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[54] **HEIGHT ADJUSTMENT APPARATUS**
13 Claims, 6 Drawing Figs.

[52] **U.S. Cl.**..... **248/412,**
248/414, 297/345
 [51] **Int. Cl.**..... **F16m 11/00**
 [50] **Field of Search**..... **297/345,**
347, 349, 339; 248/400, 399, 412, 414, 161, 404

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ABSTRACT: A height adjustment apparatus for a chair having a base with a tubular hub therein and a seat frame includes an elongated cylindrical barrel having a closed lower end and an upper end fixedly connected to the hub. An elongated inner cylinder having closed upper and lower ends with hydraulic fluid therein has its lower end received within the barrel. An elongated open-ended outer cylinder has the seat frame mounted thereon and is sleeved on an elongated collet tube which has a closed upper end and is fitted between the inner and outer cylinders. An elongated lever is pivotally mounted on the seat frame and has one end operatively connected to the closed upper end of the collet tube and to the upper end of a piston rod having a piston movable within the inner cylinder with the piston having a plurality of flow passages for flow of the hydraulic fluid therethrough. An elongated spiral spring is mounted within the inner cylinder and has opposite ends engaging the lower closed end of the inner cylinder and a lower face of the piston, respectively. Releasable gripping means are associated with the lower ends of the outer cylinder and the collet tube for supporting the seat in adjusted position and for controlling the relative movement therebetween in response to operation of the lever.

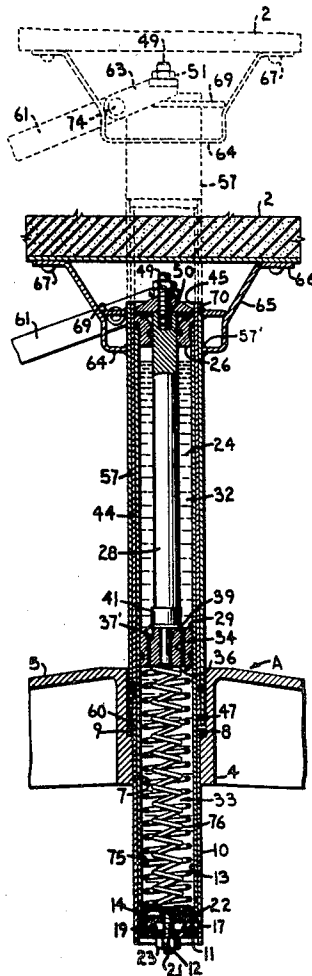


Fig. 2.

