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Ranger

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[54] **METHOD AND APPARATUS FOR SUSPENDEDLY SUPPORTING A PLATFORM**

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[73] Assignee: **Combustion Engineering, Inc.**, Windsor, Conn.

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[52] **U.S. Cl.** ..... **214/1 BB**; 74/22 R; 165/76; 214/1 CM; 214/152; 294/85

[51] **Int. Cl.** **F28g 15/02**

[58] **Field of Search** ..... 214/1 B, 1 BB, 1 CM, 152; 165/76; 74/22 R, 22 A, 23; 294/85

[56] **References Cited**

UNITED STATES PATENTS

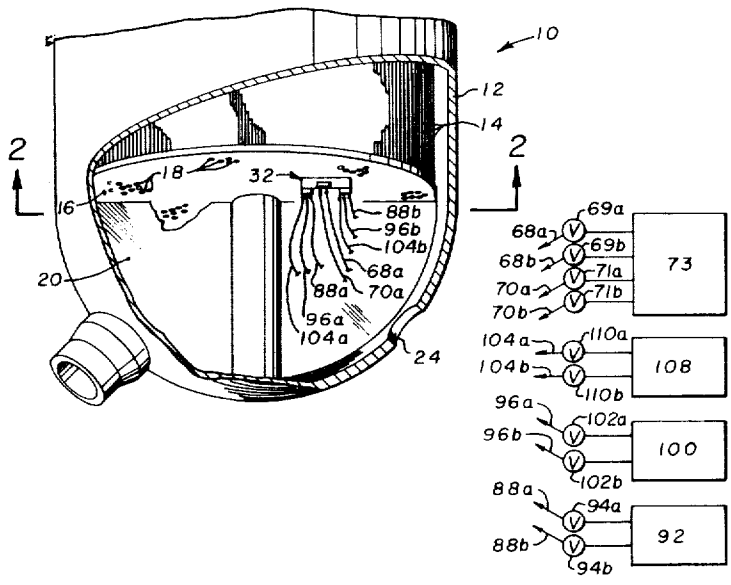
2,136,255	11/1938	Scanlon	294/85 X
3,643,701	2/1972	Wadiak	165/76

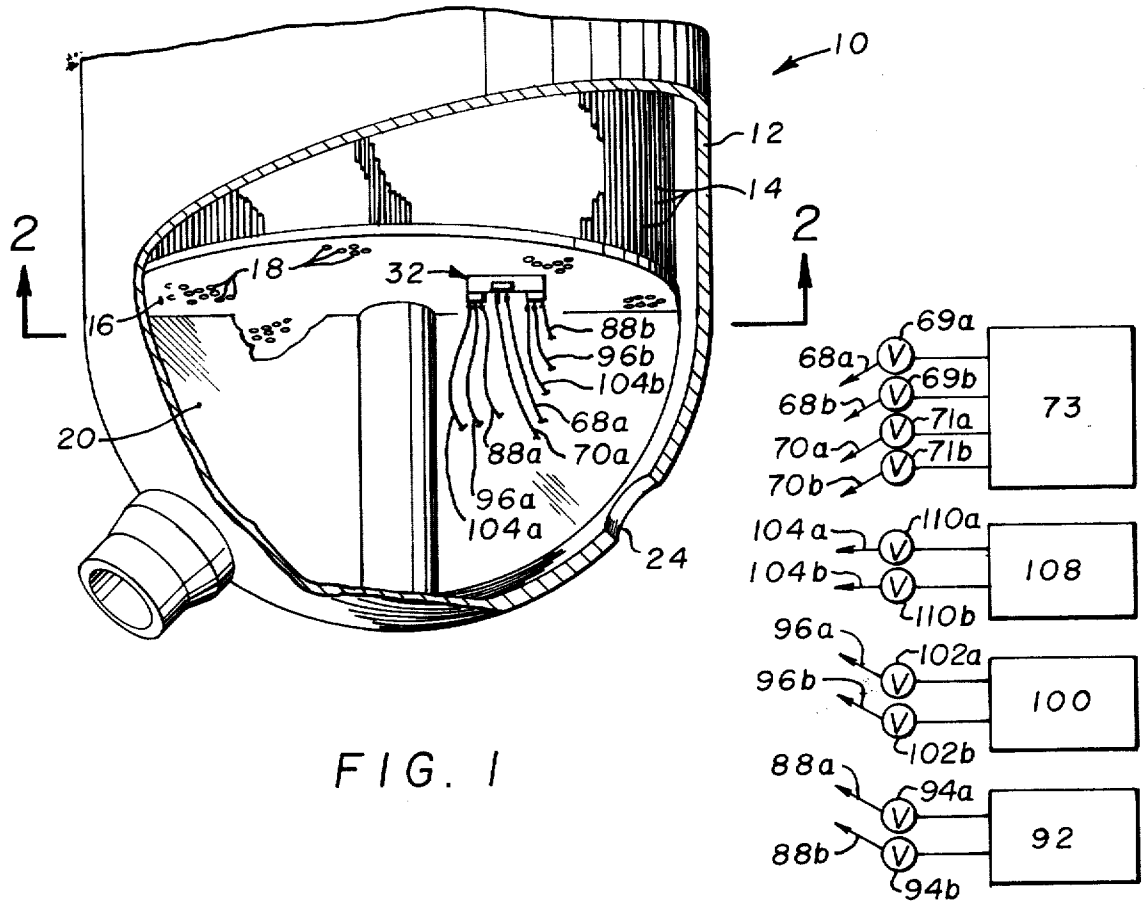
Primary Examiner—Robert J. Spar
Assistant Examiner—George F. Abraham

[57] **ABSTRACT**

A method and apparatus for lifting a platform dependently supported from a member by support arms supportingly connected to the platform and independently reciprocable relative thereto between raised and lowered positions. A force is applied between support arms in engagement with the member and the platform, acting relatively downward on the support arms and upward on the platform. The force is of sufficient magnitude to lift the platform and will move it from a position spaced below the member to a position in contact therewith. The lifting force is preferably provided by a pressurized fluid, such as air. The lifting operation may be utilized to recover vertical slippage between the platform support arms and the member with which they are engaged.

22 Claims, 10 Drawing Figures

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68a
69b
68b
71a
70a
71b
70b
73
104a
110a
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96a
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96b
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102b
88a
94a
88b
92
94b

FIG. 1

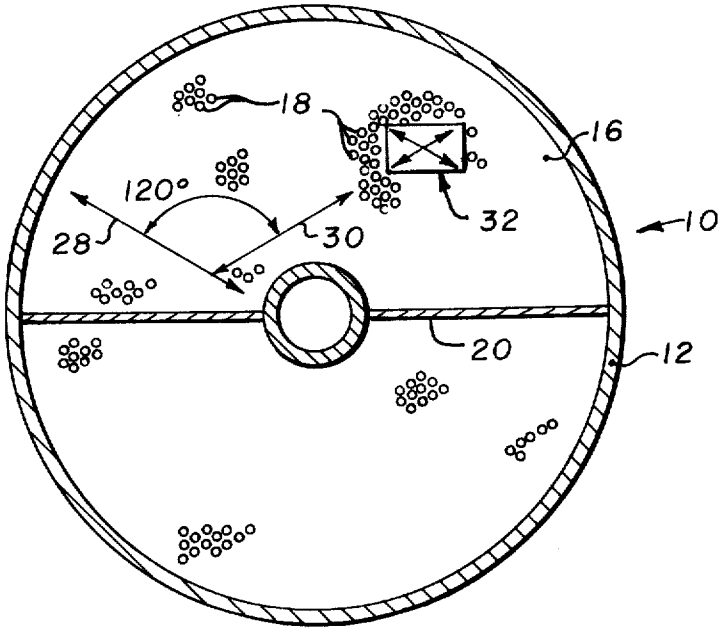
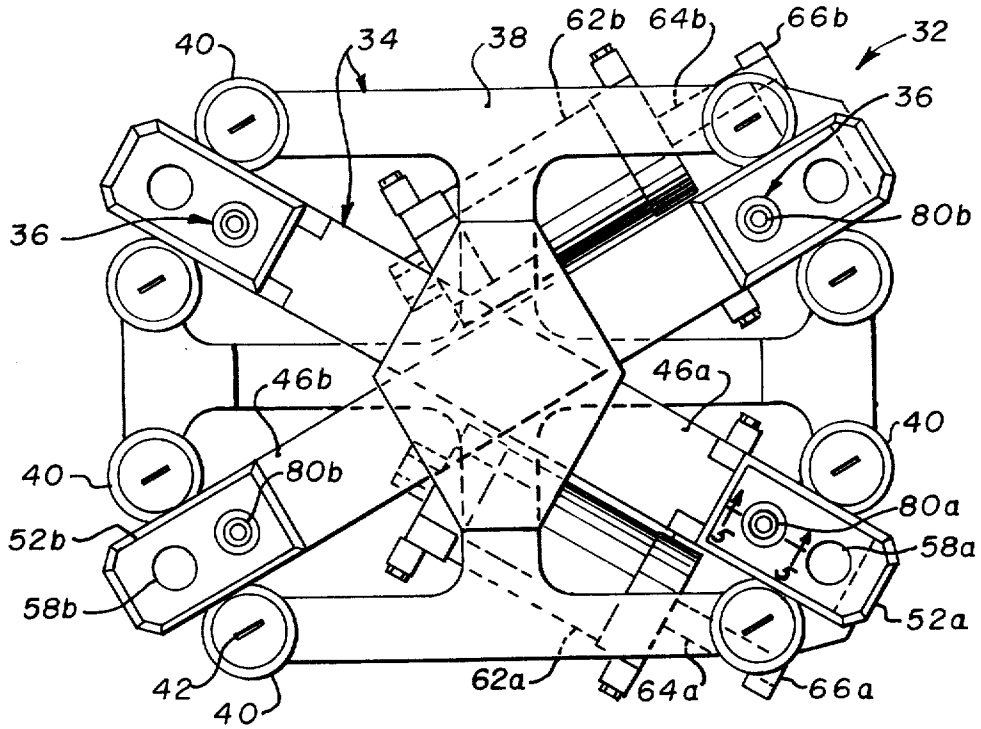

