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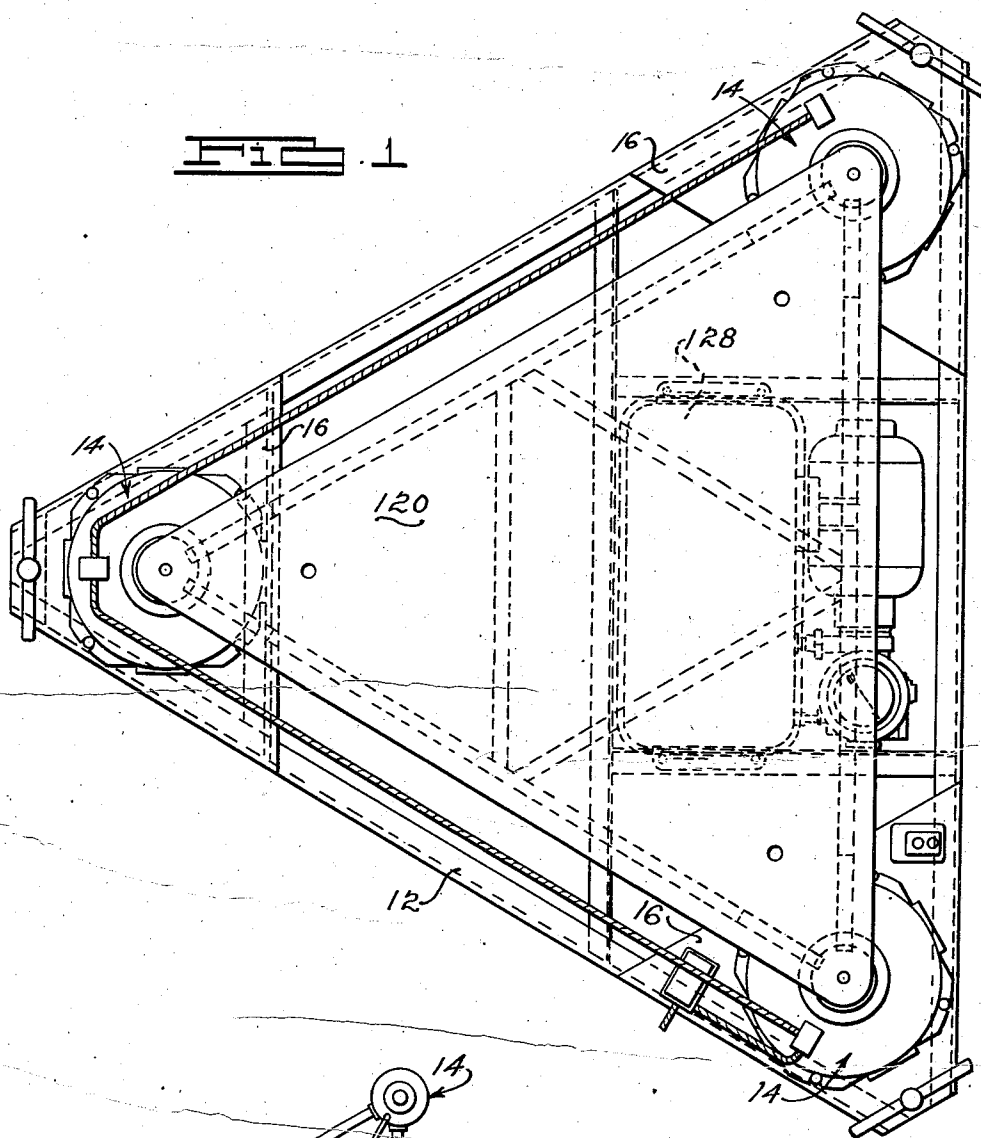
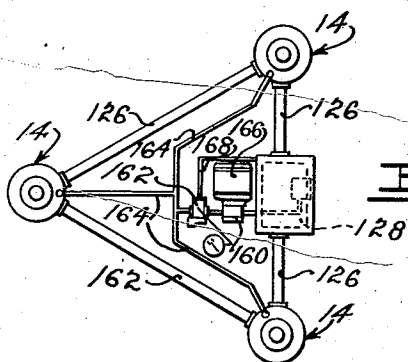
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2,408,169

