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COUNTERBALANCED SUPPORTING ARM

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3 Sheets-Sheet 1

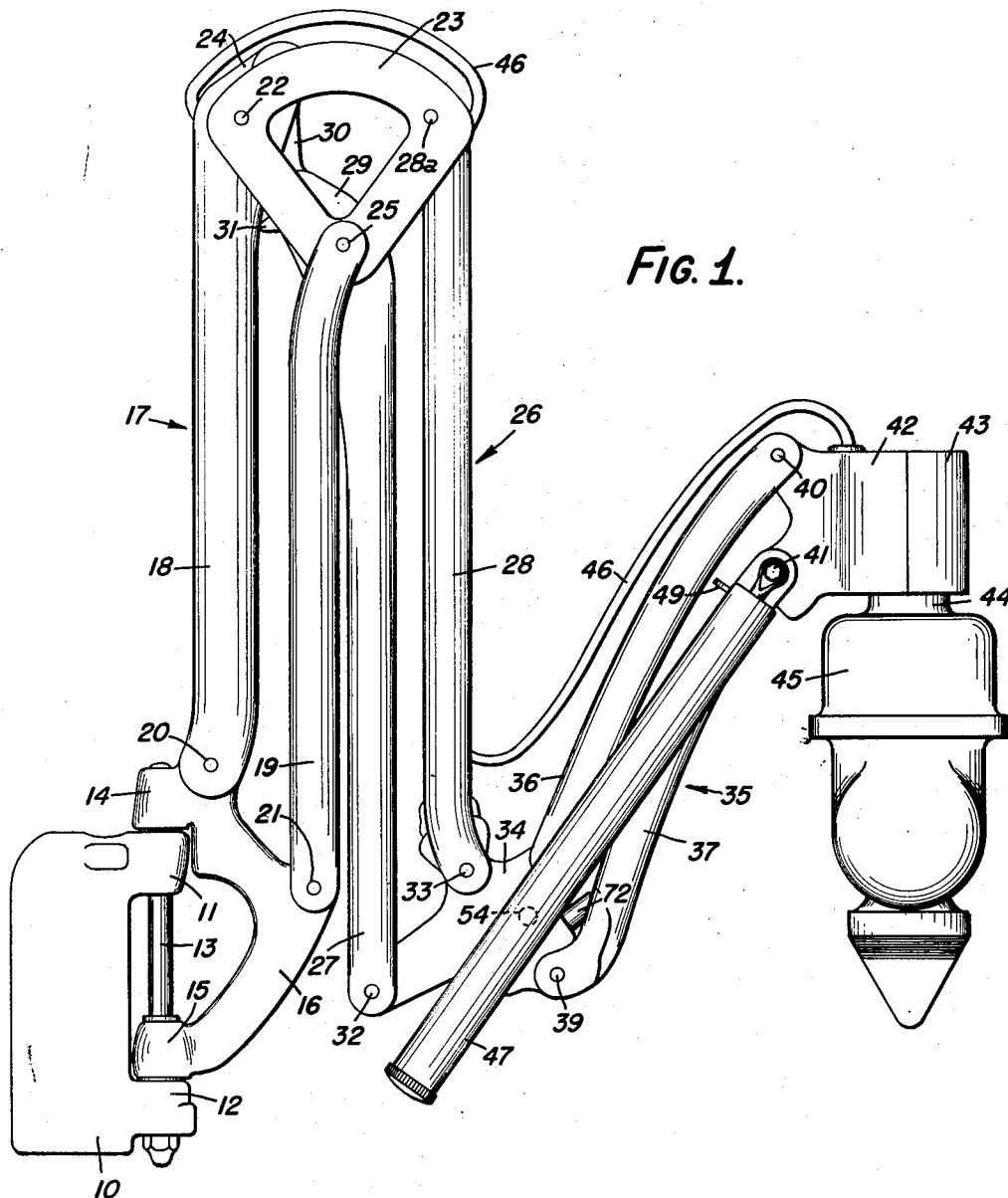


FIG. 1.

