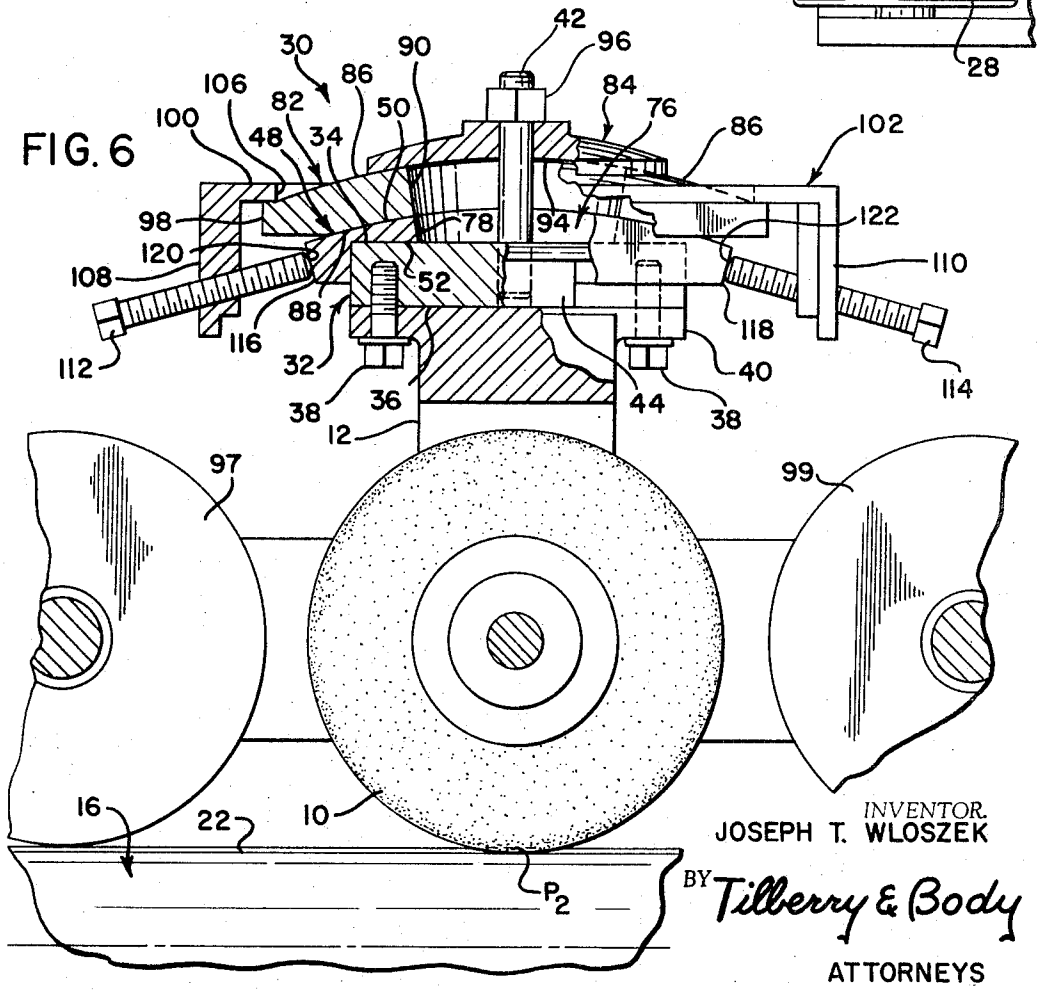


FIG. 6



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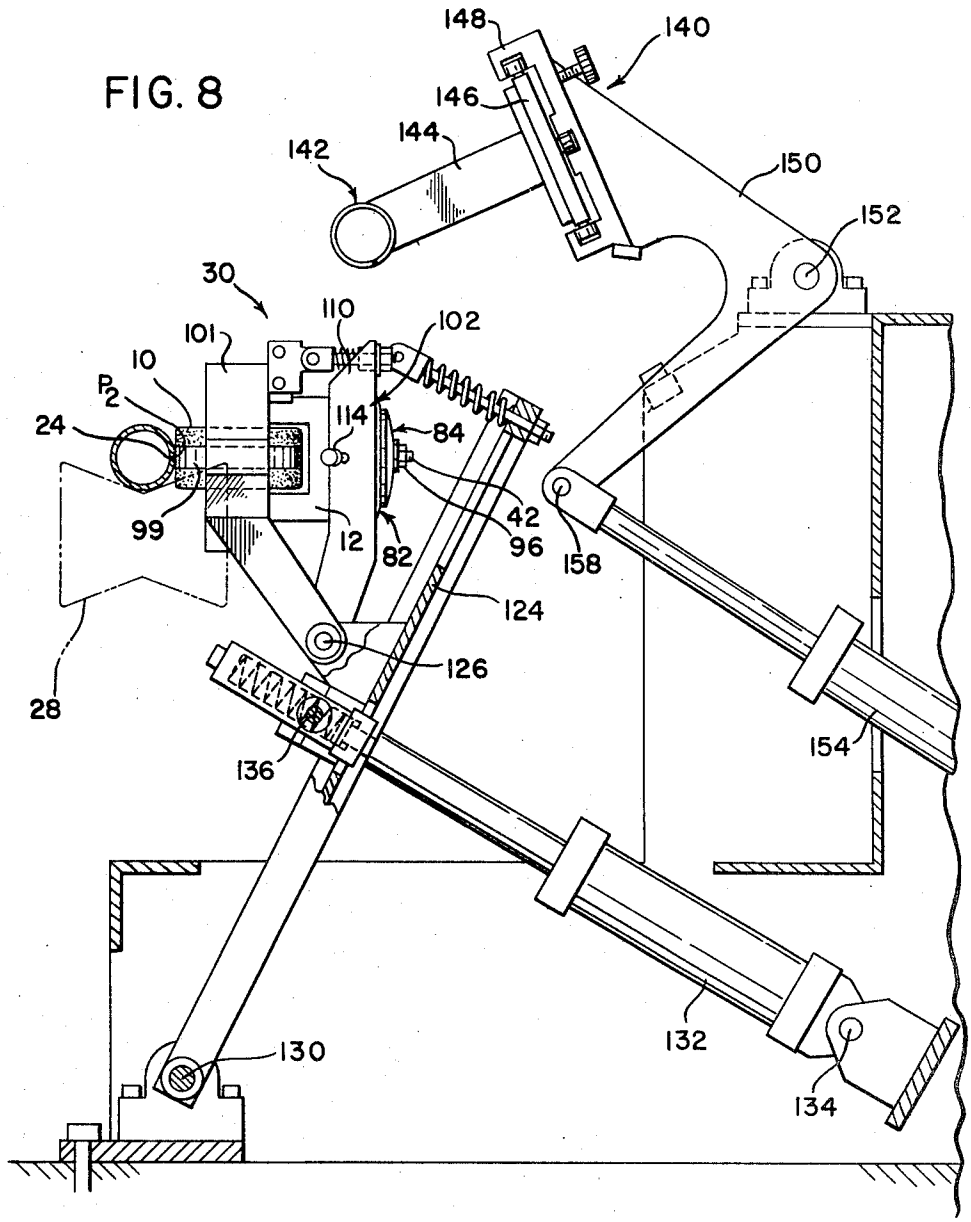
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FIG. 8