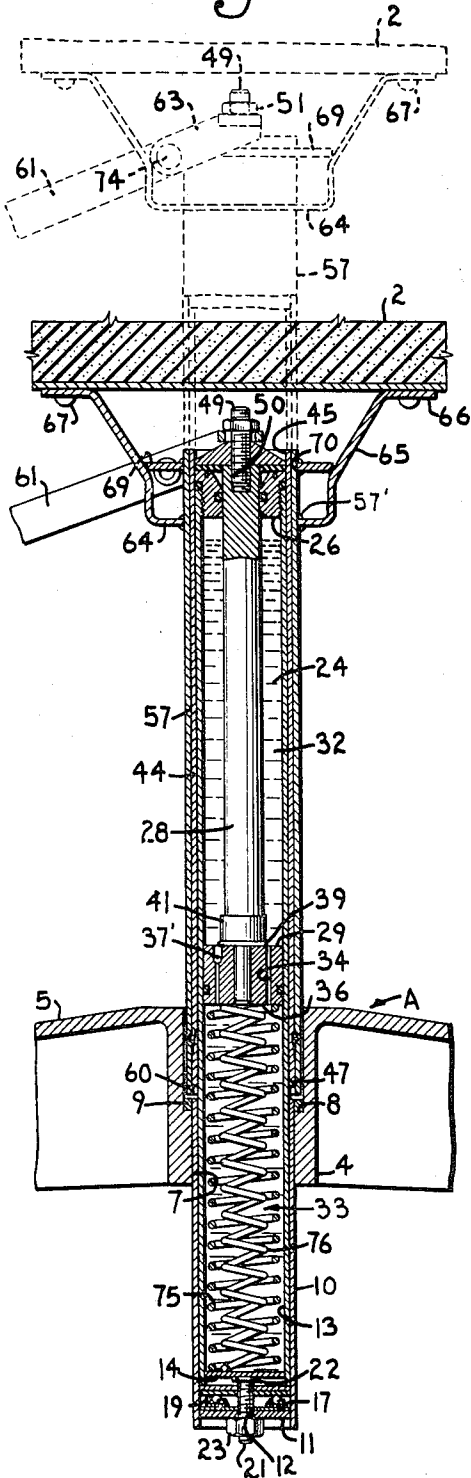
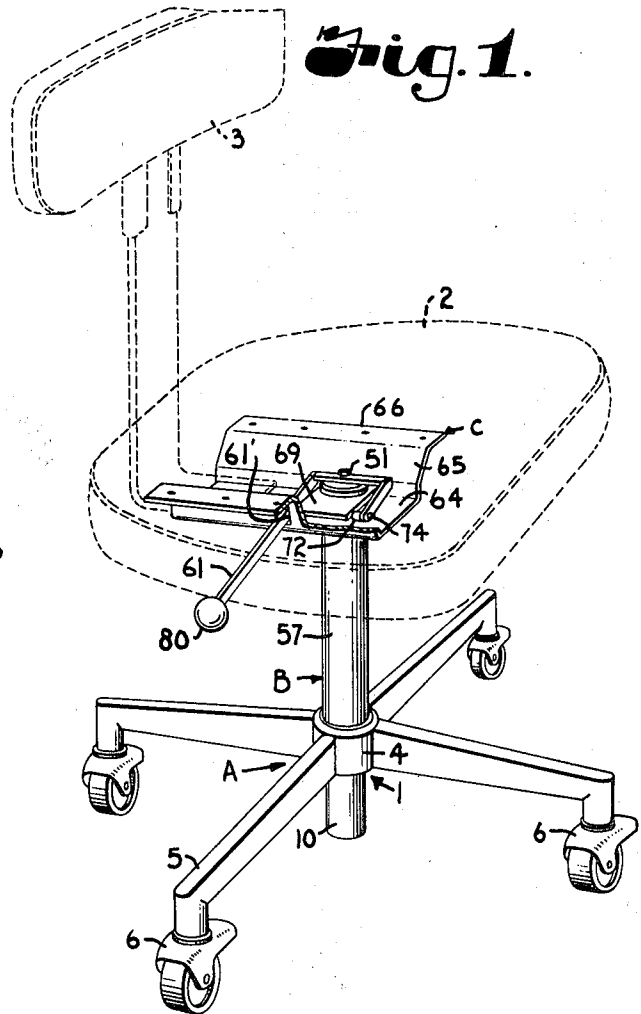


Fig. 1.



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Fig. 4.

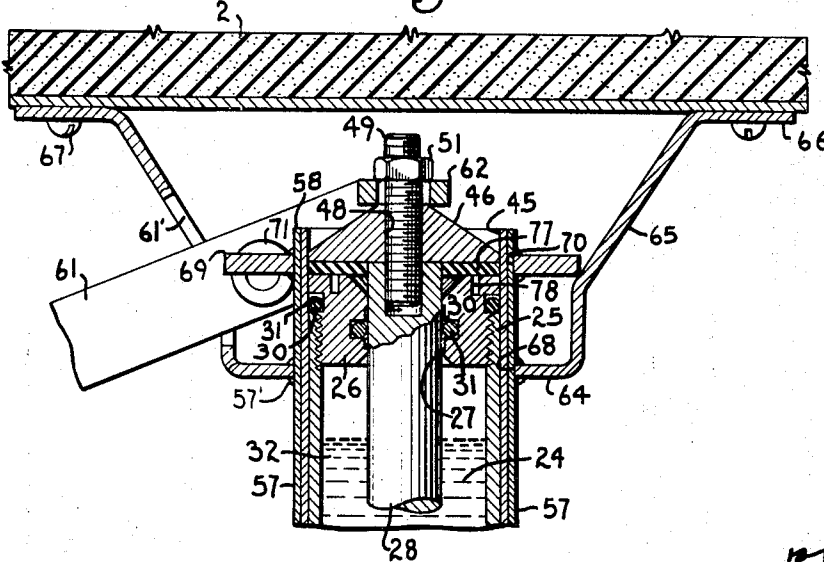


Fig. 3.