18
16
120°
32
10
28
30
20
12

FIG. 2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34
38
62b
64b
66b
32
36
36
80b
46b
46a
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80a
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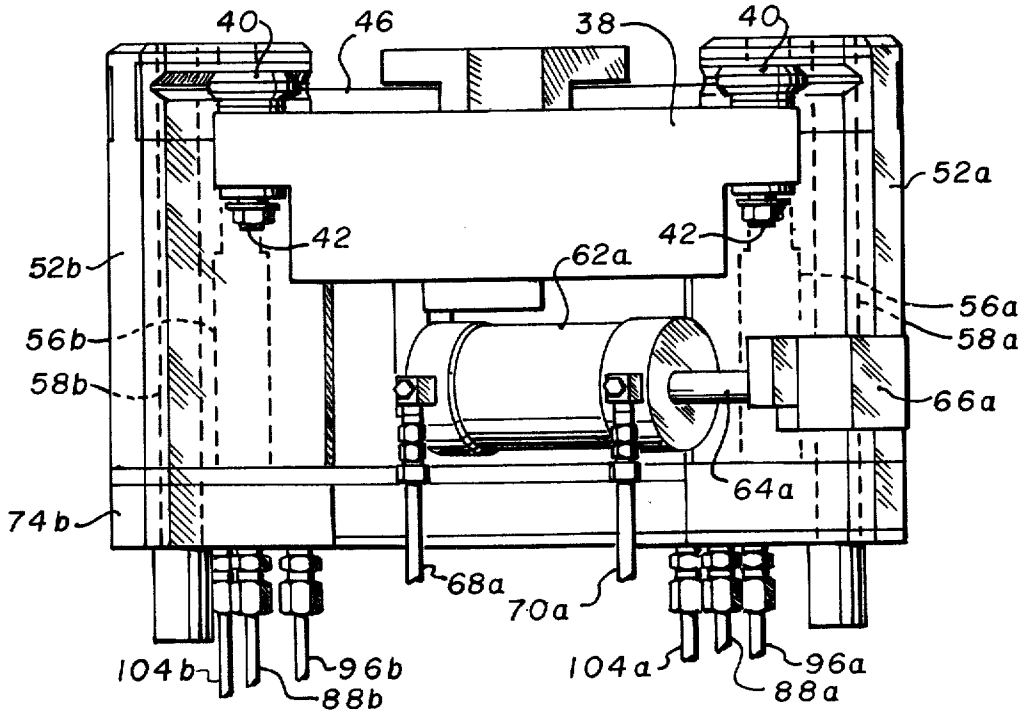
58a
58b
52a
42
40
62a
64a
66a

FIG. 3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46
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40
52a
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56a
56b
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64a
74b
68a
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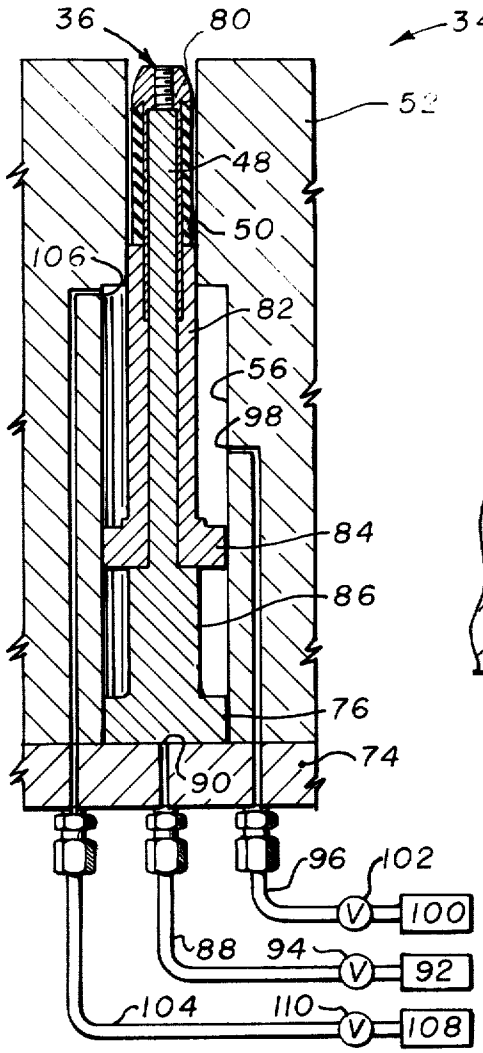
104b
96b
88b
104a
96a
88a

FIG. 4


36
80
34
52
48
50
106
82
56
98
84
86
76
74
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100
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92
104
110
108