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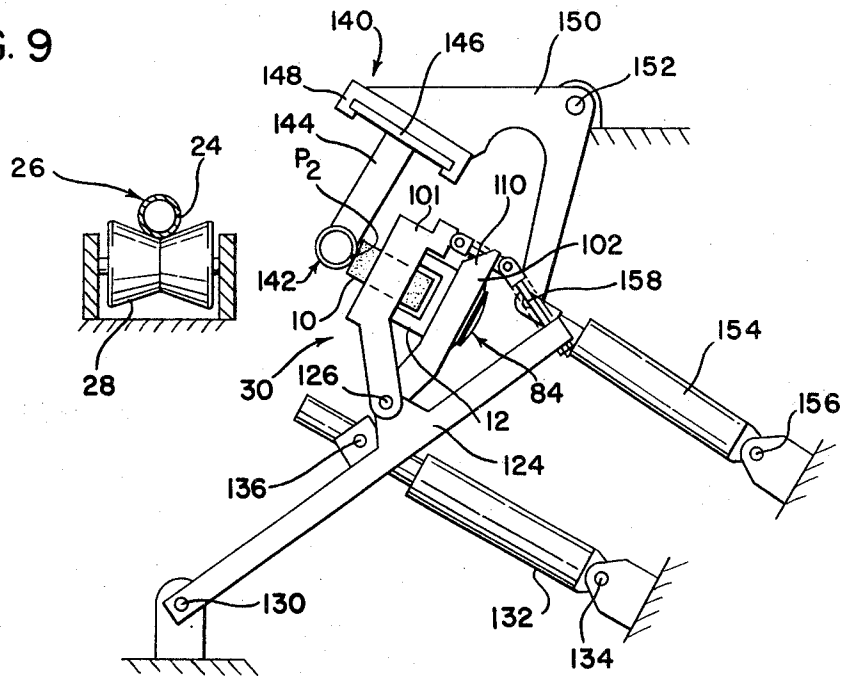
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APPARATUS FOR POSITIONING A SEARCH UNIT