LEVEL WORK SUPPORTING STRUCTURE

Filed Feb. 12, 1944

3 Sheets-Sheet 1



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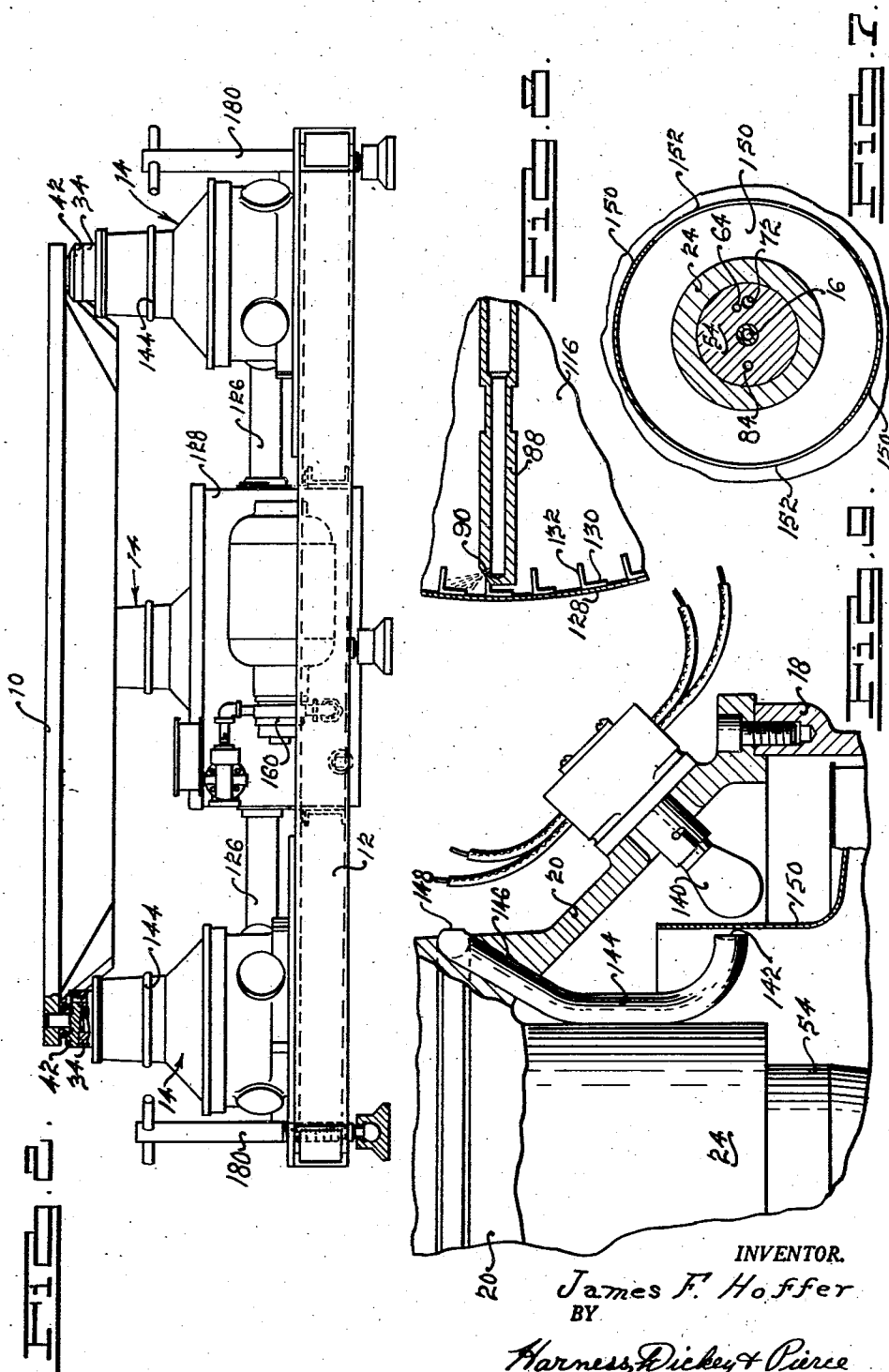
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