FIG. 5

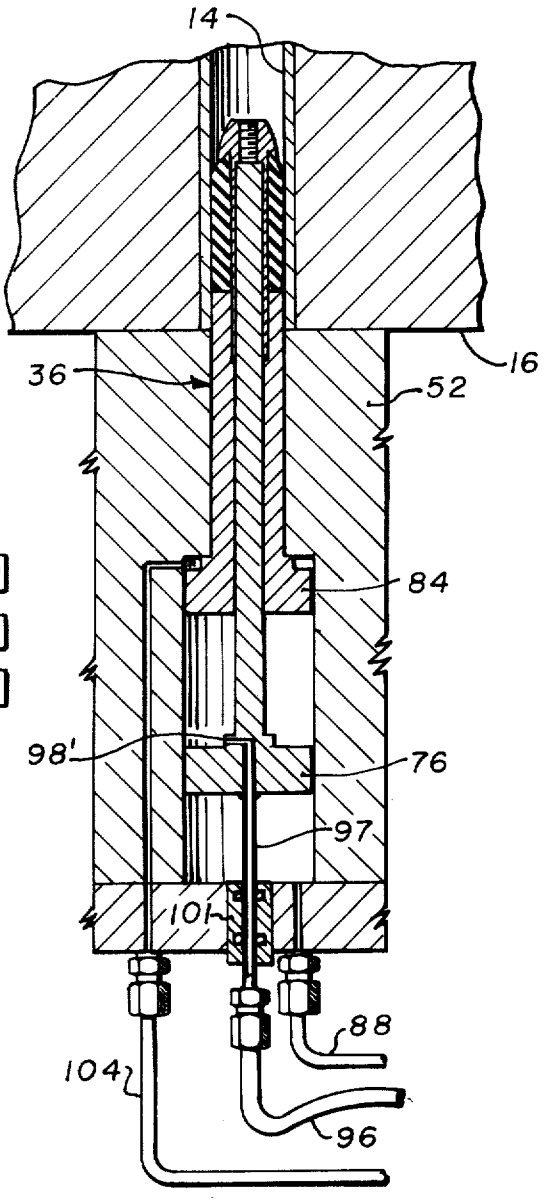

14
16
36
52
84
98'
76
97
101
88
104
96

FIG. 8

FIG. 6a

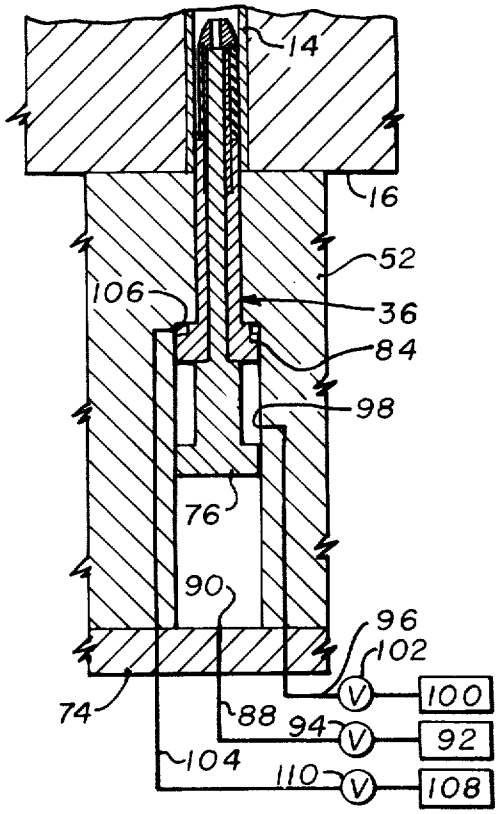


FIG. 6b

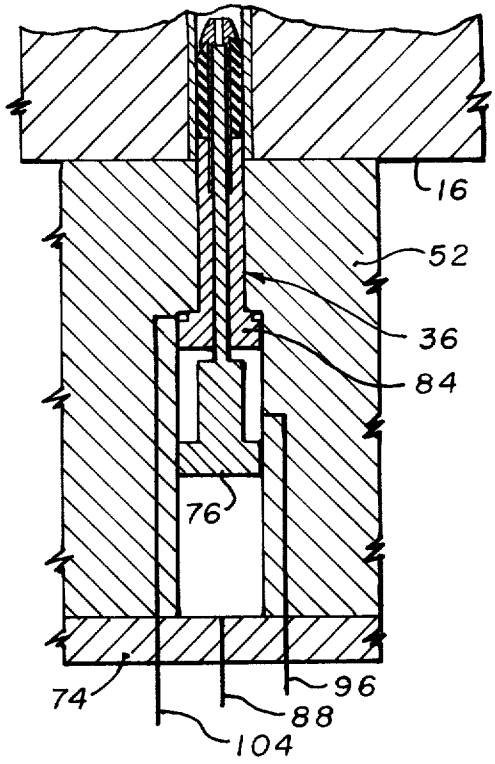


FIG. 7a

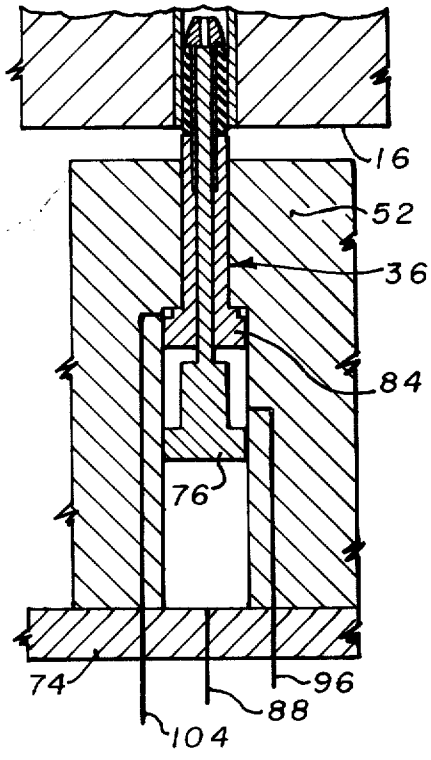
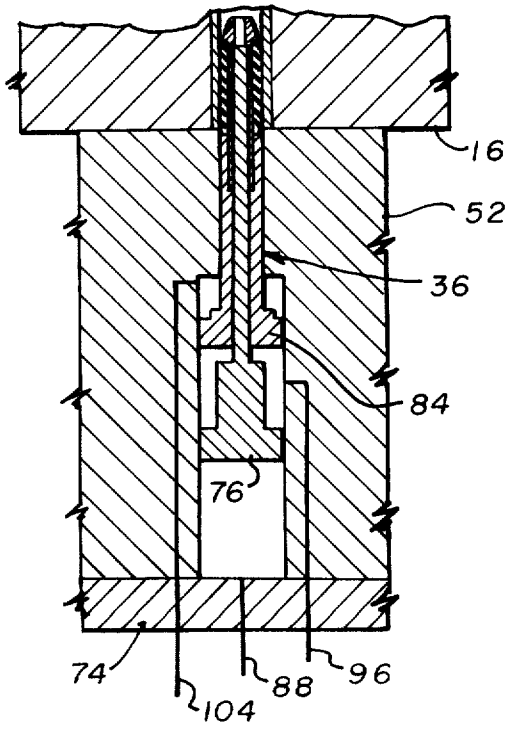


FIG. 7b



METHOD AND APPARATUS FOR SUSPENDEDLY SUPPORTING A PLATFORM

BACKGROUND OF THE INVENTION

The invention relates generally to means for supporting a platform from and beneath a member having holes in the undersurface. More particularly, the invention pertains to a supporting means adapted to grippingly engage said member while inserted in said holes. More particularly still, the invention pertains to a method and apparatus for recovering any slippage of the platform and its support means relative to the member from which it is suspended.

In a variety of environments it may be necessary to provide a platform or carriage from which various types of work can be remotely conducted. Further, it may be necessary to movably suspend the platform from another member. It may be further necessary to permit the platform to be remotely moved parallel the member from which it is suspended. An example of this situation arises in nuclear steam generators where it may be necessary to inspect and/or repair some of the tubes contained therein.

A remotely operated moving platform may allow remote operations to be conducted therefrom without requiring continued or frequent presence of a human in the steam generator which may be radioactive. Two such platforms, capable of remote operation and locomotion are described respectively in U.S. Pat. application Ser. No. 384,658 for REMOTELY MOVABLE PLATFORM by C. T. Ward, D. L. Mathis, F. T. Radcliff and R. Vorwerk filed Aug. 1, 1973 and U.S. Pat. application Ser. No. 384,657 for REMOTELY MOVABLE PLATFORM by C. T. Ward, D. L. Mathis, F. T. Radcliff and E. Ranger filed Aug. 1, 1973. Each of these remotely moved platforms may be suspendedly supported beneath the undersurface of a tube sheet by support means extending upwardly therefrom and grippingly engaging the tube sheet or some member affixed thereto. In the preferred embodiments of the platforms of the above two patent applications, selectively expandable anchors are extensibly connected to the platform. These anchors include a finger and a gripper thereabout and moving therewith. The anchors are extended relative to the platform base into the openings formed by the tubes in the tube sheet. The gripper is then expanded into gripping engagement with the wall of the tube to bear a portion of the weight of the platform base connected thereto. A sufficient number of anchors are used to always support the platform. Further, the anchors may be translated relative to the base in a direction which substantially parallels the plane of the base and the tube sheet in order to move the platform base substantially parallel the undersurface of the tube sheet. By selective extension, expansion, retraction and translation of various of the anchors, it is possible to "walk" the platform "across" the undersurface of the tube sheet to align it, or a work station portion, with a tube or tubes to be inspected and/or repaired.

The supported positioning of platform base relative to the tube sheet should be such as to maintain a constant spacing between the base and the tube sheet, and this would be possible if gravity forced the platform toward the tube sheet, or if the grippers of the anchors were always uniformly inserted in the tubes and gripped sufficiently to prevent any slippage, regardless of weight or work loading. However, in practice, the

platform will generally be used where it depends below the tube sheet, such that gravity acts against the anchor grippers. Further, the work operations may include forcing a plug into the tube end which would further downwardly load the platform. Further still, it may be necessary for the platform to be "stepped" hundreds or even thousands of times and small slippage with each step could accumulate to a significant extent. If, in any of these instances, the extent of slippage accumulated sufficiently to remove the grippers from gripping engagement with the tube walls, the platform would fall face free of the tubes and tube sheet, possibly damaging it and requiring human presence for reinstallation.

SUMMARY OF THE INVENTION

According to the invention there is provided a method and apparatus for remotely lifting a platform, or at least the base portion thereof, when it is supported beneath a tube sheet by anchor means extensibly connected thereto for insertion into gripping engagement with walls of openings in the undersurface of the tube sheet.

Broadly, the invention includes means and a method of operating the means which prevent a dependently suspended platform from falling out of suspended engagement with the member from which it is suspended. Further, the invention provides a method and apparatus for lifting a platform base relative to a member from which it is suspended to maintain it in close proximity therewith therebelow. More specifically, the invention provides means and a method of operation thereof which recovers relative slippage between the platform support and the member with which it is grippingly engaged, this function being accomplished either when the platform remains fixedly positioned laterally of the tube sheet or when it "walks" or "steps" laterally thereof. Further, the invention may be utilized to maintain the base portion of the platform proximate or in contact with the tube sheet undersurface, particularly when all of the support means grippingly engage the tube sheet.

The platform includes a base portion and at least two, and preferably four or more, anchor or support means of the finger and gripper type for selective insertion into gripping engagement with the walls of holes in the tube sheet undersurface. A support means typically comprises an upwardly extending finger mounted on a finger piston reciprocable in an upwardly extending cylinder carried by the platform base, a resilient sleeve about the finger, and sleeve expanding means including a compression jaw surface and second piston about the finger below the sleeve and above the finger piston and vertically movable relative to the finger and sleeve to longitudinally compress and radially expand the sleeve. The sleeve, when inserted in a hole in the tube sheet and expanded, will grippingly engage a wall of the hole.