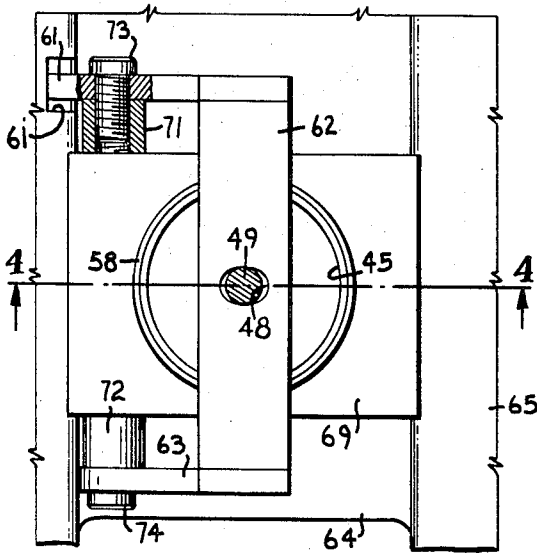


Fig. 5.

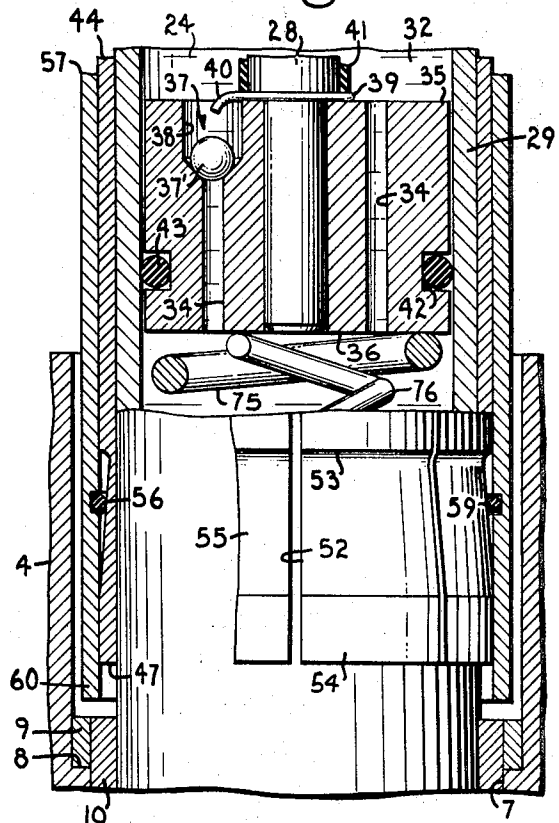
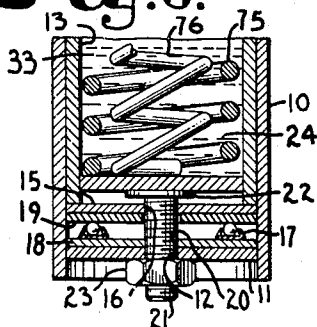


Fig. 6.



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HEIGHT ADJUSTMENT APPARATUS

The present invention relates to vertically adjustable articles of furniture and more particularly to an apparatus for adjusting the height of a chair seat.

The principal objects of the present invention are: to provide a height adjustment apparatus for an elevatable portion of an article of furniture, such as a chair seat, and which securely supports the chair seat in a selected position; to provide such a height adjustment apparatus having a wide range of vertical adjustment; to provide such a height adjustment apparatus which permits relative rotation between the chair seat and the base portion thereof; to provide such a height adjustment apparatus having inner and outer cylinders and a collet tube movably mounted between said cylinders and having means on the collet tube and means cooperating with the outer cylinder and collet tube to grippingly engage the inner cylinder when the chair seat is in a selected position; to provide such a height adjustment apparatus adapted for operation by a person using the chair; and to provide such a height adjustment apparatus which is positive in operation, easily maintained, and particularly well suited for the proposed use.

Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings wherein are set forth by way of illustration and example certain embodiments of this invention.

FIG. 1 is a perspective view of an article of furniture having a height adjustment apparatus therein embodying features of the present invention, with portions shown in broken lines to better illustrate the component parts.

FIG. 2 is an enlarged fragmentary transverse sectional view through the height adjustment apparatus with an adjusted position shown in broken lines.

FIG. 3 is a further enlarged fragmentary plan view of a release or activating lever.

FIG. 4 is a fragmentary transverse sectional view of an upper end of the height adjustment apparatus taken on line 4-4, FIG. 3.

FIG. 5 is a further enlarged fragmentary transverse sectional view showing a piston and releasable gripping means for supporting the article of furniture in the selected position.