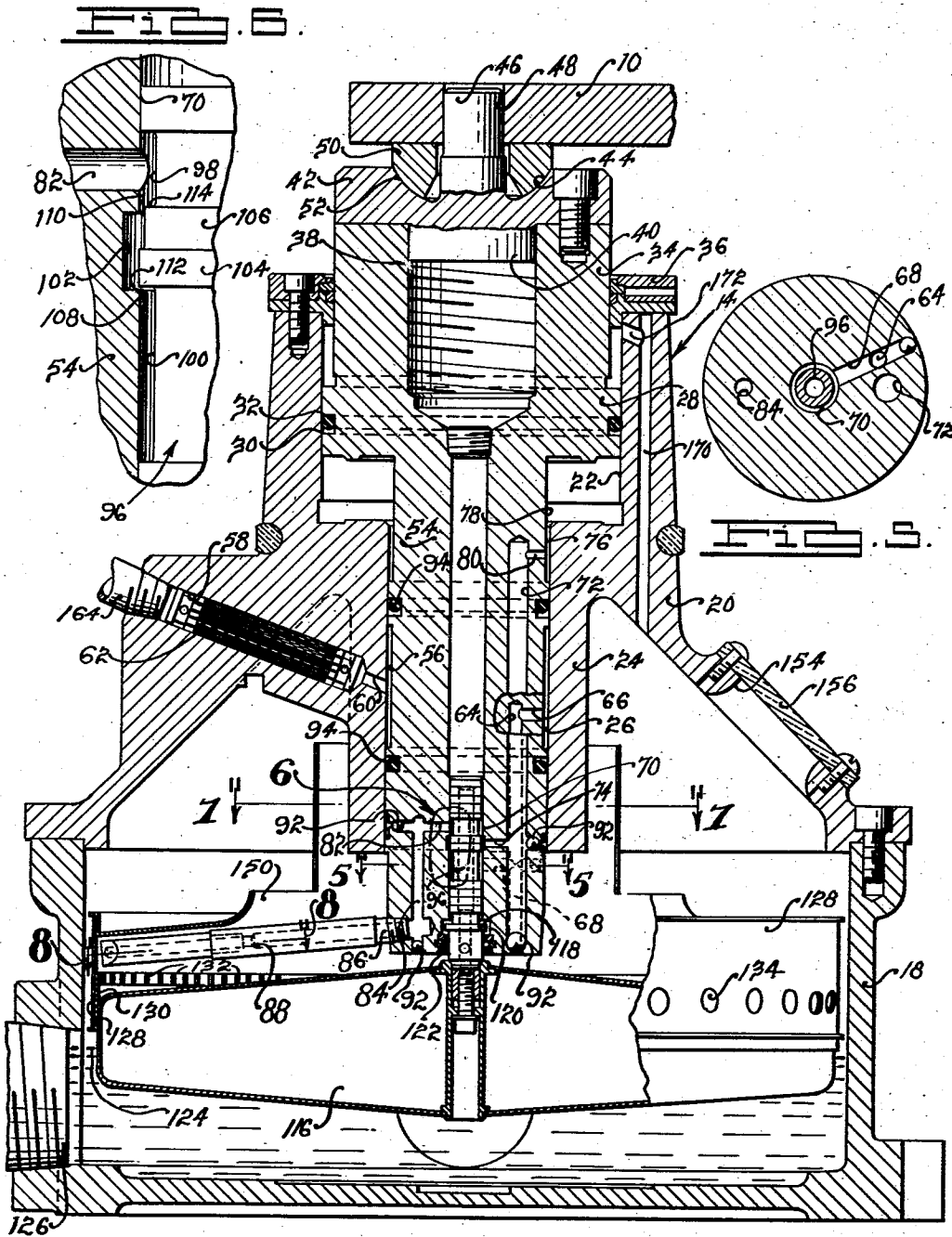


FIG. 4.

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LEVEL WORK SUPPORTING STRUCTURE

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4 Claims. (Cl. 121-41)

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The present invention relates to a work supporting structure and particularly relates to such a structure in which the work support is automatically maintained level.

One of the primary objects of the present invention is to automatically maintain a work support level with extreme accuracy regardless of any variations in level in the floor or ground support.

Another object of the invention is to automatically maintain a work support level through the action of a novel float controlled, fluid actuated servo-mechanism.