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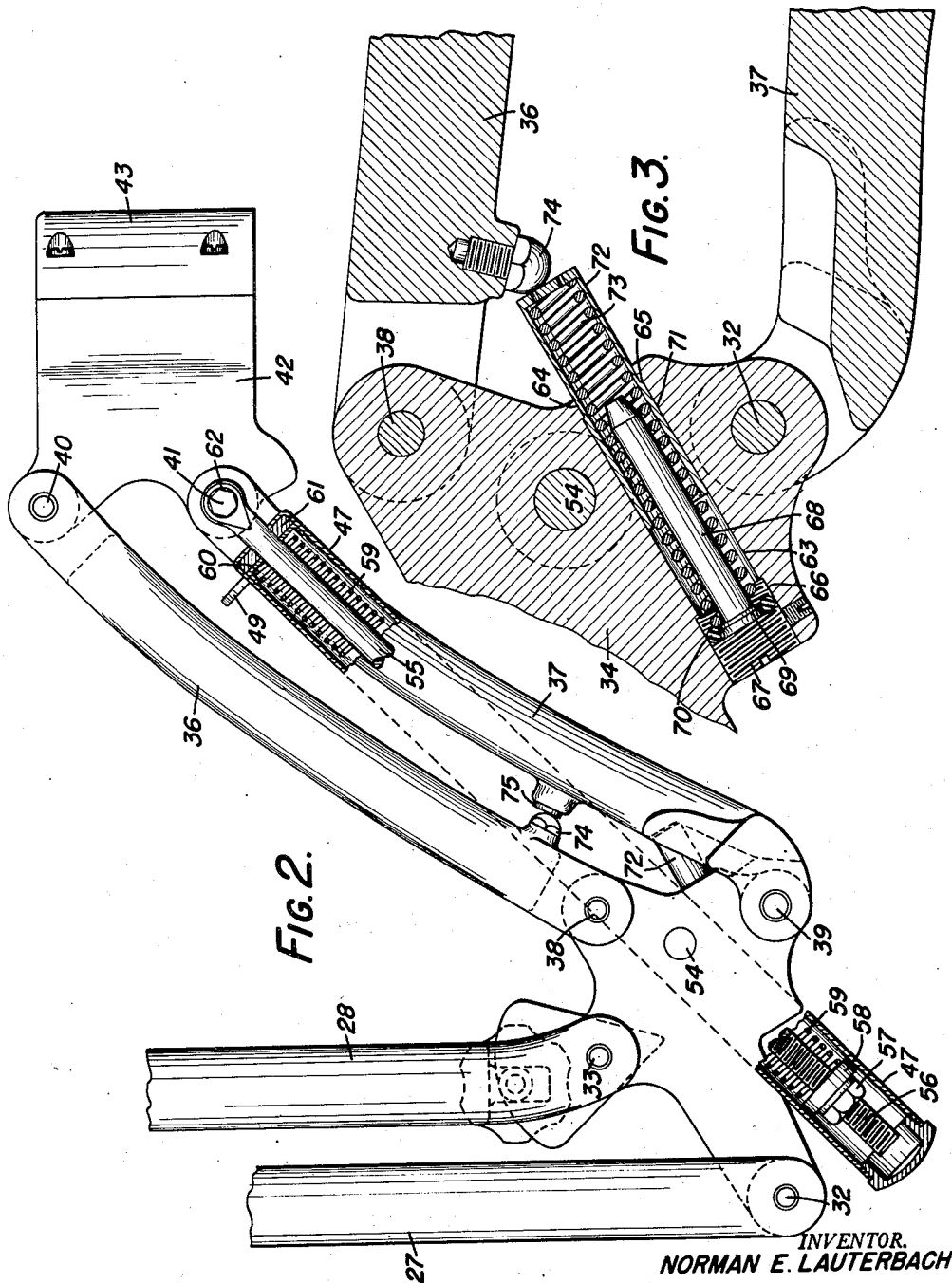
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3 Sheets-Sheet 2