The finger and its piston may be moved upward relative to the cylinder and base carrying the resilient sleeve for insertion in a hole by a first force applied between the piston and cylinder. The sleeve may be expanded by a second, repulsive force applied between the finger piston and the second piston. The second piston, and accordingly the finger piston, may be moved downwardly relative to the cylinder and base, even when said second force exists between the pistons and the sleeve is engaging a hole wall, when a third force of greater magnitude and opposite direction to the first

force is applied between the second piston and the cylinder. This effects a lifting or "cinching" of the base relative to the tube sheet if the third force is of sufficient magnitude. In each instance, the force may be provided by a pressurized fluid, such as air.

The third force may be continuously applied during the time that all support means are in gripping engagement with the tube sheet to maintain the platform base in close proximity or in contact with the tube sheet undersurface. Further, the third force may be applied to one or more support means in gripping engagement with the tube sheet during such time as other support means are being extended and inserted into holes and expanded into gripping engagement. This operation insures maximum insertion of the newly implanted support means and provides means for recovering slippage of the support means. This latter function may be accomplished while the platform remains laterally stationary relative to the tube sheet or it may be accomplished as part of a stepping operation if the support means have a stepping capability. If attendant to a stepping operation, it may be desirable for certain platform constructions to avoid or remove application of said third force during the lateral movement of the platform to prevent sliding contact between the relatively moving platform and tube sheet.

In one embodiment, a spacer between the finger piston and second piston of each support means defines a minimum chamber length therebetween which approximates the distance between the platform base and the upper gripping surface of the resilient sleeve when it is at its upwardly extended limit. A fluid admitting port for applying the sleeve expanding force between the finger piston and second piston is located in the cylinder wall closely above the finger piston when it is fully extended such that it will remain in registry with the chamber between the pistons even when they are partially withdrawn by the cinching operation.

In another embodiment, the spacer between the pistons may be greatly reduced in length, or eliminated, by introducing the sleeve expanding fluid to the region between the pistons from a port and conduit which move with one of the pistons.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cutaway perspective view of a steam generator showing the platform incorporating the novel support system operatively positioned therein.

FIG. **2** is a transverse section of the steam generator taken along line **2—2** of FIG. **1** to show the pattern of tube ends.

FIG. **3** is a plan view of the mobile platform incorporating the novel support system.

FIG. **4** is an elevational view of the mobile platform depicted in FIG. **3.**

FIG. **5** is a sectional view of a typical support member of FIG. **3** taken along line **5—5** therein.

FIG. **6***a* is a view of a support member, showing it inserted in a tube prior to expansion.

FIG. **6***b* is a view, similar to **6***a*, however showing the support member following expansion into gripping engagement with the tube wall.

FIG. **7***a* is a view similar to FIG. **6***b*, however showing an increased vertical spacing between the tube sheet and the base portion of the platform.

FIG. **7***b* is a view similar to FIG. **7***a*, however showing reduction of the vertical spacing through operation of the invention.

FIG. **8** is a view similar to FIG. **7***b*, however showing an alternate means for delivering air to the region between the two pistons of the support system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. **1**, there is depicted a typical nuclear steam generator **10** including a vessel **12** having a large number of tubes **14** supported therein and terminating at one or both ends in a tube sheet **16.** In the steam generator **10** depicted, the vessel **12** and tubes **14** are generally vertically oriented with the tubes being of an inverted U shape with both ends of the tubes terminating in or slightly below the generally horizontally extending tube sheet **16.** The tubes **14** are hollow and circular in cross section and extend through generally cylindrical passages extending vertically through the tube sheet **16** and are snugly and securely affixed therewithin. Tubes **14** have an inside diameter of 0.75 inch. The tubes **14** terminate at or slightly below the lower surface of tube sheet **16** creating circular, vertically extending openings extending upwardly in the tube sheet.

Tube sheet **16** is supported within vessel **12** in spaced relationship with the bottom of the vessel. The tube sheet may be **10** to **15** feet in diameter and receives both the hot and cold ends of as many as 9,000 primary coolant U tubes **14.** The region below tube sheet **16** may be divided into halves by a vertical divider **20** and a manway **24** in vessel **12** on each side of divider **20** permits human access to the steam generator below tube sheet **16.** A manway **24** may have a diameter of about 16 inches.

The tubes **14,** and accordingly the ends thereof, are positioned such that openings **18** are in a particular pattern which is fairly uniform and repetitive. A carriage, or platform **32** has been developed which is suspended from and thus supported by, the tube sheet **16** or tubes **14** and is remotely actuable for movement parallel the tube sheet. This movement is utilized to move a work station contained with the platform into alignment with various, and preferably all, of the openings **18.**

Remotely movable carriages or platforms of the type generally described above are described in greater detail in U.S. Pat. application Ser. No. 384,658 for REMOTELY MOVABLE PLATFORM to C. T. Ward, D. L. Mathis, F. T. Radcliff and R. Vorwerk filed Aug. 1, 1973 and Ser. No. 384,657 for REMOTELY MOVABLE PLATFORM to C. T. Ward, D. L. Mathis, F. T. Radcliff and E. Ranger filed Aug. 1, 1973 mentioned earlier herein. The platforms described in the above-mentioned applications generally utilized two or more anchor or support means which could be remotely engaged and disengaged from the tube sheet to support the platform. Further, one or more of the anchors or support means is translatable relative to the platform base in a direction parallel said base to effect locomotion of the platform. The invention will be described as embodied in one of the platforms described in the aforementioned applications, however, it will be appreciated that it will also be similarly applicable to the other platform described therein.

One typical pattern in which the ends of the tubes **14** are arranged in tube sheet **16** is seen in FIG. **2.** This pat-

tern of tube **14** ends, or similarly, of openings **18**, has a triangular pitch. By triangular pitch it is meant that the straight rows of openings **18** which intersect one another and share a common hole do so at an angle other than 90°. In the steam generator here described, this angle of intersection is 120° (or its supplement 60°), as defined by directional arrows **28** and **30** in FIG. **2**. This arrangement comprises a continuous series of equilateral triangles adjacent rows or offset from one another to create this pattern. In another pattern, not shown here, the openings **18** may have a square or rectangular pitch in which rows of holes which intersect one another and share a common hole do so at an angle of 90°.

Typically, the internal diameter of the tube **14** which generally defines opening **18** is about three quarters of an inch. The distance between centers of adjacent tubes **14** having the above-mentioned uniform spacing is one inch. This distance may be referred to later herein as the "unit distance".

The invention is associated with a platform or carriage **32** capable of being remotely moved laterally substantially parallel to the lower surface of tube sheet **16** and which is dependently supported from and by the tube sheet. Carriage **32** in this embodiment is intended for use as a work platform from which various remotely controlled operations may be performed. As an example, carriage **32** may serve as a platform or support for nondestructive testing equipment such as an eddy current probe. Alternatively or additionally it may be used as a platform from which repair procedures on a particular tube **14** may be remotely performed. Additional explanation of such capabilities will follow a description of the carriage **32**.

A preferred embodiment of carriage **32** is depicted in FIGS. **3** and **4** and comprises essentially a base portion **34** and a supporting mechanism **36** according to the invention, connected to said base **34**. Mechanism **36** includes means for supporting the carriage below the undersurface of tube sheet **16**. A stepping mechanism forming part of base portion **34** and to which support mechanism **36** is connected may provide means for propelling base **34** and accordingly carriage **32** parallel the undersurface of tube sheet **16**.

The base **34** of carriage **32** includes a member **38** which is preferably of a strong light material such as aluminum or magnesium and is in plan view in the form of a pair of E's back-to-back and having a short crossarm at the outer end of the middle arm of each E. The lateral extent of base member **38** may be some eight to ten inches in each direction and it may be an inch or more in thickness. A pair of rollers **40** are mounted in each diagonally opposite laterally outer corner of base member **38** for rotation about a vertical axis. The rollers **40** are horizontally disposed for rotation about a vertical axis provided by mounting bolts or pins **42**. Each pin **42** is captively retained on or in base member **38** against substantial vertical or lateral motion relative thereto and a roller **40** is retained on each pin against substantial vertical or lateral motion relative thereto. A limited amount of vertical freedom of roller **40** relative to base member **38** may be desirable to permit limited vertical movement between base member **38** and sliders **46***a* and **46***b*. Each roller **40** is free to rotate relative to base member **38**, as mounting pins **42** may also. Rollers **40** are generally above base member **38**. A pin **42** and associated roller **40** is positioned near the extremity of each arm of the back-to-back E's of base **34** and at the extremities of the crossarms on the middle arms of the E's. These portions of the base **34** and accordingly the rollers **40** are positioned and spaced such that a pair of rollers are in laterally spaced opposition at each corner of the base.