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FIG. 9



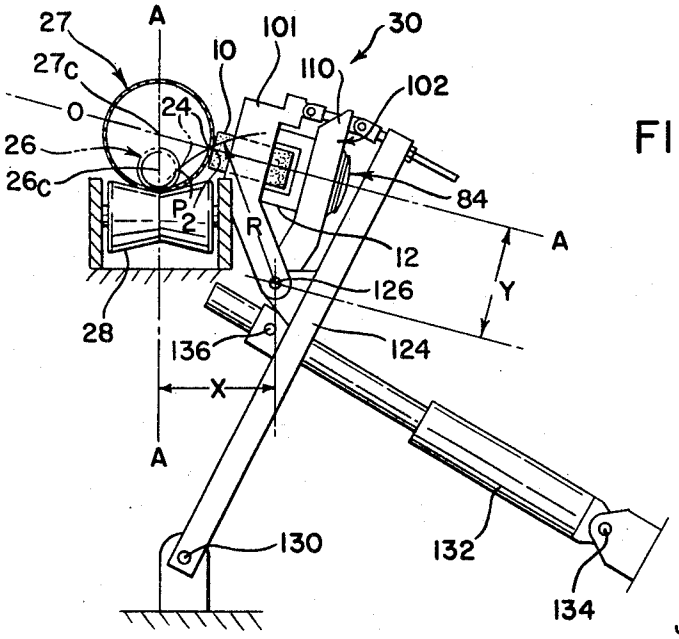


FIG. 10

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3,371,524

APPARATUS FOR POSITIONING A SEARCH UNIT

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Filed Oct. 15, 1964, Ser. No. 404,128
5 Claims. (Cl. 73—67.8)

ABSTRACT OF THE DISCLOSURE

Apparatus for positioning a nondestructive ultrasonic search unit, such as a liquid filled, flexible wheel containing a sound transducer, with respect to a workpiece. Structure is provided for pivoting the wheel in two mutually perpendicular planes about a pivot point located substantially at the point of contact between the wheel and a workpiece. Structure is also provided for calibrating the search unit against a calibration piece, which is normally located in a retracted position remote from the search unit while the search unit is inspecting a workpiece.

This invention relates to the art of nondestructive testing and more particularly to apparatus for positioning a nondestructive search unit.

The invention is particularly adapted for positioning the effective axis of a nondestructive search unit, such as an ultrasonic search unit, in a desired manner with respect to a workpiece being searched for flaws, internal or surface discontinuities, etc., and will be described with particular reference thereto although it will be appreciated that the invention has broader applications.

Search units utilized in nondestructive ultrasonic inspection may take several forms and, for example, may be cylindrical in shape, coaxially surrounding a disk shaped transducer or may be a liquid filled flexible wheel containing a disk shaped transducer. In either case, the effective axis of the transducer, i.e., the direction of transmitted sound pulses, may not be in exact alignment with the apparent search axis of the search unit as determined by the search unit's geometrical configuration. Further, even if the effective search axis is in alignment with the apparent or geometrical search axis, it may be desirable in certain applications to direct the sound pulses in a direction to obtain a desired propagation angle. The propagation angle is the angle defined by the intersection of the effective axis of the transducer and the entrant surface of the workpiece. Accordingly, it is desirable that means be provided for positioning the search unit relative to the entrant surface of the workpiece to obtain a desired propagation angle.

Heretofore in the art of nondestructive testing with the use of ultrasonic search units, adjustments of the propagation angle have been obtained by pivoting the search unit about a point where the search unit is supported by a suitable support mount. However, by so pivoting the search unit the effective search axis will be directed at a point spaced from the desired area to be inspected and carriage means are required to move the search unit laterally so that the effective search axis will again be directed at the desired area.

The present invention is directed toward a search unit mounting means for adjusting the propagation angle by pivoting the effective search axis of the search unit about a point located substantially on the entrant surface of the workpiece. In this manner, the need for displacing the pivot point according to such prior art search unit positioning means, described hereinabove is effectively eliminated.

In accordance with the present invention there is provided an apparatus for supporting and positioning a search unit to obtain a desired relationship between the effective search axis of the unit and a workpiece being inspected. The apparatus includes supporting means for supporting the search unit with one end being adapted to be positioned facing the entrant surface of the workpiece. Positioning means are provided for pivoting the search unit about a point substantially on the surface of the workpiece. The positioning means may, for example, take the form of a pair of relatively movable cylindrical segments with the axes of cylindrical symmetry of the two cylindrical segments being perpendicular to each other and intersecting at the pivot point.

In accordance with a still further aspect of the present invention, an apparatus for supporting and positioning a search unit is provided for the inspection of workpieces of annular cross-section, such as cylinders and spheres of different diameters in such a manner that the effective search axis of the unit is always radially aligned with the workpiece being inspected. This apparatus includes movable support means for supporting the search unit with one end thereof adapted to be positioned in contact with the outer surface of the workpiece. Further, stationary supporting means are provided for supporting the workpieces of various diameters one at a time so that the centers of the workpieces define a plane. The movable supporting means is pivoted about a point which is so located with respect to the plane as well as the effective axis of the search unit, that the effective axis will always be in radial alignment with each of the workpieces taken one at a time when the search unit is in contact with the outer surface of the workpiece being inspected.