FIG. 6 is a fragmentary transverse sectional view of a lower end of a barrel, inner cylinder and springs of the height adjustment apparatus.

Referring more in detail to the drawings:

The reference numeral 1 generally designates an article of furniture, such as a chair, having a base A, a standard B, and a seat frame C. The seat frame C supports an elevatable portion of the article of furniture, such as a seat 2 and a back portion 3. The base A has a hub 4 having a plurality of arms 5 extending radially outwardly therefrom with rollers or casters 6 mounted in their respective outer ends, as is the usual practice.

The hub 4 is a tubular member wherein an opening 7 therethrough has an offset portion defining upper and lower end portions of the opening 7 and forming a shoulder 8 for receiving a stop ring 9, as later described. An elongated cylindrical barrel 10 has an open upper end thereof fitted within the lower end portion of the opening 7 and is welded or otherwise suitably secured to the stop ring 9 for retaining the barrel 10 in the hub 4. A lower end of the barrel 10 is closed by a suitable end member, such as a plate 11, welded to the inner periphery thereof and having a bore 12 through the center thereof, for a purpose later described.

An elongated inner cylinder 13 has a lower portion thereof rotatably received within the barrel 10. A lower end of the inner cylinder 13 is closed by a closure plate 14 which is suitably secured therein, as by being welded to the inner periphery thereof adjacent the lower end. A lower end plate 15 is spaced from the closure plate 14 and is suitably secured therein, as by being welded to the inner periphery thereof adjacent the lower end. A lower end plate 15 is spaced from the closure plate 14 and is suitably secured thereto, as by welding, and has a bore 16 through the center thereof, for a purpose later described.

Thrust-type roller bearings 17 are positioned between the plate 11 in the barrel 10 and the lower end plate 15 to rotatably support the inner cylinder 13 within the barrel 10. In the illustrated structure, a thrust plate 18 is placed on the end member or plate 11 with the bearings 17 thereon and a thrust washer 19 is positioned between the bearings 17 and the lower end plate 15. The thrust plate 18 also has a bore 20 through the center thereof.

The bores 12, 16 and 20 are aligned vertically and sized to permit an elongated threaded retaining shaft 21 to extend therethrough and to rotate therein. The retaining shaft 21 is suitably secured to the closure plate 14, as by a head portion 22 of the shaft 21 being welded to a lower surface thereof, and depends below the end member or plate 11. A suitable threaded locking nut 23 is mounted on a lower end portion of the shaft 21 and is slightly spaced below the end member or plate 11 to permit the inner cylinder 13 to rotate within the barrel 10. The locking nut 23 is sized to engage a lower surface of the end member or plate 11 upon lifting of the seat 2 of the chair 1, thereby preventing the removal of the inner cylinder 13 from the barrel 10.

The inner cylinder 13 is adapted to be closed and to be filled with a suitable hydraulic fluid 24 to provide a smooth, even vertical adjustment of the height of the seat 2 above a suitable support surface such as a floor (not shown).

In the illustrated structure, an upper end 25 of the inner cylinder 13 is internally threaded to receive an externally threaded top plug 26 for closing said upper end 25. The threaded top plug 26 has a central bore 27 extending vertically therethrough to permit an elongated piston rod 28 to move vertically through the bore 27 in the top plug 26. A piston 29 is suitably secured on a lower end of the elongated piston rod 28, as by being swaged or pressed tightly thereonto. An annular recess 30 extends inwardly from the periphery of the central bore 27 and is sized to receive a suitable seal member, such as an O-ring seal 31, to engage the periphery of the piston rod 28 and provide a fluidtight seal during vertical movement of the piston rod 28 through the top plug 26.

The piston 29 is positioned within the inner cylinder 13 and defines upper and lower chambers 32 and 33, respectively, therein, and the piston 29 is movable vertically within the inner cylinder 13. Fluid flow means is provided for flow of the hydraulic fluid between the upper and lower chambers 32 and 33. In the illustrated structure, the piston 29 has a plurality of fluid passages 34 extending vertically therethrough in the form of elongate bores, extending between upper and lower faces 35 and 36, respectively, of the piston 29 for flow of the hydraulic fluid 24 therethrough during the vertical movement of the piston 29 within the inner cylinder 13.