The stepping mechanism on base **34**, and accordingly carriage **32**, includes a pair of sliders **46***a* and **46***b*, which house supporting mechanisms **36** which include fingers **48***a* and **48***b* respectively and gripping sleeves **50***a* and **50***b* respectively. The sliders **46***a* and **46***b* each comprise a pair of laterally spaced parallel vertically extending housing members **52** connected at or near their upper ends by a transversely extending rigid connecting arm **54**. Arm **54** and housing members **52** may be integrally formed of aluminum or magnesium or the like. Each housing member **52** includes an upwardly or vertically extending cylinder therein which is closed at its bottom and opens upwardly to be used in a manner described hereinafter. The cylinders **56** in slider **46***a* will be designated cylinders **56***a* and correspondingly those in slider **46***b* will be designated cylinders **56***b*. Work stations or locations such as cylindrical bores or tubes **58** may extend through or be affixed to each slider **46***a* and **46***b* at or near laterally opposite ends thereof preferably outward of cylinders **56**. Tubes **58** might additionally or alternately be positioned on or within base member **38** along its outer perimeter. However certain advantages obtain if tubes **58** may be variably positioned relative to the base, as by movement of the sliders **46**.

Sliders **46***a* and **46***b* are movably connected with base member **38**, or more accurately, are connected in a manner to movably support the base by means of rolling contact with the rollers **40**. Each slider **46** is of such length laterally that it concurrently extends between a pair of rollers **40** at diagonally opposite ends of base member **38** and is of such lateral width that it is in supported or supporting contact with the pair of rollers. Preferably each slider **46** is wider than the space between a pair of rollers **40** and includes a pair of horizontally extending grooves or guides **60** along opposite sides thereof parallel the longitudinal extent of the slider at or near each end thereof. Guide grooves **60** each receive a portion of the outer periphery of a roller **40** therewithin and are in rolling and supported contact therewith. In this manner sliders **46***a* and **46***b* may be translated or reciprocated in a direction which substantially parallels the plane of base member **38** and base **34**.

The connecting arm **54** of one slider **46** extends or crosses over the arm of the other slider in noninterfering relationship, both above base member **38**. The sliders **46***a* and **46***b* cross one another at an angle which corresponds to the angle made between intersecting rows of holes **18** in the tube sheet **16**. For the tube sheet shown this angle is conveniently 120° (with a supplementary angle of 60°) in accordance with the angle revealed by the intersectional arrows **28** and **30** in FIG. **2**. It might be 90° for tubes having a square or rectangular pitch. In the rows of holes **18** paralleling the directional arrows **28** and **30** each hole in the rows in both directions is uniformly spaced from the immediately adjacent hole in that row in the spacing is the same in both intersecting directions and corresponds to the unit distance earlier mentioned. This uniformity of spacing of holes **18** permits a uniformity of spacing of the sup-

port means which include fingers **48** and gripping sleeves **50** to be described later. Further, this uniformity of spacing of holes **18** permits uniformity in the length of lateral thrust of each slider relative to base **34.** The fingers **48** and gripping sleeves **50** at opposite ends of each slider **46** are spaced from one another by some integer number times the unit distance between centers of adjacent pairs of holes **18.** Typically this spacing might be five to ten times the "unit distance". Further, the probe tubes **58** are also spaced from fingers **48** and gripping sleeves **50** by an integer multiple of the unit distance, usually one. Tubes **58** in the depicted embodiment are centered in the same plane that extends vertically through the centerline of the fingers **48** in cylinders **56** of a slider. Each slider **46** is of sufficient length that it may be reciprocated longitudinally an extent corresponding to one, or possibly two, times the unit distance between an adjacent pair of holes **18** while in supported or supporting engagement with rollers **40.** This reciprocation or translation of each slider **46***a* and **46***b* is effected by means of respective motors, preferably linear motors, such as fluid actuated piston and cylinder combinations **62***a* and **62***b* respectively. It will be appreciated that such linear motion might also be obtained by converting the rotary motion of a motor to linear motion, as with a rack and pinion. Each piston and cylinder combination **62***a* and **62***b* is horizontally disposed and the cylinder portion thereof is affixed to the base **34** as by being rigidly joined to base member **38.**

Cylinders **62***a* and **62***b* are oriented to parallel the respective sliders **46** with which they are associated. A piston rod **64** extends from each of the pistons associated with the combination **62***a* and **62***b* and is nonyieldingly secured at its outer end to a flange **66***a* or **66***b* respectively associated with slider **46***a* or **46***b*. Flange **66***a* is fixedly secured to slider **46***a* near one end thereof and flange **66***b* is fixedly secured to slider **46***b* near one end thereof. Actuation of the piston and cylinder combination **62***a* and/or **62***b* thus serve to reciprocate or translate the respective sliders in an obvious and well known manner. Each slider **46** may have two discrete lateral positions relative to base **34,** or possibly three such positions, as disclosed in either of the aforementioned patent applications. If only two positions are to be used piston and cylinders **62** will be conventional double acting pistons requiring two air conduits **68***a* or **68***b* and **70***a* or **70***b* shown in FIG. **4** connected respectively through control valves **69***a* or **69***b* and control valves **71***a* or **71***b* to air supply **73.** If the piston and cylinder combination is to have a two stroke capability (three positions), then a third conduit to each combination will be required. A two stroke, three position piston and cylinder combination is described in the aforementioned patent applications to which reference may be made for any further details. Each stroke length of the piston and cylinder combination **62** is made equal to the "unit distance" between centers of an adjacent pair of holes **18.**

A description of the novel supporting mechanism **36** for the carriage **32** and the operation thereof will now be undertaken. Referring to FIG. **5** the housing member portion **52** of a slider **46***a* or **46***b* is shown with a vertical section taken through the center of cylinder **56** therein. Each cylinder **56** may be formed by a cylindrical vertical bore in a housing member **52.** This bore may be made from the underside of the housing member and extend upwardly part way therethrough. A smaller bore concentric with cylinder **56** may extend the remainder of the way upward from the cylinder through housing member **52.** The bottom end of the bore forming cylinder **56** will be sealingly closed, as by a cover plate **74.** A cylinder **56** might typically be three or more inches in length with the smaller diameter concentric bore extending upwardly therefrom being nearly the same length, or somewhat less.

Typically a cylinder **56** might be about one inch in diameter with the smaller bore thereabove being about one-half an inch in diameter.

A finger piston **76** is radially sized for sliding relationship within cylinder **56** axially thereof. A rigid rod or finger **48** is affixed to and extends upwardly from finger piston **76.** Each piston **76** includes an O-ring thereabout for sliding sealing contact between the piston and the wall of cylinder **56.** Piston **76** is movable within cylinder **56** between a lowered position in which it contacts the bottom end of the cylinder and a raised position thereabove but below the upper end of the cylinder. The length of finger **48** is such that it extends more than an inch, and preferably two inches or more, above the upper surface of housing member **52** of a slider **46** when the piston **76** is in its raised position. Further, this length is such that the upper end of finger **48** is flush with or below the upper surface of the housing member when the piston **76** is in its lowered position. Finger **48** includes a downwardly facing jaw **80** at or near its upper end. Jaw **80** may be formed as an integral part of finger **48** or by means of an enlarged nut threadedly secured thereto.

Means for grippingly engaging the inner wall or walls of openings **18** defined by tubes **14** are associated with and carried by the finger **48.** In this embodiment these engaging means comprise a deformable gripping sleeve **50** disposed about an axially extending portion of finger **48** and of somewhat smaller outer diameter than the diameter of the small bore above cylinder **56.** A gripping sleeve **50** may be tubular and comprised of a flexible or deformable material or elastomer, such as gum rubber, a polyurethane or the like. The material of sleeve **50** is preferably one having a relatively high coefficient of friction.

A rigid tubular sleeve **82** slidably encircles each finger **48** along its lower extent below the deformable gripping sleeve **50** and also extends radially outward beyond the inner diameter of the gripping sleeve, thus forming an upwardly facing lip or jaw against the undersurface of the gripping sleeve **50.** A piston **84** is affixed to rigid sleeve **82** near its lower end and slidably encircles finger **48.** Each piston **84** is of essentially the same diameter as the piston **76** associated with the finger **48** and includes an O-ring thereabout for sliding fluid sealing contact between the piston and the wall of cylinder **56.** In this arrangement piston **84** is positioned intermediate piston **76** and the upper end of cylinder **56** and, accordingly, will contact the upper end of the cylinder when the finger piston **76** is driven upwardly to its raised position. The underside of piston **84** may serve as a stop limit for finger piston **76** to define the raised limit position of the latter piston. It may be desirable for reasons to be described hereinafter to prevent the entire upper surface of piston **76** from contacting the lower surface of piston **84** in order to maintain a fluid receiving chamber therebetween, therefore spacer means such as the raised land **86** on the upper

side of piston **76** is provided. The spacer, in this instance land **86,** is significantly smaller in diameter than the diameter of either of pistons **76** or **84.** The spacer might also have been a free standing shim or washer encircling finger **48** below piston **84** or it might have been a downwardly extending land affixed to the bottom side of piston **84.** Land **86,** in one embodiment, is of an axial length equal to or somewhat less than the distance from the upper surface of housing member **52** to the upper extent of the active gripping portion of sleeve **50** when pistons **76** and **84** are in their raised limit positions.