A further object of the invention is to provide an improved valve mechanism associated with the servo-mechanism.

A further object of the invention is to provide an improved valve mechanism having a shiftable valve element in which the friction is reduced between the valve element and the valve housing by effecting continuous relative rotation therebetween, thereby providing a sensitive and accurately responsive servo-mechanism.

A further object of the invention is to provide a visual signal which indicates the relative rotation above mentioned.

Other objects and advantages of the invention will become clearly apparent from the following specification, the drawings relating thereto, and from the claims hereinafter set forth.

In the drawings, in which like numerals refer to like parts in the several views throughout:

Figure 1 is a top plan view of a work supporting structure embodying features of the present invention;

Fig. 2 is a front elevational view of the structure shown in Fig. 1;

Fig. 3 is a diagrammatic view of the hydraulic circuit and its relationship to the servo-mechanism.

Fig. 4 is a vertical, cross-sectional view through one of the servo-mechanisms of the present invention and showing such mechanism in its relationship to the supporting surface;

Fig. 5 is a cross-sectional view taken substantially along the line 5-5 of Fig. 4;

Fig. 6 is an enlarged, cross-sectional view of that portion within the circle 6 of Fig. 4;

Fig. 7 is a cross-sectional view taken substantially along the line 7-7 of Fig. 4;

Fig. 8 is a fragmentary, cross-sectional view taken substantially along the line 8-8 of Fig. 4; and

Fig. 9 is a vertical, cross-sectional view of a portion of the structure shown in Fig. 4 and taken at substantially 90° therearound.

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According to the present invention, a structure is provided by which a workpiece may be supported and maintained level regardless of irregularities in the ground or floor support. This is necessary and desirable in many fields, for example, in the airplane assembly field. There it is desirable to hold large subassemblies absolutely level during the entire procedure of assembling the individual parts. The structure of the present invention may be either mounted directly on the floor, or it may be carried on trucks along trackways, or supported merely by trucks, or the like. In any case, variations in the level of the ground supporting surface or trackways would tend to disturb the level support of the workpiece, which is necessarily supported at numerous points, so that under those circumstances it would not remain in accurate alignment during assembly. With a structure of the present invention, all of the supporting points of the workpiece will remain in accurate relation regardless of any variations in levelness of the supporting ground or track.

Referring to the drawings, a flat table member 10 is mounted on a frame 12 and interconnected thereto through servo-mechanisms generally indicated at 14. In the embodiment illustrated, the table 10 and frame 12 are triangular in shape with three servo-mechanisms 14, one located at each corner and fixed to plate members 16, which are mounted on the frame 12 at the corners thereof. Through the action of the servo-mechanisms 14, to be described in detail hereinafter, the table 10 is maintained absolutely level regardless of any tilting of the frame 12.

Each servo-mechanism includes a base 18 forming a receptacle for a bath of liquid, such as oil. The base 18 is secured to a plate 16 by means of bolts or the like. An upper housing member 20 is removably secured to the top edge of the base 18 and is formed to provide an upwardly directed cylinder chamber 22. A depending central portion 24 is formed integral with the housing 20 centrally thereof and is forced with a vertical central bore 26. The upper end of bore 26 opens into the chamber 22 and the lower end opens into the space above receptacle 18. A piston 28 is slidably disposed within chamber 22 and is formed with an annular recess 30 on the periphery thereof within which an annular synthetic rubber ring 32 is disposed. Such ring 32 is circular in cross-section and sealably engages the wall of chamber 22 as the piston 28 slides therein.

The integral upper end 34 of piston 28 extends through a sealed opening in an end cap 36 which

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is secured to the upper end of housing 20. The upwardly projecting end 34 has an axial opening 38 formed therein which receives a pilot stem 40 of an adapter 42. The axial opening 38 may be tapped to receive another type of adapter which may be desirable for adjustability. The adapter 42 has a dish-shaped recess 44 formed in the top surface thereof with an upstanding integral pin 46 in the center thereof. The pin 46 is received through an opening 48 in table 10 and the undersurface of table 10 rests upon a top flat surface of a supporting member 50. Such supporting member 50 is formed with a central opening therethrough through which the pin 46 passes with a loose fit. The undersurface 52 of member 50 is formed complementary in shape to the shape of the dished recess 44 so that the member 50 may tilt slightly with respect to piston portion 34 for properly supporting the table 10.