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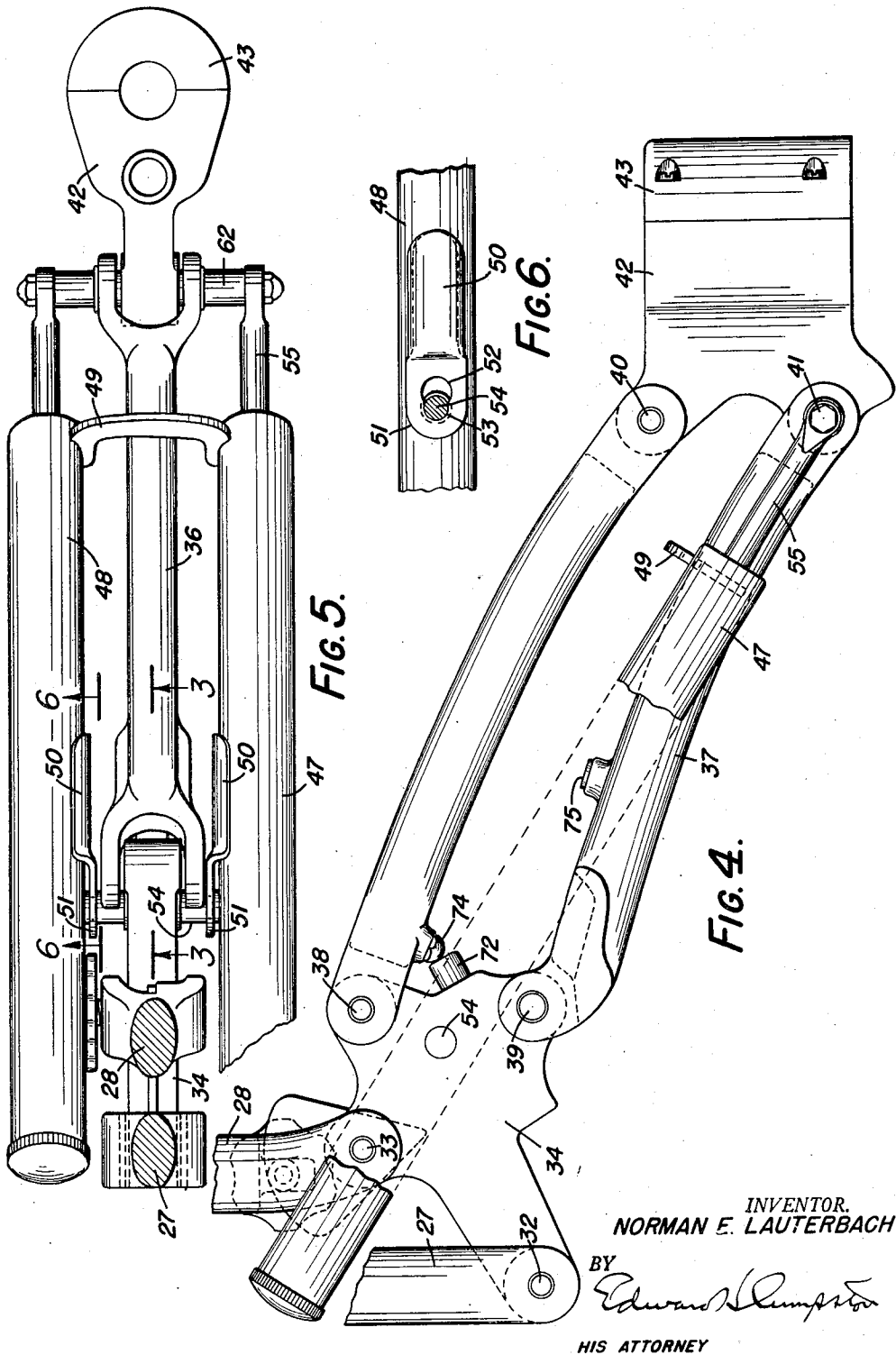
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3 Sheets-Sheet 3