In accordance with another aspect of the present invention, means are provided for protecting a flexible rotatable search wheel from damage by the leading edge of a workpiece to be inspected by the search wheel. The protective means includes means for rotatably supporting a protective guide wheel with its plane of rotation parallel to the plane of rotation of the flexible search wheel, and with the protective guide wheel being located to one side of the search wheel with its periphery spaced slightly inward from the periphery of the flexible search wheel. In this manner, the guide wheel serves to guide movement of the workpiece relative to the search wheel so that only a slight portion of the periphery of the search wheel is in the path of the relative movement between the search wheel and the workpiece.

In accordance with a still further aspect of the present invention, search unit calibration apparatus is provided for calibrating the search unit and includes a calibration piece which is normally in a retracted position remote from the search unit while the search unit is inspecting a workpiece. Means are provided for selectively positioning the calibration piece in a retracted position and in a calibration position. Also, suitable positioning means are provided for positioning the search unit either adjacent the workpiece or adjacent to the calibration piece when the latter is in its calibration position for purposes of calibrating the search unit.

The primary object of the present invention is to provide apparatus for supporting and positioning a search unit in a desired relationship with respect to a workpiece being inspected, which apparatus is simple in construction and economcal to manufacture.

Another object of the present invention is to provide apparatus for supporting and positioning a search unit relative to a workpiece in which the need for displacing a support carriage is effectively eliminated.

A still further object of the present invention is to provide calibration means for calibrating a sensing unit in a simple and time saving manner.

In accordance with a still further object of the present invention, means are provided for radially aligning the effective search axis of a search unit with workpieces of annular cross-section and various diameters, taken one at a time, in a manner which is simple in construction and economical in manufacture.

In accordance with a still further aspect of the present invention, means are provided for protecting a search wheel unit from damage by the leading edge of a workpiece to be inspected, which means is simple in construction and economical to manufacture.

The invention may take physical form in certain parts and arrangement of parts, the preferred embodiment of which will be described in detail in this specification and illustrated in the accompanying drawings which form a part hereof and wherein:

FIGURE 1 is a perspective view illustrating one embodiment of the invention for inspection of pipe weld joints;

FIGURE 2 is a schematic diagram illustrating a problem incurred when using an ultrasonic search unit for detecting a flaw in a workpiece when the effective axis of the transducer contained by the unit is not aligned with the apparent or geometrical axis of the unit;

FIGURE 3 is a schematic diagram illustrating the manner in which a search unit may be positioned with respect to a workpiece with an apparatus known heretofore in the prior art for purposes of obtaining a desired propagation angle of the effective axis of the search unit;

FIGURE 4 is a schematic diagram illustrating apparatus according to the present invention by which a search unit is positioned with respect to a workpiece to obtain a desired propagation angle of the effective axis of the search unit with respect to a workpiece;

FIGURE 5 is an elevational view partly in cross-section illustrating the apparatus according to one embodiment of the present invention for positioning a search unit with respect to a workpiece;

FIGURE 6 is a sectional view taken along line **6—6** of FIGURE 5;

FIGURE 7 is a plan view similar to that of FIGURE 6, but of smaller size illustrating a pair of protective guide wheels;

FIGURE 8 is a schematic diagram of the invention illustrating a sensing unit in position for purposes of inspecting a workpiece and a calibration piece in its retracted position;

FIGURE 9 is a schematic diagram of the invention illustrating the calibration piece in its calibration position and the sensing unit in position for calibration; and,

FIGURE 10 is a schematic diagram of the invention illustrating the manner in which the effective axis of the sensing unit is always radially aligned with workpieces of various diameters.

Referring now to the drawings in which the showings are for the purposes of illustrating one embodiment of the invention and not for limiting same, FIGURES 2, 3 and 4, respectively, schematically illustrate a problem posed in the use of sensing units similar to that utilized in the present invention, the manner in which the problem has been solved by prior art apparatus, and the manner in which the problem is solved according to the present invention. FIGURES 2, 3 and 4 each discloses an ultrasonic search unit taking the form of a conventional liquid filled flexible search wheel **10** rotatably supported by a suitable yoke **12** secured in any suitable manner to a support mount **14**. As is well known in the art of nondestructive ultrasonic flaw inspection, the liquid filled wheel **10** operates on the immersion principle in which a beam of high frequency sound is projected through the liquid path into a workpiece **16** for purposes of locating internal or surface discontinuities, such as internal flaw **18**. A transducer **20** is located within the liquid filled wheel **10** and is held in a fixed position relative to the entrant surface **22** of the workpiece **16** while the wheel