At least one of the fluid passages 34 has a check valve 37 therein for directionally controlling fluid flow through the respective flow passage 34. In the illustrated structure, the check valve 37 is a ball-type check valve having a ball 37' received in a counterbore 38 formed in the upper face 35 of the piston 29. A keeper 39 is mounted on the upper face 35 of the piston 29 and has a tongue portion 40 to at least partially cover the counterbore 38 to maintain the ball 37' within the counterbore 38 during downward movement of the piston 29 within the inner cylinder 13. The ball 37' seats against an upper end of the respective flow passage 34 during upward movement of the piston 29 and the ball 37' engages the tongue portion 40 during downward movement of the piston 29.

To prevent air flowing below the piston 29 when the chair seat 2 is in its highest position, a spacing sleeve 41 is mounted on the piston rod 28 and engages the keeper 39. When the piston 29 is in its uppermost position, an upper end of the spacing sleeve 41 engages a lower surface of the top plug 26, thereby providing a spacing between the top plug 26 and the upper face 35 of the piston 29 equal to the length of the sleeve 41. When the inner cylinder 13 is substantially filled with the hydraulic fluid 24, the spacing sleeve 41 prevents air from flowing below the piston 29 to cause uneven and erratic fluid flow through the passages 34.

An annular recess 42 extends inwardly from the exterior periphery of the piston 29 and is sized to receive a suitable seal member, such as an O-ring 43, which also engages the inner periphery of the inner cylinder 13 to prevent fluid flow between the exterior surface of the piston 29 and the inner periphery of the inner cylinder 13.

A collet tube 44 is sleeved on the inner cylinder 13 and has its upper end 45 closed by a top cap 46, here shown to be cone shaped, and has an open lower end 47. The top cap 46 is secured in the upper end 45 of the collet tube 44 by welding, and the top cap 46 has a central plain or unthreaded bore 48 therethrough. An elongated retaining member 49 extends through the bore 48 and has a lower end threadedly received in a threaded socket 50 in an upper end of the piston rod 28. The elongated retaining member 49 extends upwardly from the top cap 46 and has an internally threaded nut or adjustable member 51 mounted on its upper end. The retaining member 49 is illustrated as an elongated threaded shaft and the adjustable member 51 is illustrated as a tightening device, such as a locking nut, threadedly mounted on the upper end of the threaded shaft.

The lower end 47 of the collet tube 44 has a plurality of elongated slots 52 circumferentially spaced around the lower end 47 with each of the slots 52 extending vertically from said lower end of the collet tube 44 to a point above a shoulder 53, as later described, thereby defining a plurality of flexible gripping fingers 54 for grippingly engaging the exterior surface of the inner cylinder 13, as later described.

A tapered recess 55 is formed in the exterior periphery or surface of the lower end 47 of the collet tube 44 and is positioned intermediate the ends of the elongated slots 52. The tapered recess 55 tapers upwardly and inwardly from a point adjacent the lower end 47 of the collet tube 44 toward the shoulder 53. The shoulder 53 extends inwardly substantially radially from the exterior surface of the collet tube 44 to form an upward limit for the movement of a resilient ring member 56 received within the tapered recess 55, as later described.

An elongated outer cylinder 57 is sleeved on the collet tube 44 and is secured near its top, as by welding, to the seat frame C, as shown at 57', and its lower end extends in the bore 7 of the hub 4. The outer cylinder 57 has an annular recess 59 in the inner periphery thereof spaced from its lower end 60. The recesses 55 and 59 are alignable in facing relation and the recess 59 is sized to receive and retain a portion of the resilient member 56 therein. When the resilient member 56 is received within the recesses 55 and 59, the relative movement longitudinally between the collet tube 44 and the outer cylinder is limited to the longitudinal length of the tapered recess 55.

When the annular resilient member 56 is positioned adjacent the shoulder 53, the collet tube 44 and the outer cylinder 57 are movable along the inner cylinder 13 and when the resilient member 56 is positioned below the shoulder 53 and adjacent the lower end 47 of the collet tube 44, the resilient member 56 is expanded to provide an inwardly directed gripping force against the gripping fingers 54, whereby the fingers 54 engage the outer periphery of the inner cylinder 13, thereby supporting the collet tube 44 and the outer cylinder 57 on the inner cylinder 13.