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COUNTERBALANCED SUPPORTING ARM

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5 Claims. (Cl. 248—280)

This invention relates to flexible arm means for supporting X-ray tubes and other objects requiring adjustment to different positions of use and, more particularly, to an arm of this character adapted to be carried by a pedestal wall or other support and provided with means for counterbalancing the weight of the object in its different positions of vertical adjustment, one object of the invention being to provide an improved mechanism of the above character having a more simple, practical and economical type of construction.

Another object is to provide a supporting mechanism of the character described adapted to provide more uniform counterbalancing support for the object to support it stationarily in any desired position for use.

Still a further object is to provide a counterbalanced supporting mechanism having the above advantages, with fewer parts and more simple construction and capable of being readily manufactured and assembled at lower cost.

To these and other ends the invention resides in certain improvements and combinations of parts, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

Fig. 1 is a side elevation of a counterbalanced supporting mechanism embodying the present invention and showing an X-ray tube supported in a raised position;

Fig. 2 is an enlarged elevation of portions of the mechanism in the same position, as shown in Fig. 1, and partly broken away for better disclosure;

Fig. 3 is an enlarged sectional view on the line 3—3 in Fig. 5;

Fig. 4 is a view generally similar to Fig. 2 but showing the parts as arranged in a lowered position of the X-ray tube;

Fig. 5 is a top plan view of the parts shown in Fig. 4, partly in section, and

Fig. 6 is a fragmentary, sectional view on the line 6—6 in Fig. 5.

The invention is disclosed in the present instance in an embodiment adapted for supporting an X-ray tube on a pedestal, wall or other support, in uniformly counterbalanced condition so that it may be readily moved to and stationary adjusted in any position in its range of movement. Referring more particularly to the drawings, there is shown at 10, Fig. 1, a bracket which may be fastened on a floor pedestal, or a wall surface, or other suitable support. This bracket has spaced bearings 11 and 12 for a pivot bolt 13 supporting the spaced bearings 14 and 15 of a plate 16 so that the plate may be swiveled horizontally about the axis of the bolt 13 and relative to the support or bracket 10. Plate 16 forms part of the flexible arm means for adjustably supporting the X-ray tube and forms, more particularly, a part of an inner parallel motion linkage of the arm indicated generally at 17 which will now be described.

Linkage 17 comprises a pair of parallel links 18 and 19 having their lower ends preferably bifurcated to embrace projecting edge portions or lugs of the plate 16, being pivotally connected thereto at 20 and 21, respectively. The upper end of link 18 is pivotally connected, as at 22, between a pair of spaced and rigidly connected plates 23, the end of the link being somewhat extended beyond the pivot as at 24 for a purpose hereafter described. The upper end of arm 19 is pivotally connected at 25 with the plates 23 and it is apparent that such

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parts 16, 18, 19 and 23 form a parallel motion linkage such that the arms 18 and 19 may be swung in a vertical plane but in parallel relation, with the pivots 22 and 25 of plates 23 remaining parallel with the pivots 20 and 21 of the plate 16.

A second parallel motion linkage, indicated generally at 26, comprises a pair of links 27 and 28. Link 27 has its upper end pivoted at 25 to plates 23 and is extended somewhat beyond the pivot as at 29. Link 28 has its upper end pivoted at 28a to the plates 23. A link 30 is pivoted to extension 24 of link 18 and to extension 29 of link 27, to preserve symmetrical inclination in a vertical plane as the pairs of links are pivoted about the plates 16 and 23 and moved apart to extend the arm and move the X-ray tube horizontally. A lug 31 on arm 27 is positioned to engage arm 18 to limit the upward movement of the parts in the retracted position shown in Fig. 1.