The piston 28 is also formed with a depending stem 54, which is slidably received within bore 26. The stem 54 is formed with chambers, ports and passageways for the flow of fluid therethrough and for the reception of a valve element to control the flow therethrough. A reduced annular portion 56 is formed on stem 54 to provide an inlet chamber which receives fluid through passageway 58 and port 60 formed in housing 20. A filter 62 is disposed in passageway 58 to filter the oil passed therethrough. The passageway 58 is connected to a source of fluid under pressure in a manner that will be described hereinafter.

A vertical passageway 64 is formed in stem 54 and communicates through passageway 66 with the annular chamber 56. A passageway 68 communicates with passageway 64 and also communicates with central bore 70 formed in stem 54.

Another vertical passageway 72 is formed in stem 54 and communicates with bore 70 through passageway 74 and also communicates with an annular chamber 76, formed by reduced portion 78 of stem 54, through passageway 80. The chamber 76 communicates with the cylinder chamber 22 on the underside of piston 28.

Another passageway 82 is formed in stem 54 and communicates with another passageway 84 formed on stem 54, which passageway 84 also communicates through opening 86 with the interior of a tubular jet member 88. Such tubular member 88 is fitted to the lower end of stem 54 and the outer end thereof is formed to provide a tangential jet outlet 90, as best shown in Fig. 8. The purpose of the tubular member 88 and the jet outlet will be described hereinafter.

The outer ends of passageways 64, 68, 72, 82 and 84 may be closed by ball plugs 92, with the adjacent surfaces of stem 54 beveled thereover.

The chamber 56 is sealed with respect to bore 26 by means of upper and lower sealing rings 94 which are disposed in annular grooves formed in stem 54. The arrangement of passageways 68, 74 and 82 with respect to each other is as shown and a control of the flow of fluid therebetween is effected by means of a valve element generally indicated at 96. Such valve element 96 is slidably disposed within bore 70 and is formed at its upper and lower ends with land surfaces which slidably engage the sides of the bore 70. Certain portions of the valve element 96 are shown in enlarged form in Fig. 6 and certain of the dimensions are exaggerated for the

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purpose of clear illustration. The valve element 96 is formed with reduced annular portions 98 and 100. Stem 54 is provided with an enlarged recess forming an annular chamber 102, such annular chamber being located below passageway 82, above passageway 68, and in direct communication with passageway 74. The valve element 96 is formed with a pair of annular valve portions 104 and 106. The shoulders formed by the chamber 102 define annular valve surfaces 108 and 110. The diameter of valve portion 104 is such that the lower annular edge 112 thereof will seat against valve surface 108 to prevent the passage of fluid thereacross when in its seated position. The diameter of valve portion 106 is smaller than that of valve portion 104 and the upper annular edge 114 thereof is disposed so that it will not entirely cut off the flow of fluid past valve surface 110 in any of its positions, but will vary the resistance to flow past the valve surface 108 as the relative positions of the valve surface 110 and valve portion 106 vary with respect to each other.

The lower end of valve element 96 extends downwardly through the lower end of bore 70 and is connected to a float 116. In order to limit the relative movement between valve element 96 and bore 70, the valve element has an enlarged annular shoulder 118 which is received within an annular recess 120 formed adjacent the lower end of bore 72. A stop ring 122 is fixed in position adjacent the enlarged recess 120 to limit relative movement in one direction while the adjacent shoulder of the recess limits movement in the opposite direction. The lower end of valve element 96 is fixed to the float 116 so that it occupies the same vertical position as the float and so that it will rotate as the float rotates. The float 116 is supported in a bath of fluid, such as oil, the level of which is indicated generally at 124. All of the receptacles 18 are in open communication with each other through interconnecting pipes 126, one of the pipes 126 having a tank or reservoir 128 connected therein and in open communication with that particular pipe 126. The level of the fluid in all of the receptacles 18 will thus always be the same so that the floats 116 may be considered as being disposed in a common bath of fluid.