A small land might also be provided on the upper surface of piston **84** to maintain it slightly spaced below the upper end of cylinder **56** when it and piston **76** are in their raised limit positions to facilitate introduction of driving fluid thereabove.

Finger **48** and gripping sleeve **50** are shown in the lowered position in FIG. **5.** In order for sleeve **50** to grippingly engage the wall of an opening **18** it is necessary that the finger **48** and sleeve **50** be upwardly extended to the raised limit position determined by piston **76** and that the sleeve **50** then be radially expanded by axially separating pistons **76** and **84** relative to one another. By axially moving pistons **76** and **84** away from one another the upper surface of rigid sleeve **82** and the downward facing surface of jaw **80** are moved relatively toward one another axially compressing sleeve **50** therebetween. Sleeve **50** may not move radially inward because of the presence of finger **48** thereat and accordingly expands radially outward. If carriage **32** has been previously placed, possibly manually, closely below the undersurface of tube sheet **16,** with fingers **48** aligned with openings **18,** the upward extension of finger **48** and sleeve **50** and the subsequent expansion of the latter member will result in the sleeve grippingly engaging the wall of a tube **14** into which it was inserted.

FIG. **6***a* depicts carriage **32** closely below and preferably with base portion **34** in contact with the undersurface of tube sheet **16** and shows the finger **48** and its gripping sleeve **50** in its raised limit position and fully inserted within an opening **18** defined by tube **14.** FIG. **6***b* depicts the gripping sleeve **50** in its radially expanded configuration and shows it in gripping engagement with the interior wall of a tube **14.** The outside diameter of sleeve **50** in its relaxed state is enough smaller than the inside diameter of tube **14** to permit its easy insertion therewithin but is sufficiently large to provide good radial expansion into gripping contact with the tube when axially compressed and shortened by 10–20 percent of its length. Typically the outside diameter of gripping sleeve **50,** when relaxed, is 0.56 inch.

The means for actuating pistons **76** and **84** preferably include pressurized driving fluid, and more particularly, a pressurized gas such as air. It will be appreciated however that other means such as springs might be used in combination with pressurized air. Raising of the pistons **76** and **84** to the raised limit positions is effected by admitting air to cylinder **56** below piston **76** when it is in its lowered limit position. This is accomplished by connecting one end of a conduit **88** to port **90** in the lower end of cylinder **56** and connecting the other end to a relatively low pressure source of air **92** through a control valve **94.**

In order to effect axial compression of sleeve **50** and to obtain the necessary radial expansion, pressurized air is admitted to the region or chamber between pistons **76** and **84** when they are in their raised limit positions. This is accomplished in one embodiment by connecting a relatively high pressure source of air **100** through control valve **102** in conduit **96** to port **98** in cylinder **56.** Port **98** is located just above the upper surface of piston **76** when it is in its raised limit position.

The pressures involved will of course depend on the quality and geometry of sleeve **50,** the active surface areas of the piston, and the weight and friction of the elements to be moved, however in the embodiment described a pressure of about **25** pounds per square inch at source **92** has been found adequate to extend finger **48** and insert it within a tube **14** and a pressure of some 100–150 pounds per square inch has been required of source **100** to effect the necessary separating force between the two pistons to expand the sleeve **50** into snug gripping engagement with the tube.

The several control valves discussed and to be discussed herein are conventional three-way valves which utilize only two operative positions, one being that which admits air from the source to the cylinder and the other being that which vents air from the cylinder to the atmosphere. These valves may be manually or automatically operated, as is well known. To release sleeve **50** from gripping engagement with tube **14** it is only necessary that valve **102** be vented to the atmosphere removing the separating force between piston **76** and **84.** Finger **48** might descend to its lower limit position when control valve **94** is vented to the atmosphere following venting of control valve **102,** however, friction between the pistons and cylinder may require that an additional downwardly applied force be applied. This additional downward force would normally be applied to piston **84** and would not normally be of great magnitude. This may be accomplished by admitting air to cylinder **56** above piston **84** through a conduit **104** connected at one end to a port **106** in cylinder **56** above sleeve **84** in its raised limit position and connected at its other end to a source of air **108** through valve **110.** Air source **108** would normally have to be at a pressure no greater than 10–25 pounds, however, according to the invention, a greater pressure may be desirable to accomplish the lifting of carriage **32** in the manner to be hereinafter described.

Referring to FIG. **7***a*, finger **48** and gripping sleeve **50** are shown respectively in their fully extended and fully expanded configurations, however, it will be noted that they are not fully inserted within tube **14** to an extent which brings the upper surface of housings **52** of a sliders **46** into contact with the undersurface of tube sheet **16.** This condition may result either because carriage **32** was spaced somewhat below tube sheet **16** when finger **48** was initially extended and inserted, or because it has slipped downward relative to tube sheet **16** and tube **14.** The latter-mentioned slippage may arise from excessive loading of carriage **32** as during a work operation in which an instrument or plug is inserted into a tube **14** and the carriage is used as the support platform from which this work operation is launched or a slight amount of slippage may occur during the stepping operation in walking the carriage across the undersurface of the tube sheet.

It is preferable that carriage **32,** and specifically base portion **34** thereof, remain as closely adjacent the undersurface of tube sheet as possible, both to serve as a relatively constant reference point from which work

operations may be conducted and additionally to avoid the problem of lateral misalignment of a test probe or the like which may be launched from base **34** into a tube **14.** Further, if the spacing results from slippage of the gripping sleeve **50** and is repetitive with time then it will be necessary to recover some or all of this slippage to prevent the carriage **32** from ultimately falling free of tube sheet **16.**

To eliminate this greater than minimum spacing between the tube sheet **16** and the base portion **34** of carriage **32** and/or to insure maximum insertion of finger **48** and sleeve **50** into tube **14,** the invention provides means and a method for lifting base **34** relative to tube sheet **16** and/or fully inserting finger **48.** Firstly, the pressure of air from source **108** admitted to cylinder **56** through port **106** is sufficiently great to force piston **84** and accordingly piston **76** downwardly relative to the cylinder **56** and base **34,** or stated another way, to force the base **34** upwardly relative to piston **84.** This pressure will depend principally upon the weight being supported by finger **48** and gripping sleeve **50** and the frictional forces between the pistons and the wall of cylinder **56.** The greater the number of supporting means in gripping engagement with tubes **14** and tube sheet **16,** the less the amount of weight supported by each individual support means. In the embodiment being described in which normally at least two supporting means are always in engagement with the tube sheet **16** a lifting force of some 20–50 pounds at each finger **48** is quite sufficient. As the effective work area of the upper surface of piston **84** is about three quarters of an inch, an air pressure greater than 30 psi, typically about 70 psi, has been found to be adequate. Such pressures may of course be adjusted to suit the particular design and weight. The pressure of air required to separate pistons **76** and **84** might have to be increased somewhat to accommodate the increased downward force on finger **48** and sleeve **50** needed to raise and hold base portion **34.** FIG. **7***b* shows carriage **32,** or more specifically housing member **52** of slider **46** thereof, in contact or nearly in contact with the undersurface of tube sheet **16** following the above-mentioned introduction of air to cylinder **56** through conduit **104.** This operation may be termed a "lifting" or "cinching" operation.

By considering the extent to which the gripping sleeve **50** might extend above the uppermost surface of base **34** or housing **52** when fully raised, it will be seen as depicted in FIG. **7***a*, that the base **34** and housing **52** might descend to a spacing of an inch or more below the undersurface of tube sheet **16** if the gripping sleeve **50** slips somewhat. In such instance the pistons **76** and **84** will move downward relative to cylinder **56** by an equivalent amount during a cinching operation. It is for this reason that, in one embodiment, the spacer land **86** on piston **76** is placed between the two pistons and the port **90** is positioned near the upper surface of finger piston **76** in the latter's raised limit position. By making the land **86** of an axial length which approximates the distance or spacing between the upper surface of housing member **52** and the upper extent of the active gripping portion of sleeve **50** when pistons **76** and **84** are in their raised limit positions, port **98** may move upward relative to piston **76** and **84** by that distance during a cinching operation and still remain in fluid communication with the chamber between spaced pistons. This is true even for the maximum amount of cinching movement, so long as the sleeve **50** was initially in gripping engagement with a tube **14.** While the length of the spacer land **86** does not effect the length of the stroke of finger **78** it does require that cylinder **56** be made axially longer than would otherwise be the case for a particular stroke length without the spacer.