The lower ends of links 27 and 28 are preferably bifurcated and embrace and are pivotally connected at 32 and 33, respectively, to spaced edge lugs of a supporting part or plate 34, to complete the linkage 26. It is apparent from this construction that as links 27 and 28 are swung horizontally about their pivots on the plates 23, away from linkage 17, they are maintained in parallel relation with each other and maintain the plate 34 in the same relation in a vertical plane with the plates 16 and 23.

A third arm part of parallel motion linkage indicated generally at 35, comprises links 36 and 37 the lower ends of which are preferably bifurcated and pivoted at 38 and 39, respectively, to spaced edge portions of plate 34. The opposite ends of links 36 and 37 are pivoted at 40 and 41, respectively, to spaced edge portions or lugs of an object to be supported such as a head 42 having a bearing portion 43 in which the trunnion portion 44 of the X-ray tube housing 45 is supported for rotary adjustment of the tube in a horizontal plane, as well understood in the art. It is apparent from this construction that as the outer ends of links 36 and 37 are raised and lowered about their pivotal connections with the plate 34, they are maintained in a parallel relation and maintain the vertical position of the head 42 and X-ray tube as the latter is raised and lowered to different operation positions. Preferably the links 18 and 28 are mainly of hollow construction and the electrical cable 46 for the X-ray tube is preferably carried partly through and housed in these links and thence to the head 42, as partially shown in the drawings.

Counterbalancing means are required to support the weight of the X-ray tube and associated parts including the linkage 35. As head 42 and the X-ray tube are moved from the upper position shown in Figs. 1 and 2 through the intermediate position shown in Fig. 3 and to a lowered position, as shown in Figs. 4 and 5, their distance from the pivots on plate 34 is varied so as to vary the torque force due to the weight of the parts. It has been found that resilient counterbalancing means exerting suitable force for holding the tube stationary in its upper positions above that of Fig. 3 tends to lose its efficiency and exert insufficient force to counterbalance the tube in its lower range of positions below that of Fig. 3. It has been a known practice heretofore to provide resilient spring means adapted to counterbalance the tube in its upper positions and to include an arrangement for increasing the resistance of such spring means in the lowered positions of the tube. Such compensated counterbalancing mechanisms have not been wholly satisfactory, however, because of their complicated, cumbersome and expensive constructions.

I have found that this problem can be solved by a more satisfactory type of construction comprising in part a first resilient spring means pivotally connected to the plate 34 and to the head 42 and operating to counterbalance and support the parts in their upper positions. I preferably employ for this purpose a pair of connected cylinders 47 and 48 connected together at one end by a bridge 49 (Fig. 5). Each cylinder has fixed on its inner side a clip 50 having one end 51 spaced from this cylinder and formed with an opening 52 connected with a smaller opening 53. The plate 34 carries pins 54 projecting from opposite sides and having ends of suitable

size for entering clip openings 52. Each pin is grooved circumferentially adjacent its head to a diameter equal to that of the smaller clip opening 53 and it is apparent from this construction that each cylinder may be detachably connected to its pin 54, the spring tension on the cylinder serving to normally maintain the pins in the smaller openings 53 and so maintain the pivotal mounting of the cylinders on the plate.