The tapered recess 55 permits relative vertical or longitudinal movement between the collet tube 44 and the outer cylinder 57 upon operation of an elongate release or activating lever 61. However, the relative movement thereof is limited to the longitudinal length of the tapered recess 55. The release or activating lever 61 is pivotally mounted intermediate the ends thereof on the seat frame C and extends through a slotted opening 61' in the seat frame C. One end portion 62 of the activating or release lever 61 operatively engages the top cap 46 and the adjustable member 51 mounted on the retaining member 49 mounted in the piston rod 28 at the upper end thereof. In the illustrated structure, the one end portion 62 of the activating or release lever 61 is a crossarm extending transversely from one end of the lever 61 and is positioned between and engaging the adjustable member 51

and the top cap 46 in the closed upper end 45 of the collet tube 44. An arm portion 63 extends transversely from the crossarm 62 and is substantially parallel to the lever 61 with one end thereof pivotally mounted on the seat frame C to provide balanced pressure on the top cap 46 or balanced upward pull on the piston rod 28, as later described.

The seat frame C is illustrated as channel shape having a bottom portion 64 with upwardly and outwardly sloping sidewalls 65 and terminating in flanges 66. The seat is secured to the flanges 66 by screws 67. The bottom portion 64 has an aperture 68 to receive the upper end portion 58 of the outer cylinder 57 which is rigidly secured to the bottom portion 64, as by welding. A bridge plate 69 extends between the sidewalls 65 and has an aperture 70 to receive the upper end portion 58 of the outer cylinder 57 which is also rigidly secured to the bridge plate 69, as by welding.

Threaded sockets 71 and 72 are rigidly mounted on opposite edges of the bridge plate 69 to threadedly receive studs 73 and 74 extending through an opening in the lever 61 and an opening in the arm portion 63 respectively to pivotally mount the lever 61 on the seat frame C.

Resilient means are positioned within the lower chamber 33 of the inner cylinder 13 for urging the piston 29 upwardly within the inner cylinder 13 and for controlling the downward movement of the piston 29 and thereby the chair seat 2. In the illustrated structure, the resilient means is an elongated spiral lifting spring 75 having opposite ends engaging the lower face 36 of the piston 29 and an upper surface of the closure plate 14 in the lower end of the inner cylinder 13 respectively for urging the chair seat 2 upwardly under operation of the activating or release lever 61. It may be desirable to provide additional resistance to downward movement of the chair seat 2 and to provide an additional lifting force for the chair seat 2, therefore, a booster spring 76 may be sleeved within the elongate spiral lifting spring 75 and have opposite ends thereof also engaging the lower face 36 of the piston 29 and the upper surface of the closure plate 14 respectively. It is preferable that the booster spiral spring 76 be wound in an opposite direction to that of the main lifting spiral spring 75 to provide a smooth and even vertical movement for the chair seat 2.

A suitable resilient cushion 77 of rubber, plastic, or the like, is positioned between the threaded top plug 26 and the top cap 46 to prevent noise when the chair seat 2 has moved to its lowest position. It is preferable that the hydraulic fluid 24 be a 30—70-weight oil and that the inner cylinder 13 be filled with the piston 29 in its lowest position which is when the lower end of the outer cylinder 57 engages the stop ring 9. An upper surface of the top plug 26 has a pair of recesses 78 therein to receive a suitable tool, such as a spanner wrench (not shown) for installing the top plug 26 in the upper end 25 of the inner cylinder 13 and for removing same therefrom.

Downward movement of the crossarm 62 moves the collet tube 44 downwardly thereby causing the annular resilient member 56 to move within the tapered recess 55 and toward the shoulder 53 with a resultant contraction thereof and a release of the gripping action on the gripping fingers 54, whereby the piston 29 may be moved within the inner cylinder 13, as later described. Upward movement of the crossarm 62 in response to downward movement of the lever 61 moves the lower end 47 of the collet tube 44 upwardly relative to the lower end 60 of the outer cylinder 57, thereby moving the annular resilient member 56 toward the lower end 47 of the collet tube 44, thereby expanding the resilient member 56 and increasing the gripping action of the resilient member 56 against the gripping fingers 54. The relative vertical or longitudinal movement between the collet tube 44 and the outer cylinder 57 is limited to the longitudinal length of the tapered recess 55 in the lower end 47 of the collet tube 44.