So as to effect an accurate and sensitive action of the valve element 96 to control the flow of fluid, friction between the valve element 96 and the wall of bore 70 is reduced by rotating the valve element 96 with respect to bore 70. Such rotation is effected by rotating the float 116. An upwardly extending skirt 128 is secured to the float 116 around the peripheral edge thereof and extends above the top surface thereof. A ring member 130 is also connected to member 128 and float 116 and is formed with in-struck tabs 132 therearound which form rotor or turbine blades against which the fluid from jet 90 impinges to cause rotation of the float 116 and, therefore, rotation of the valve element 96. Drain openings 134 are formed through members 128 and 130 at spaced intervals therearound so that the fluid directed against the vanes 132 may drain back to the receptacle.

In order that an attendant may be instantly apprized of the fact that the valve element 96 is rotating, a visual signal is provided which will indicate such rotation and will indicate whether such rotation has stopped. Such means are best shown in Figs. 4, 7, and 9 and include an electric lamp 140 disposed in each of the housings 20 and

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provided with suitable electric connections for each of the bulbs. The bulb is so located as to direct light against the facing end 142 of a Plexiglas or Lucite rod 144. Such Plexiglas and Lucite are well known types of thermoplastic material which transmit light rays and may be bent so that the rod extends upwardly through opening 146 provided in housing 20 and then extends completely around the housing within an annular groove formed therein on the outside. The outer edge may then be ground flat as shown at 148. It is one of the properties of this material that light rays impinging against surface 142 will be visible on the roughened surface 148. A shutter or screen 150 is formed with an upstanding central portion having cutaway sections 152 between the upstanding screen sections 150. Such upstanding sections are disposed to pass between surface 142 and bulb 140 as the float 116 rotates so that sections 150 will intermittently blank the direction of light rays against surface 142. This will be indicated by a blinking on surface 148. In the event that the blinking stops, it will at once be apparent that the rotation of the valve element has stopped indicating excessive friction in valve, failure of hydraulic pressure, etc. Access to the interior of the receptacle 18 may be had through an opening 154 having a transparent removable window 156 associated therewith.

A source of fluid under pressure is constantly supplied each of the passageways 58 of each of the mechanisms 14. Such source comprises a pump 160 having the inlet end thereof communicating with tank 128 and having the outlet end thereof communicate through a pressure relief valve 162 with each of three branch lines 164. Each of the branch lines 164 is attached to the opening into passageway 58. The pump is driven by a suitable prime mover such as an electric motor 166. The relief valve 162 communicates back to the tank through a return conduit 168, as is usual in hydraulic circuits. Suitable means may be provided within tank 128 to prevent turbulence therein, and also suitable means may be provided to filter the oil to the inlet to the pump.

Housing 20 is formed with a vertical passageway 170 which communicates at its lower end with the space above receptacle 18 and communicates at its upper end through a passageway 172 with the chamber 22 above piston 28 so as to vent or return any fluid which may have leaked past piston 28 to the reservoir.

In the embodiment illustrated, the frame 12 is shown as being supported upon the ground or floor surface. In order to effect an approximate leveling of the device, screw jacks 180 are disposed adjacent each corner of the frame. While in the embodiment illustrated, three jacks are shown, any number may be used, if desired. However, it is to be understood that such frame 12 might just as well be supported on trucks running on a trackway or on trucks having ground-engaging wheels. As mentioned above, if there is any unevenness in the ground or floor surface or in the trackways causing a tilting of frame 12, the servo-mechanisms 14 automatically act to maintain the support 10 level.

In the operation of the device above described, the work article is supported upon the table 10. The frame 12, which may be supported as described above, may not be level so that each of the three corners of the frame may be disposed at different levels. In that event, the servo-mechanisms of each of the corners will automatically act to maintain the support 10 abso-