10 rotates freely about its axis of rotation. A problem posed in the use of such a search unit is that the effective axis OA of the transducer, that is the direction of the transmitted sound pulses, may not be in exact alignment with the apparent search axis OB of the search unit as determined by its geometrical dimensions. During a particular inspection it may be desirable that the propagation angle be 90°, where the propagation angle is the angle defined by the intersection of the effective axis of the search unit and the entrant surface of the workpiece. As seen in FIGURE 2, if a search unit **10** has a misalignment of its effective axis and its apparent or geometrical axis, a propagation angle of 90° will not be obtained by directing the search unit so that its geometrical or apparent axis OB defines an angle θ_b equal to 90° with respect to the entrant surface **22** of a test workpiece **16**. Instead, the true propagation angle θ_a as defined by the effective axis OA and its intersection with the entrant surface **22** will be less than 90°. Accordingly, for the propagation angle θ_a to equal 90° the search wheel **10** must be repositioned so that its effective axis OA is displaced in a clockwise direction, as viewed in FIGURE 2, by an angle equal to θ_c, where $\theta_c=\theta_b-\theta_a$.

In accordance with the teachings of the prior art mechanisms for positioning a search unit with respect to the entrant surface of a workpiece, reference is made to FIGURE 3 in which the propagation angle θ_a has been increased to 90° by pivoting both the wheel **10** and its support mount **14** about a pivot point P_1 by an angle θ_c in a clockwise direction, as viewed in FIGURE 3. Pivot point P_1 is located at a point at or behind the wheel mount **14**. By so pivoting the search wheel **10** the new effective axis O'A' is located by a distance S in the downward direction, as viewed in FIGURE 3, from the flaw **18** in the workpiece **16**, which was to be detected. Accordingly, in order to maintain the propagation angle θ_a equal to 90°, but yet position the effective axis O'A' at the location of effective axis OA in FIGURE 3 then suitable carriage means must be provided for purposes of displacing both the wheel **10** and its mount **14** in a vertical direction, as indicated by the arrow V, for a distance equal to the distance S. Further, due to the pivotal movement of wheel **10** about pivot point P_1 the periphery of the wheel may be displaced from the entrant surface **22** a slight distance in a direction away from the entrant surface. Accordingly, means must be provided for repositioning the wheel **10** and its mount **14** by an equal distance in a direction toward the entrant surface **22**, as indicated by the arrow H, in order that the periphery of the wheel be in contact with the entrant surface of workpiece **16**.

In accordance with the present invention means to be described hereinafter are provided for pivoting the search wheel **10** about a pivot point P_2 substantially located on the entrant surface **22** of the workpiece **16** at the point of contact of the wheel **10** and the entrant surface. In this manner it is seen that by pivoting the wheel **10** and its mount **14** about the pivot point P_2 in a clockwise direction by an angle θ_c, as viewed in FIGURE 4, a propagation angle θ_a equal to 90° may be obtained. The effective axis OA has not been materially displaced as is the case with such prior art means as discussed with reference to FIGURE 3. Accordingly, the need for repositioning the search wheel in the directions indicated by the arrows V and H in FIGURE 3, is effectively eliminated by the present invention when positioning the search wheel **10** so that its effective axis OA is directed at the flaw **18** in the workpiece **16**.

Although the description given heretofore has been with respect to angularly positioning a search wheel **10** in a vertical plane, i.e., the plane of the paper, it is to be appreciated that the discussion is equally applicable with respect to positioning the search wheel in a plane perpendicular to that of the paper. The description which follows is directed toward the means according to the present in-

vention for angularly positioning the search wheel **10** relative to a workpiece **16** in each of two mutually perpendicular intersecting planes.

Referring now to FIGURES 1, 5, 6, 7 and 8, there is illustrated apparatus for supporting and positioning the search wheel **10** in accordance with the present invention so that the periphery of the wheel is in contact with a workpiece area being inspected taking the form of a weld joint **24** extending longitudinally of a pipe **26**, which is annular in cross-section, as illustrated in FIGURE 5. The pipe **26** is supported for relative movement with respect to the search wheel **10** by means of a guide roller **28** suitably mounted for free rotation about its axis of rotation. The yoke **12** which rotatably supports the search wheel **10** is secured to a supporting and positioning apparatus **30**, one embodiment only being illustrated in the drawings for purposes of illustrating the invention and not for limiting same.

The supporting and positioning apparatus **30** includes an inner cylindrical segment **32** with its outer surface **34** taking the form of a cylindrical surface having a radius of curvature equal to the distance from surface **34** to the pivot point P_2, located at the point of contact of the periphery of search wheel **10** and the workpiece **26**. The axis of cylindrical symmetry of surface **34** extends perpendicular to the plane of the paper of FIGURE 5 through the pivot point P_2. The inner surface **36** of the cylindrical segment **32** is flat and parallel to the axis of symmetry of surface **34**. Suitable fastening means, such as bolts **38**, serve to secure a depending mounting flange **40** of the yoke **12** to the inner cylindrical segment **32**. A suitable stud **42** is secured, such as by a press fit, or threaded at one end to the inner cylindrical segment **32** so that the axis of the stud is perpendicular to the flat surface **36** and bisects segment **32** in the plane of the paper of FIGURE 5. The cylindrical segment **32** terminates in opposite directions from stud **42** in stop surfaces **44** and **46**, each extending radially of the cylindrical surface **34** of segment **32** and spaced equally from the axis of the stud **42**.