When it is desired to raise the chair seat 2, after the inner cylinder 13 has been filled with the hydraulic fluid 24 or at any time subsequent thereto, an end knob 80 of the release or activating lever 61 is moved upwardly thereby moving the crossarm portion 62 thereof downwardly against the top plug 46 in

the collet tube 44. The collet tube 44 is thereby moved downwardly relative to the outer cylinder 57 thereby allowing the resilient member 56 to move to engage the shoulder 53, thereby relaxing the gripping engagement between the gripping fingers 54 and the exterior surface of the inner cylinder 13. The upper end of the piston rod 28 extends through the cushion 77 and is sized to engage and thereby support the top cap or plug 46 and the collet tube 44 and the chair seat 2. The main lifting spring 75 and the booster spring 76 will then force the piston 29 upwardly within the inner cylinder 13, thereby raising the collet tube 44 and the outer cylinder 57 with the chair seat 2 mounted thereon.

The lever 61 is maintained in the upward position until the desired height of the chair seat 2 above the floor surface (not shown) has been reached, then the lever 61 is released and weight is applied to the chair seat 2, as by sitting on same. The outer cylinder 57 is thereby moved downwardly relative to the collet tube 44 which moves the resilient member 56 downwardly from the shoulder 53 along the tapered recess 55 so as to urge the gripping fingers 54 into gripping engagement with the exterior surface of the inner cylinder 13.

If further locking is desired, the lever 61 is moved downwardly thereby moving the crossarm portion 62 of the activating or release lever 61 upwardly against the adjustable member 51 thereby slightly raising the collet tube 44 relative to the outer cylinder 57 to further move the resilient member 56 toward the lower end 47 of the collet tube 44.

To lower the chair seat 2, the lever 61 is raised and held up while applying weight to the chair seat 2, as by sitting on same, to force the chair seat downwardly against the resistance of the springs 75 and 76 and force hydraulic fluid 24 through the fluid passages 34. When the chair seat 2 is at the desired height relative to the floor, the lever 61 is released thereby accomplishing the locking or gripping action of the resilient member 56, as previously described. Further locking can than be effected by lowering the lever 61, as previously described.

It is to be understood that, while I have illustrated and described one form of my invention, it is not to be limited to the specific form or arrangement of parts herein described and shown.

I claim:

1. A height adjustment apparatus for an article of furniture, said height adjustment apparatus comprising:

- a. an elongated cylindrical barrel having a closed lower end and an open upper end secured to a base of the article of furniture;
- b. an elongated inner cylinder having closed upper and lower ends and hydraulic fluid therein, a lower portion of said inner cylinder being received within said barrel;
- c. a piston mounted on an elongated piston rod and movable within said inner cylinder, said piston forming upper and lower chambers within said inner cylinder;
- d. flow means for flow of said hydraulic fluid between said upper and lower chambers during movement of said piston within said inner cylinder;
- e. an elongated collet tube sleeved on an upper portion of said inner cylinder for longitudinal movement therealong;
- f. an elongated outer cylinder sleeved on said collet tube, said outer cylinder being rigidly secured to an elevatable portion of the article of furniture;
- g. releasable gripping means associated with said collet tube for gripping said inner cylinder to support said elevatable portion of said article of furniture; and
- h. movement and control means associated with said inner cylinder and with said collet tube and outer cylinder for adjusting vertically said elevatable portion of said article of furniture.

2. The height adjustment apparatus as set forth in claim 1 wherein said releasable gripping means includes:

- a. a recess in an interior surface of said outer cylinder and adjacent a lower end thereof;
- b. a recess in an exterior surface of said collet tube and adjacent a lower end thereof, said recesses in said collet

tube and outer cylinder being alignable in facing relation; and

- c. an annular resilient member received in said recess in said outer cylinder and in said recess in said collet tube for providing a gripping engagement between said collet tube and said inner cylinder.

3. The height adjustment apparatus as set forth in claim 2 wherein said recess in said collet tube exterior surface tapers upwardly and inwardly from adjacent said lower end of said collet tube to a shoulder whereby relative movement between said collet tube and said outer cylinder is limited to the length of said tapered recess in said collet tube.

4. The height adjustment apparatus as set forth in claim 3 including a plurality of elongated slots circumferentially spaced around said lower end of said collet tube, said slots each extending from said lower end of said collet tube to a point above said shoulder thereby defining a plurality of gripping fingers, said resilient member engaging each of said gripping fingers.

5. The height adjustment apparatus as set forth in claim 1 wherein:

- a. said inner cylinder with said collet tube and said outer cylinder are rotatable relative to said barrel; and
- b. bearing means are positioned to engage said closed lower end of said barrel and said closed lower end of said inner cylinder for relative rotation therebetween.