As an alternative to the spacer land **86,** the increased length and weight of cylinder **56** and the precise positioning of port **98,** there is depicted in FIG. **8** an embodiment of the carriage supporting means in which the air conduit **96** is connected to a hollow rigid tubular conduit **97** which in turn is carried by and moves with piston **76.** Conduit **97** is connected at one end to conduit **96** remote from air source **100** and is securely connected at its other end to finger piston **76** at the underside thereof and is preferably concentric therewith. A passage or port **98'** extends from the end of conduit **97** through piston **76** and possibly into finger **78** and opens or exits into the region or space between pistons **76** and **84.** Rigid conduit **97** slidably passes through a central opening in cover plate **74** across the lower end of cylinder **56.** An O-ring seated in housing member **52** or plate **74** at the lower end of cylinder **56** fluidly isolates the cylinder **56** from the atmosphere while allowing reciprocable motion of the conduit **97** relative thereto. Conduit **97** may be of a material such as stainless steel. A downwardly extending sleeve **101** is affixed at its upper end to the undersurface of cover plate **74** and extends downwardly about conduit **97** to protect it. By delivering the driving fluid to the region between pistons **76** and **84** in this latter described manner, port **98'** will always remain in registry with the region between the pistons regardless of their positionings relative to cylinder **56.** It may be desirable to retain a short axially extending spacer between the pistons to insure at least a minimum space therebetween.

The operation of carriage **32** and more specifically, of the support means including fingers **48** and gripping sleeves **50** will now be described. The description is equally applicable to the different embodiments for introducing air through port **98** or **98'**. As described more thoroughly in the earlier mentioned patent applications, fingers **48** and gripping sleeves **50** are divided functionally into two independent groups with the elements of a group being controlled preferably in unison. The support means associated with one such group have been given the subscript *a* and those associated with the other group have been given the subscript *b.* Structurally the supporting means of one group are identical to those of the other group, however their sequence of operation may be varied as described below.

In the description above relative to FIGS. **6–8,** no subscripts were assigned to the several air conduits, control valves and ports associated with the cylinder and pistons under discussion. It will be appreciated that if these elements are associated with a cylinder **56***a* of one functional group, they would bear the *a* subscript and those associated with a cylinder **56***b* of the other functional group would bear the *b* subscript. For purposes of discussing the operation of the support means in the two different functional groups, the *a* and *b* subscripts will be used. It will be appreciated that the air supplies **92, 100** and **108** may be common to both groups. Further there might only be a single one of each control valve **94, 102,** and **110** associated with the several cylinders **56** of a functional group, with distribution of the air occurring between a valve and the several cylinders for unity of control.

First, platform **32** will be considered as remaining laterally stationary at a particular location below tube sheet **16.** As mentioned earlier, it is preferable that the carriage **32** and particularly the base portion **34** thereof be positioned vertically closely below or in contact with the undersurface of tube sheet **16** to provide a constant and reliable reference from which to launch or conduct work operations. In this configuration some, and probably all, of the support means which include fingers **48***a* and **48***b* in gripping sleeves **50***a* and **50***b*, will be in gripping engagement with tubes **14.** This will mean that air is being provided to the region between pistons **76** and **84** from source **100.** Concurrently therewith, air will be admitted to cylinder **56** from source **108** through conduit **104** and ultimately port **106.** This air is of sufficient pressure as mentioned earlier to effect relative longitudinal motion between the pistons and cylinders housed in member **52,** with members **52***a* and/or **52***b* rising until they contact the undersurface of tube sheet **16.** At this point control valves **110***a* and **110***b* and **102***a* and **102***b* remain open to retain the supporting means in gripping engagement within the tubes **14** and to "cinch" the carriage up closely against the undersurface of the tube sheet while any work functions are performed.

As a modification of the above-described procedure some, but not all, of the gripping sleeves **50** may be released from gripping engagement with their associated tubes **14.** For instance, it will be assumed that the gripping sleeves **50** of the *b* subscripted functional group are released. This is effected by operation of valves **102***b* to disconnect source **100** from cylinders **56***b* and vent that region of the cylinder to the atmosphere. This is accomplished prior to the introduction of air through port **106***b*. Source **108** is subsequently connected with cylinders **56***a* through conduits **104***a* and ports **106***a* to lift the base **34** relative to those fingers **48***a* in gripping sleeves **50***a* which remained in gripping engagement with tubes **14.** The support means bearing the disengaged gripping sleeves **50***b* will be raised to their upper limit through admission of air to cylinders **56***b* via ports **90***b* and are subsequently reexpanded into gripping engagement with the tubes **14** by application of air from source **100** through ports **98***b*. In this manner those support means which were released from gripping engagement will have been reinserted to the maximum depth within their particular tubes **14.** Those support means which originally remained in supporting engagement with tubes **14** may now be released from gripping engagement with the tubes by venting through ports **98***a* and valve **102***a*. These support means may now also be extended to their raised limit position and reexpanded such that all support means will now be fully extended and fully inserted within the various tubes **14** and gripping engagement therewithin.

A somewhat similar procedure is followed in stepping the platform **32** laterally of the tube sheet **16** and is described hereinafter. The operation will be assumed to begin from a condition in which all sleeves **50** are expanded and the carriage base **34** is cinched up against the tube sheet undersurface by means of air pressure from source **108** admitted to the cylinders **56** through ports **106.**

While maintaining expansion pressure on the pistons of cylinders **56***a* through ports **98***a*, the expansion pressure is released from the pistons of cylinders **56***b* by venting through ports **98***b* and control valves **102***b*. If the cinching pressure has been maintained in all cylinders **56** through ports **106** during this operation, both pistons **76***b* and **84***b* in cylinders **56***b* will be moved to their lower limit positions. Then the cinching pressure may be removed from some or all cylinders **56** by venting through ports **106** and control valves **110.** This release of cinching pressure might have been occurred prior to or concurrent with the above-mentioned release of the expansion pressure. In either event, the gripping sleeves **50***a* will now remain in gripping engagement, fingers **48***b* are in their lowered positions, and the platform **32** will be released from its cinched position, for easy lateral movement relative to tube sheet **19.** At this point, the platform is ready to be stepped laterally of tube sheet **19.** It should be noted that the aforementioned release of the cinching pressure from cylinders **56** *a* will be necessary only if there will be some sliding contact or interference between the sliders **46***a* or **46***b* and the underside of tube sheet **16** during the stepping operation. If, as noted earlier, some degree of vertical freedom exists between base member **38** and sliders **46***a* and **46***b*, it will not generally be necessary to release the cinching pressure or force from that group of cylinders (**56***a* above) which are to remain in gripping engagement with the tube sheet **16** during the stepping operation. Rather, the slider (**46***b* above) which will move laterally relative to tube sheet **16** drops away from the tube sheet by the amount of limited vertical freedom provided between it and base member **38.** This allows a clearance between the slider which moves relative to the tube sheet during the stepping operation.

Because sleeves **50***a* remain inserted and expanded in tube sheet **16,** their slider **46***a* must remain fixed relative to the tube sheet. However, slider **46***b* may be moved relative to slider **46***a* and tube sheet **16** by actuating piston and cylinder **62***a* to move the base **34** and slider **46***b* in a direction parallel the extent of slider **46***a*. Alternatively, if the step is to be parallel the extent of slider **46***b*, piston and cylinder **62***b* will be actuated moving slider **46***b* relative to base **34** and tube sheet **16.** This latter mentioned operation might be considered a half-step as it moves only the slider and not the base and carriage. In either event, the fingers **48***b* of slider **46***b* will now be aligned with a "new" pair of tube openings **18.** Air will be reintroduced to cylinders **56***a* via ports **106***a* by control of valve **110***a* to "cinch" the base **34** up into contact with the tube sheet **16.** This step is of course unnecessary if the cinching pressure was not previously released from cylinders **56***a*. Fingers **48***b* with sleeves **50***b* are then fully raised by introducing air to cylinders **56***b* through ports **90***b*. Because base portion **34** was cinched up into contact with the tube sheet, fingers **48***b* will be inserted to the maximum extent in tubes **14.** At this point, sleeves **50***b* will be expanded into gripping engagement with tubes **14** by admitting air to cylinders **56***b* through ports **98***b* (or **98**'*b*) by control of valve **102***b*. Thus, fingers **48***b* and sleeves **50***b* are fully inserted in and are gripping tubes **14** of tube sheet **16,** thereby recovering any slippage or spacing previously accruing between base **34** and the tube sheet. It will be appreciated that fingers **48***b* might have been raised or extended prior to, or concurrent with, the "cinching" operation with fingers **48***a*.

Sleeves **50***a* might now be relaxed, fingers **48***a* raised to their limit and sleeves **50***a* reexpanded into gripping engagement to obtain a fully inserted configuration for

all fingers **48** and sleeves **50.** Alternatively, this repositioning of fingers **48***a* might wait until those fingers are moved to a new set of openings **18** during a stepping operation.

The earlier-mentioned half-step operation, in which slider **46***b* was moved relative to base **34,** may be completed now by moving the base in the same direction relative to slider **46***b*. This is accomplished by freeing and retracting fingers **48***a* and sleeves **50***a* and actuating piston cylinder combination **62***b* as was described for movement of fingers **48***b*.

One complete step of a slider **46** and base **34** relative to tube sheet **16,** both parallel slider **46***a* and parallel slider **46***b*, has been described including the "cinching" operation. From this discussion, the interrelationship of the cinching operation with the stepping operation should be evident.