The supporting and positioning apparatus **30** is also provided with an outer cylindrical segment **48**, having an outer surface **50** taking the form of a cylindrical surface having a radius of curvature equal to the distance from the pivot point P_2 to the surface **50**. The cylindrical axis of symmetry of surface **50** is contained within the plane of the paper of FIGURE 5 and extends through pivot point P_2 in a direction perpendicular to the axis of stud **42**. The inner surface **52** of cylindrical segment **48** is also of cylindrical curvature having a radius of curvature extending from surface **52** to the pivot point P_2. The axis of cylindrical symmetry of the cylindrical surface **52** is the same as the axis of symmetry for the cylindrical surface **34** and the radius of curvature of the surface **52** is essentially that of surface **34** so that the surfaces are complementary and permit relative movement of segments **32** and **48**. The axis of stud **42** bisects segment **48** in the plane of the paper of FIGURE 5 and segment **48** terminates in a pair of bracket mounting surfaces **54** and **56**, each extending radially of the cylindrical surface **52** toward the pivot point P_2 and each spaced equally from the axis of stud **42**. The mounting surfaces **54**, **56** serve to receive L-shaped brackets **58**, **60**, respectively, which are secured to the segment **48** in any suitable manner, such as by countersunk bolts **62**. The brackets **58**, **60** are identical in shape and include depending flange portions **64** and **66**, respectively, extending toward the pivot point P_2. Adjustment bolts **68**, **70** are respectively threaded through the depending flanges **64**, **66** and extend generally perpendicularly to the stop surfaces **44**, **46**, respectively. Adjustment bolts **68**, **70** have their ends **72**, **74**, respectively, maintained in contact with the stop surfaces **44**, **46** for purposes of angularly displacing the cylindrical segment **32** about pivot point P_2, as viewed in FIGURE 5. The outer cylindrical segment **48** is provided with a circular slot **76** defined by radial wall **78** extending radially of the cylindrical surface **52** for limiting the extent of angular displacement of inner cylindrical segment **32** about the pivot point P_2.

The supporting and positioning apparatus **30** is also provided with inner and outer end caps **82** and **84** which are spherical segments. The inner end cap **82** is provided with a spherical outer surface **86** having its center of curvature at the pivot point P_2. The inner surface **88** of the inner end cap **82** is of cylindrical curvature being a portion of a cylindrical surface having its radius of curvature extending from points taken along the axis of symmetry of surface **50** to surface **88**. The cylindrical surfaces **50**, **88** are complementary to permit relative movement between segment **48** and inner end cap **82**. The inner end cap **82** is also provided with a radial wall **90** extending radially of cylindrical surface **52** toward the pivot point P_2. The radial wall **90** is preferably an extension of the radial wall **76**. The outer end cap **84** is provided with an inner spherical surface **94** corresponding in curvature essentially with that of the spherical surface **86** of the inner end cap **82** so that a sliding fit is provided therebetween. The stud **42** extends through the center of the spherical segment **84** and a suitable nut **96** is threaded to the end of the stud **42** for purposes of clamping the outer end cap **84** to the inner end cap **82**, as well as with the inner and outer cylindrical segments **42** and **48**.

The inner end cap **82** is provided with a depending annular flange **98** which overlaps one side of an annular flange **100** of a support **102** and is secured thereto in any suitable manner, such as by bolts **104**, so that the spherical end caps **82** and **84** extend through a circular aperture **106** defined by the annular flange **100**. A pair of depending side walls **108** and **110** are provided on the support **102**, each serving to threadably receive an adjustment bolt **112** and **114**, respectively, as illustrated in FIGURE 6. The outer cylindrical segment **48** terminates in the plane of the paper of FIGURE 6 in stop surfaces **116** and **118**, respectively, extending radially of the cylindrical surface **50** of segment **48**. The adjustment bolts **112** and **114** extend through the side walls **108** and **110** in such a manner that their ends **120**, **122** contact the stop surfaces **116**, **118**, respectively.

In the operation of the supporting and positioning apparatus **30** illustrated in FIGURES 5 and 6, the search wheel **10** may be pivoted about the pivot point P_2 for angular displacement in each of two mutually perpendicular planes which intersect at the pivot point P_2. Thus, for example, it may be desirable to pivot the search wheel **10** in the plane of the paper of FIGURE 5 about the pivot point P_2. This is accomplished by loosening the nut **96** for purposes of releasing the clamping force exerted between segment **34** and the outer cap **84**. Thereafter, the inner cylinder segment **32** to which the search wheel **10** and yoke **12** is secured may be pivoted in the plane of the paper about the pivot point P_2 by merely tightening one of the adjustment bolts **68**, **70** and loosening the other. That is, if it is desired to pivot the search wheel **10** in a counterclockwise direction about the pivot point P_2, as viewed in FIGURE 5, then adjustment bolt **68** should be retracted with respect to stop surface **64** of the inner segment **32** and the adjustment bolt **70** should be extended an equal amount in the direction toward stop surface **46** of the segment **32**.