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lutely level. The manner in which each of the servo-mechanisms 14 acts or operates to maintain the level condition is the same for all of such mechanisms and a description for one will be sufficient for an understanding of all. It will be appreciated that all of the floats 116 are disposed in a common bath so that they are all maintained at the same level, thus maintaining the valve elements 96 at the same level. Hydraulic fluid under pressure is supplied passageway 58 and chamber 22 under piston 28 will be filled with oil with the piston in the approximate position indicated in Fig. 4. A tilting down of one of the corners of the frame would cause a corresponding downward movement of receptacle 18 and housing 20; and, while the absolute level of the liquid remains substantially the same, the depth of the liquid in receptacle 18 is increased. This increase in depth causes the float to rise with the result that the valve surface 108 moves away from valve edge 112 so that the fluid under pressure would pass from passageway 58, through passageway 60, into chamber 56, through passageways 66, 64, and 68, past valve surface 112, into passageways 74, 72, 80 and into chamber 76 and from there into chamber 22 under piston 28, thus raising the piston 28. At the same time, fluid is passing from chamber 102 past valve surface 110 into passageway 82. The fluid from such passageway then passes through passage 84 into and through tubular jet member 88 and through the jet opening 90 so that it impinges against the vanes 132 to cause the valve 96 to rotate. The passage of fluid into chamber 22 would cause the piston 28 to raise so that the valve surface 108 would move to a position adjacent valve surface 112 to shut off the flow of fluid from passageway 68. Any tendency on the part of the table 10 to lower would cause piston 28 to move downwardly so that fluid from chamber 22 would pass into chamber 76 and through passageways 80, 72, and 74 into chamber 102 and past valve surface 110 through passageway 82. The fluid from the passageway 82 then passes through the jet against the smooth annular surface above the blades 132 to cause the valve to rotate as mentioned above. By directing the stream against the smooth surface it is spread over a relatively large area and flows down against the blades in a tangential direction so that a smooth rotative action is attained. The valve edge 112 may be considered as the control edge and, in a balanced condition, it will be very slightly removed from seating contact with valve seat 108. The relative linear movement between valve 96 and piston stem 54 is very slight, in the neighborhood of a few thousandths of an inch, so that the control is very accurate with a constant flow of fluid past valve surface 110 either from port 68 or port 74. The slightest variations in levels at the corners of the frame will thus be instantly reflected in any of the servo-mechanisms which instantly act to compensate for such variations in tilting of the frame.

It is to be understood that within the broader aspects of the present invention a single servo-mechanism 14 could be employed in which event the projecting end of the plunger 34 would serve as a supporting member.

What is claimed is:

1. A device of the type described comprising a supporting member, a float disposed in a bath of liquid, and a fluid servo-mechanism interconnecting said float with said member, said mechanism including a cylinder, a piston disposed therein and connected to said supporting mem-

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ber, a pair of cooperating and relatively shiftable valve elements, one of said valve elements being connected to said piston and the other to said float, and means to supply fluid under pressure past said valve elements, said valve elements being so constructed and arranged that fluid is continuously passed to atmosphere.

2. A device of the type described comprising a supporting member, a float disposed in a bath of liquid, and a fluid servo-mechanism interconnecting said float with said member, said mechanism including a cylinder, a piston disposed therein and connected to said supporting member, a pair of cooperating and relatively shiftable valve elements, one of said valve elements being connected to said piston and the other to said float, and means to supply fluid under pressure past said valve elements, said valve elements being so constructed and arranged that fluid is continuously passed to atmosphere and for certain positions of said valve a portion of said fluid is passed to said cylinder.

3. A device of the type described comprising a supporting member, a float disposed in a bath of liquid, and a fluid servo-mechanism interconnecting said float with said member, said mechanism including a cylinder, a piston disposed therein and connected to said supporting member, a pair of cooperating valve elements shiftable relative to each other in a linear direction, 30

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one of said valve elements being connected to said piston and the other to said float, means to supply fluid under pressure past said valve elements, said valve elements being so constructed and arranged that fluid is continuously passed to atmosphere, and means disposed in the path of the fluid passed to atmosphere and connected to one of said valve elements to continuously rotate said one of said valve elements.

4. A device of the type described comprising a supporting member, a float disposed in a bath of liquid, and a fluid servo-mechanism interconnecting said float with said member, said mechanism including a cylinder, a piston disposed therein and connected to said supporting member, a pair of cooperating valve elements shiftable relative to each other in a linear direction, one of said valve elements being connected to said piston and the other to said float, means to supply fluid under pressure past said valve elements, said valve elements being so constructed and arranged that fluid is continuously passed to atmosphere and for certain positions of said valve a portion of said fluid is passed to said cylinder, and means disposed in the path of the fluid passed to atmosphere and connected to one of said valve elements to continuously rotate said one of said valve elements.

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