6. The height adjustment apparatus as set forth in claim 1 wherein said movement and control means includes:

- a. elongated resilient means within said lower chamber of said inner cylinder, opposite ends of said resilient means engaging a lower face of said piston and said closed lower end of said inner cylinder respectively;
- b. a frame supporting said elevatable portions of the article of furniture; and
- c. an elongated lever pivotally mounted on said frame supporting said elevatable portion of the article of furniture, said pivotal mounting being intermediate the ends of said lever, said lever being operatively connected to said piston rod and to said collet tube for vertically adjusting said elevatable portion.

7. The height adjustment apparatus as set forth in claim 6 including check valve means associated with said fluid flow means for directionally controlling fluid flow therethrough.

8. The height adjustment apparatus as set forth in claim 7 wherein:

- a. said fluid flow means is a plurality of flow passages through said piston for flow of hydraulic fluid between said upper and lower chambers of said inner cylinder;
- b. said check valve means is a ball check valve; and
- c. an upper surface of said piston has means associated therewith for retaining the ball of said ball check valve within said piston during downward movement thereof.

9. The height adjustment apparatus as set forth in claim 6 wherein said connection between said one end of said lever and said piston rod includes:

- a. an elongated retaining member mounted in said closed upper end of said collet tube and extending upwardly therefrom;
- b. an adjustable member mounted on one end of said retaining member and positioned above said collet tube closed end; and
- c. an arm portion extending from said one end of said lever and positioned between and engaging said adjustable member and said collet tube closed end whereby downward movement of said arm portion moves said shoulder on said collet tube toward said resilient member and upward movement of said arm portion moves said lower end of said collet tube toward said resilient member thereby increasing the gripping action thereof.

10. A height adjustment apparatus for a chair having a base with a hub having a vertical opening therethrough, said chair having a seat, said height adjustment apparatus comprising:

- a. an elongated cylindrical barrel having a closed lower end and an open upper end secured within a hub of a base of the chair;
 - b. an elongated inner cylinder having closed upper and lower ends and hydraulic fluid therein, said inner cylinder having a lower portion thereof received within said barrel;
 - c. a piston and piston rod movable within said inner cylinder, said piston forming upper and lower chambers within said inner cylinder, said piston having fluid passages therethrough for flow of said hydraulic fluid between said upper and lower chambers;
 - d. an elongated collet tube sleeved on an upper portion of said inner cylinder, said collet tube having a closed upper end;
 - e. an elongated outer cylinder sleeved on said collet tube, said outer cylinder having an upper end thereof rigidly secured to a frame supporting the chair seat;
 - f. an elongated lever pivotally mounted intermediate its ends on said frame, said lever having one end thereof operatively connected to said piston rod;
 - g. resilient means within said lower chamber of said inner cylinder for releasable urging said piston upwardly; and
 - h. gripping means associated with said collet tube and with said outer cylinder for gripping said inner cylinder and for controlling relative movement between said collet tube and said outer cylinder in response to operation of said lever.
11. The height adjustment apparatus as set forth in claim 10 including:
- a. a thrust-type ball bearing member positioned between

- said closed lower end of said barrel and said closed lower end of said inner cylinder for rotatably supporting said chair seat;
 - b. a thrust plate mounted on said lower end of said inner cylinder and having a bore therethrough, said thrust plate being engageable by said ball bearing member;
 - c. a bore through said closed lower end of said barrel;
 - d. an elongated retaining member mounted on said closed lower end of said inner cylinder and depending therefrom, said retaining member extending through said bores in said thrust plate and said closed lower end of said barrel; and
 - e. a locking member mounted on said retaining member below said closed lower end of said barrel for retaining said inner cylinder within said barrel.
12. The height adjustment apparatus as set forth in claim 10 including an elongated spacing sleeve mounted on said piston rod adjacent said piston, an upper end of said spacing sleeve being engageable with a lower surface of said closed upper end of said inner cylinder.
13. The height adjustment apparatus as set forth in claim 10 wherein said resilient means within said lower chamber of said inner cylinder includes:
- a. an elongated spiral main lifting spring having opposite ends engaging a lower surface of said piston and said closed lower end of said inner cylinder respectively; and
 - b. an elongated spiral booster spring having opposite ends engaging a lower surface of said piston and said closed lower end of said inner cylinder respectively.

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