Angular adjustment of the search wheel **10** about the pivot point P_2 in the plane of the paper of FIGURE 6, may be obtained by loosening one of the adjustment bolts **112**, **114** and tightening the other. Thus, for example, if it is desired that the search wheel **10** be pivoted about the pivot point P_2 in a counterclockwise direction, as viewed in FIGURE 6, then bolt **112** should be retracted with respect to the stop surface **116** of the other cylindrical segment **48** and adjustment bolt **114** should be ex-

tended an equal distance in the direction toward stop surface 118 of segment 48. Upon completion of the adjustments of bolts 68, 70 and 112, 114, the adjustment is locked by tightening nut 96 so as to securely clamp the end caps 84, 82 and the segments 48, 32 tightly together.

Referring now to FIGURE 7, there is illustrated a pair of protective guide wheels 97 and 99, respectively, located on opposite sides of the flexible search wheel 10, and each being rotatably supported by means of a support 101 which is in turn secured to the support plate 124. The wheels 97 and 99 are preferably constructed of non-flexible material, such as metal, relative to that of wheel 10. Each of the protective guide wheels 97, 99 has its plane of rotation parallel to that of the flexible wheel 10 and the rotational axis of wheels 10, 97, 99 define a plane as evidenced by FIGURE 7. The diameter of the outer periphery of the wheel 97 is equal to that of the wheel 99, but less than that of the search wheel 10. Accordingly, with reference to FIGURE 7, it is seen that the periphery of each of the wheels 97 and 99 in the area located adjacent workpiece 26 is spaced inwardly by a distance D from the workpiece relative to the point of contact of the periphery of wheel 10 and the workpiece. In this manner the guide wheels 97 and 99 serve to guide movement of the workpiece 26 relative to the search wheel 10 so that only a slight portion of the periphery of the search wheel 10 is in the path of relative movement between the search wheel and the workpiece. This protects the search wheel 10 from damage by the leading edge of the workpiece.

Referring now to FIGURES 8 and 9, the supporting and positioning apparatus is illustrated in schematic form. The support 102 is illustrated in a simple manner with the yoke 12 secured thereto, and with one end of the support being pivotally secured to a support plate 124 for pivotal movement about a pivot post 126 perpendicular to the plane of the paper. The support plate 124 is pivoted about a pivot post 130 for pivotal movement about a pivotal axis extending through the post 130 in a direction perpendicular to the plane of the paper. Pivotal movement of the support plate 124 is accomplished by actuating a suitable hydraulic cylinder 132 pivoted at one end to a suitable pivot post 134 and at the other end to a suitable pivot post 136 secured to the support plate 124, in the manner illustrated in FIGURE 8. To the right in FIGURE 8 there is schematically illustrated a calibration unit 140 which serves the purpose of calibrating the search wheel 10 against a calibration piece 142 having known flaws. The calibration piece 142 may take the form of a cylindrical pipe of annular cross-section, which is secured by means of a support 144 to a track 146. The track 146 is in turn slidably secured to a track holder 148 which serves to permit relative movement of track 146 together with the calibration piece 142 in a direction perpendicular to the paper, thus simulating a workpiece passing by the periphery of the search wheel 10 in the manner to be described hereinafter. The track holder 148 is provided with an extended portion 150 which is pivotally secured to a pivot post 152 for pivotal movement about a pivot axis extending through the post in a direction perpendicular to the plane of the paper. Pivotal movement of portion 150 and, hence, of the calibration piece 142, is obtained by means of a suitable hydraulic cylinder 154 pivotally secured at its opposite ends to pivot posts 156, 158.

The calibration piece 142 is normally in its retracted position as illustrated in FIGURE 8 when the search wheel 10 is in position for inspecting flaws in the workpiece 26. However, when it is desired to calibrate the search wheel 10 against the calibration piece 142, the support plate 124 is pivotally displaced about pivot post 130 in a clockwise direction as viewed in FIGURE 8 to the position illustrated in FIGURE 9. The calibration piece 142 is pivoted about its pivot axis 152 in a counterclockwise direction as viewed in FIGURE 8, by actuating the hydraulic cylinder 154 until the calibration piece 142 is in the position illustrated in FIGURE 9 with the periphery of the search wheel 10 in contact with the calibration piece 142. This is the calibration position of the calibration piece 142.

With the search wheel 10 and the calibration piece 142 in the calibration position, the calibration piece 142 may be displaced by means of its track 146 and track holder 148 in the direction perpendicular to the plane of the paper for purposes of obtaining relative movement of the calibration piece with respect to the wheel 10. After the desired calibrations have been accomplished hydraulic cylinders 154 and 132 may be suitably actuated to reposition the calibration piece 142 and the search wheel 10 to the positions illustrated in FIGURE 8.