It will be understood that the embodiment shown and described herein is merely illustrative and that changes may be made without departing from the scope of the invention as claimed.

What is claimed is:

1. A platform for support below a member comprising:

a. a base portion;

b. at least two upwardly extending support means supportingly connected to said base portion and independently reciprocable relative thereto between raised and lowered positions and including remotely actuable means therewith for grippingly engaging said member to support a portion of the weight of said platform therefrom when in said engagement; and

c. remotely controllable means for selectively applying a force to said support means relative to said base portion of a magnitude and direction to selectively move said support means either toward said raised position or said lowered position, even when said portion of platform weight is supported thereby.

2. The apparatus of claim **1** wherein said member includes openings in the undersurface thereof and said means for grippingly engaging said member are sized for insertion in said openings and are expandable into frictional engagement with a wall of openings.

3. A lifting mechanism for a platform self-supported below a member having openings in the undersurface thereof comprising in combination:

a. a generally horizontally extending carriage base portion;

b. two upwardly extending cylinders carried by said base portion in vertically fixed relationship thereto;

c. a first piston reciprocable in each said cylinder between raised and lowered positions and having a finger extending upwardly therefrom, said finger extending substantially above said base portion in said raised position and having a downwardly facing compression surface near the upper end thereof;

d. a second piston in each said cylinder concentrically disposed about said finger above said first piston and reciprocable relative thereto and to said cylinder between raised and lowered positions relative to said first piston and having an upwardly facing compression surface extending upwardly therefrom;

e. a resilient sleeve about each said finger between said upwardly and downwardly facing compression surfaces for outward expansion into gripping engagement with the wall of a said opening when inserted thereinto and said second piston is in its raised position relative to said first piston;

f. first means for admitting driving fluid to each said cylinder below said first piston at a pressure to raise said piston and finger;

g. second means for admitting driving fluid to each cylinder intermediate said first and second pistons at a pressure to move and maintain said second piston at its said raised relative position to outwardly expand said sleeve; and

h. third means for admitting driving fluid to each cylinder above said second piston at a pressure to move said second piston downward relative to said cylinder when said sleeve is in said gripping engagement, whereby said cylinder and carriage base portion are lifted towards said member.

4. The apparatus of claim **3** wherein said second means for admitting driving fluid include a fluid conduit carried by said first piston and movable relative to said cylinder in fluid sealed relationship therewith, one end of said conduit being connectable to a fluid source and the other end fluidly communicating with said cylinder intermediate said first and second pistons.

5. In a platform for suspended support below a member having holes in the undersurface thereof and including two support means supportingly connected to a base portion of said platform and including means for grippingly engaging said member, apparatus for lifting said base portion relative to said undersurface comprising:

a. each said support means being reciprocable between raised and lowered limits relative to said base portion;

b. said means for grippingly engaging said member moving with said support means and sized for insertion into a said hole for selective engagement with a wall thereof to support the weight of said support means and a portion of said base;

c. means for selectively actuating each said engaging means into and out of gripping engagement with said hole wall; and

d. means for selectively applying a force to each said supporting means relative to said base of a magnitude and direction to reciprocate said supporting means toward said raised and said lowered limits, said force applied for said downward relative reciprocation of said support means being sufficient to overcome the portion of weight of said base supported by said support means, whereby to lift said base relative to said member.

6. The apparatus of claim **5** wherein at least one of said support means is translated relative to said base in a direction parallel to said base for moving said platform parallel said member undersurface.

7. The apparatus of claim **5** wherein said base includes two cylinders joined thereto against upward and downward motion relative thereto; each said support means comprises a finger extending upwardly from a piston, said piston being reciprocably mounted within a said cylinder; and said force applying means comprise means for applying a first force between said piston and cylinder to move said piston in one direction relative to said cylinder and base and a source of driving fluid ad-

mitted to said cylinder for moving said piston in the other direction.

8. The apparatus of claim **5** wherein said base includes two cylinders joined thereto against substantial upward and downward motion relative thereto; each said support means comprise a finger extending upwardly from a piston, said piston being reciprocably mounted within a said cylinder; and said force applying means comprise a first source of driving fluid admitted to said cylinder above said piston in its raised position for moving said piston relatively downward and a second source of driving fluid admitted to said cylinder below said piston in its lower position for moving said piston relatively upward.

9. The apparatus of claim **8** wherein each said finger includes an upper jaw near its upper end; said hole engaging means comprise a resilient sleeve about said finger below said finger jaw, said sleeve being normally diametrically smaller than a said hole and expandable into gripping engagement therewith; said actuating means for each said engaging means comprise a lower jaw carried by a second piston slidably disposed in a said cylinder about said finger above said finger piston and below said resilient sleeve for reciprocation between a raised and lowered position relative to said finger piston to respectively expand and relax said sleeve; and a third source of driving fluid admitted to said cylinder between said finger piston and said second piston for relatively moving said second piston to its raised position; and said first source is admitted to said cylinder above said second piston in said raised position of said finger piston.

10. The apparatus of claim **9** wherein the uppermost gripping surface of each said resilient sleeve is a certain distance above said carriage base in said raised limit position of said support means; spacer means positioned to coact between said finger piston and said second piston establish a minimum spacing therebetween, said minimum spacing being substantially that of said certain distance of said resilient sleeve uppermost gripping surface above said base; and said third source of driving fluid is admitted to said cylinder proximate the upper surface of said finger piston in its said raised position.

11. The apparatus of claim **10** wherein at least one of said cylinders in translatable relative to said base in a direction parallel to said base, whereby to translate said support means relative to said base for moving said platform parallel to said member undersurface.

12. The apparatus of claim **9** wherein spacer means are positioned to coact between said finger piston and said second piston to establish a minimum spacing therebetween and said third source of driving fluid is admitted to said cylinder proximate the upper surface of said finger piston in its said raised limit position.

13. A method for supporting a platform closely adjacent the undersurface of a member having an opening in said undersurface, said platform having a base portion and support means supportingly connected to said base and movable relative thereto between raised and lowered positions respectively in response to raising and lowering forces applied therebetween and actuable into gripping engagement with a wall of said opening when inserted therein, comprising the steps of:

a. positioning said platform near said member undersurface such that said support means are inserted in said opening when in said raised position;

b. applying a raising force to move said support means to said raised position;

c. actuating said support means into gripping engagement with a wall of said opening; and

d. applying a lowering force to said support means while maintaining said gripping engagement, said lowering force being of sufficient magnitude to move said platform base portion upward to a limit closely adjacent said member undersurface.

14. The method of claim **13** wherein said limit is established by contact of said base with said member.

15. The method of claim **13** including the step of maintaining said support means lowering force following arrival of said base at said limit.

16. The method of claim **13** wherein said member included a plurality of openings and said platform includes two support means independently raisable and lowerable and actuable into gripping engagement with different of said openings and further comprising the steps of:

a. actuating one of said support means out of gripping engagement with a said opening wall while maintaining the other in engagement;

b. applying a raising force to said one said support means while applying said lowering force to said other support means; and

c. actuating said one support means into gripping engagement with the wall of a said opening.

17. The method of claim **16** wherein a particular said support means is translatable relative to said base in a direction substantially parallel to said base, to align a support means with a different one of said openings, and further comprising the steps of:

a. applying a said lowering force to said one support means to move it to its lowered position following its said actuation out of gripping engagement; and

b. translating said particular support means relative to said base to align said one lowered support means with a different one of said openings prior to applying said raising force thereto.

18. The method of claim **17** including the step of maintaining said support means lowering force, following arrival of said base at said limit.

19. A method for lifting a platform dependently supported from a member having openings in the undersurface thereof, said platform including a base and two upwardly extending supporting means supportingly connected thereto and independently movable relative thereto between raised and lowered positions for insertion in said raised position into said opening and actuable into and out of gripping engagement with the wall of said opening when inserted thereinto to support said platform, both said supporting means normally in gripping engagement with said member, said method comprising the steps of:

a. actuating one of said supporting means out of gripping engagement with said member;

b. moving said supporting means remaining in gripping engagement downward relative to said base, whereby said base is raised relative to said member; and

c. actuating said previously removed supporting means into gripping engagement with said member.

20. The method of claim **19** wherein at least one of said supporting means is movable relative to said base in a direction substantially parallel said base to align a

supporting means with a different said opening and further comprising the steps of:

a. moving said one supporting means actuated out of gripping engagement to its said lowered position;

b. moving said at least one supporting means relative to said base in said direction substantially parallel thereto to align said lowered supporting means with a different said opening; and

c. moving said one supporting means actuated out of gripping engagement to its said raised position.

21. The method of claim **19** wherein said downward movement of said supporting means relative to said base is sufficient to lift said base to a maximum elevation proximate the undersurface of said member.

22. The method of claim **20** wherein said downward movement of said supporting means relative to said base is sufficient to lift said base to a maximum elevation proximate the undersurface of said member.

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