Reference is now made to FIGURE 10 which schematically illustrates the supporting and positioning apparatus 30 in a manner similar to that as illustrated in FIGURES 8 and 9, but without illustrating the calibration unit 140. FIGURE 10 discloses structure by which according to the present invention the effective axis of the search wheel 10 is maintained in radial alignment with objects of annular cross-section supported one at a time regardless of their diameters. The support wheel 28 supports roll stock, such as pipes and the like, of various diameters which are to be continually inspected for weld flaws as they pass the search wheel 10. The workpiece 26 illustrated in FIGURE 9 is illustrated by means of dotted lines in FIGURE 9 and has its axis of symmetry identified by the character reference 26_c. A workpiece in the form of an annular pipe 27 is illustrated in FIGURE 10 supported by the support wheel 28 and is a much larger diameter than that of the workpiece 26. However, it will be noted that the axis of symmetry 27_c of pipe 27 and the axis of symmetry 26_c of the workpiece 26 define a plane AA perpendicular to the paper. Workpieces of annular cross-section, pipes 26 and 27, of various diameters are supported by the wheel 28, which is so constructed that each workpiece will have its axis of symmetry located in the plane AA. Pivot point 126 of support 102 may itself be pivoted about pivot post 130 by actuation of hydraulic cylinder 132. With distances Y and R held constant, pivot point 126 may be pivoted to a location so that further pivotal movement of support 102 results in radial alignment of the effective axis OA with either pipe 26 or pipe 27. With the support plate 124 maintained in the angular relationship, as illustrated in FIGURE 10, the pivot point 126 of the support 102 is displaced a distance X from the plane AA. Also, when the effective axis OA of the search unit 10 is in radial alignment with the pipe 27, the distance between the pivot point 126 and the effective axis OA will be equal to the distance Y. Also, the pivot point P_2 will be located a distance R from pivot post 126. In accordance with the present invention the distances Y and R are maintained constant. In this manner, regardless of the diameter of the workpiece being inspected radial alignment of the effective axis OA with respect to an annular workpiece will be obtained.

Although the invention has been shown in connection with a preferred embodiment it will be readily apparent to those skilled in the art that various changes in form and in arrangement of parts may be made to suit requirements without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. In an apparatus for inspection of workpieces including a search unit and positioning means for supporting and positioning said unit in a desired manner relative to an elongated workpiece being inspected as it moves along a given path, the improvement comprising: sensing unit calibrating apparatus including an elongated calibration piece extending parallel to said given path and normally located in a retracted position remote from said search unit while said search unit is inspecting a said workpiece,

said search unit positioning means and said sensing unit calibration apparatus being both located transversely from and on the same side of said given path, means for selectively pivoting said calibration piece about a pivot axis extending parallel to said given path between said retracted position and a calibration position, and said search unit positioning means having means for pivoting said search unit about a second pivot axis extending parallel to said given path so that said search unit contacts said calibration piece when the latter is in its calibration position for purposes of calibrating said search unit.

2. An ultrasonic inspection apparatus including:

wheel mounting means;

a liquid filled, flexible search wheel rotatably supported by said mounting means, said wheel containing a sound transducer for transmitting sound pulses through the periphery of said wheel in a direction defining an effective search axis extending transversely of the axis of rotation of said wheel;

means located exteriorly of said wheel for pivoting said wheel in two mutually perpendicular planes, of which one includes said axis of rotation, and about a pivot point located substantially on the periphery of said wheel;

said pivoting means including first and second relatively movable cylindrical segments;

said first cylindrical segment having an inner surface secured to said wheel mounting means and a second cylindrical surface having an axis of cylindrical symmetry extending through said pivot point;

said second cylindrical segment having an inner cylindrical surface in slideable contact with and of a curvature corresponding with the second surface of said first cylindrical segment, and an outer cylindrical surface having an axis of cylindrical symmetry extending through said pivot point and perpendicular to the axis of symmetry

of said outer surface of said first cylindrical segment; and, a support for said cylindrical segments having an inner cylindrical surface in contact with and of a curvature corresponding with the outer cylindrical surface of said second cylindrical segments.

3. An apparatus as set forth in claim 2 including first adjustable means interposed between said first and second segments for displacing said first segment with respect to said second segment so as to pivot said wheel about the axis of cylindrical symmetry of said first segment.

4. An apparatus as set forth in claim 2 including means for securing said first and second segments for movement together about the axis of symmetry of said second segment.

5. An apparatus as set forth in claim 4 including supporting means for said wheel mounting means and said pivoting means, and second adjustable means interposed between said second segment and said supporting means for displacing both said first and second segments with respect to said supporting means so as to pivot said wheel about the axis of cylindrical symmetry of said second segment.

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