Each cylinder has a plunger rod 55 extending telescopically through one end thereof and threaded at its opposite end, as at 56, to receive a nut 57 and washer 58. Surrounding the plunger rod is a coiled compression spring 59 bearing at one end against washer 58 and its other end against a cupped washer 60. Interposed between the latter and the end of the cylinder is a washer 61 of substantial thickness for strengthening the end of the cylinder against the pressure of the spring which may be adjusted by turning nut 57. The outer end of each rod 55 is pivotally connected with an end of a pin 62 (Fig. 5) extending through a lug on the head 42 for the X-ray tube and it is evident from this construction and the relative locations of the pivots of the parts that lowering of the X-ray tube head tends to pull rods 55 out of their cylinders, compress springs 59 and increase the counterbalancing force, as the gravitational torque increases and thus counterbalance the weight of the parts in a substantially uniform manner in the upper positions of the parts. However, as the tube and associated parts approximate the substantially horizontal position shown in Fig. 3, the spring and cylinder means described above approaches a dead center position (Fig. 4) with the result that the counterbalancing force becomes inadequate to support the parts. I have found that this difficulty can be overcome in a simple and practical way by providing an auxiliary or second spring counterbalancing means which is automatically brought into action in the lowered positions of the parts, so as to compensate for the decreasing effect of the counterbalancing means described above.

For this purpose I preferably form in the plate 34 a bore 63 (Fig. 3) having at one end a somewhat reduced portion 64 forming a shoulder 65. The opposite end of the bore is enlarged and threaded as at 66 for the reception of a screw plug 67 carrying a guide rod 68 extending longitudinally in the bore. This rod, adjacent the plug is enlarged and formed with a groove 69 seating a rubber buffer ring 70 for a purpose hereafter described. Slidably seated in bore 63 is a cylinder 71 having an outer end 72 reduced in diameter to slidably fit the reduced end 64 of the bore 63, thus retaining the cylinder in the bore. A coiled compression spring 73 in the bore and in cylinder 72 bears at one end against the cylinder and at the other end against the enlargement of guide rod 68 in which the ring 69 is seated. It will be seen from this construction that cylinder 72 may be moved inwardly in its bearing from its outer position shown in Fig. 3, increasingly tensioning spring 73, until it reaches an inner position in which its inner end is stopped and cushioned by the rubber ring 70. The projecting end of the cylinder is positioned for engagement by a lug 74 on link 36 as the latter reaches a substantially horizontal position as shown in Fig. 3. It is evident from this description that as the tube and links 36 and 37 are moved downwardly past a substantially horizontal position, lug 74 on link 36 engages and depresses cylinder 72 in bore 63 against spring 73 to produce increasing resistance to the further descent of the parts, thus taking up the counterbalancing function in that portion of the movement in which the spring and cylinder means connected with the head 42 is of decreasing effect. The resisting compression of spring 73 may be varied by turning the screw plug 67 to thereby adjust the coordination of the first or initial counterbalancing means and the auxiliary or supplemental counterbalancing means. The lower link 37 carries a cushioning stop 75 arranged to engage lug 74 of the other link so as to limit the upward movement of the links as shown in Fig. 2. The spring and cylinder means connecting the plate 34 and the tube head 42 and the spring and cylinder device connecting plate 34 with link 36 thus forming complementary means which, in effect, operate successively to maintain a substantially uniform counterbalancing action throughout the range of movement of the tube. Both means are of relatively simple construction capable of being manufactured and assembled at relatively low

cost and of being readily adjusted and maintained in efficient operating condition with a minimum of attention.

It will thus be seen that the invention accomplishes its objects and while it has been herein disclosed by reference to the details of a preferred embodiment, it is to be understood that such disclosure is intended in an illustrative, rather than a limiting sense, as it is contemplated that various modifications in the construction and arrangement of the parts will readily occur to those skilled in the art, within the spirit of the invention and the scope of the appended claims.

I claim:

1. A mechanism for movably supporting an object comprising a supporting part, an object part to be supported, an arm part having pivotal connections with said supporting and object parts, respectively, extending substantially transversely to said arm part for supporting said object part for upward and downward movement in a substantially vertical plane, a first resilient counterbalancing means continuously connecting two of said parts and having a connection with one of said parts at a point thereof spaced from said connection of said part with said arm part, for counterbalancing said object part during an initial portion of downward movement thereof, and an auxiliary counterbalancing means having members connected with two of said parts, respectively, in spaced inactive relation with each other during said initial portion of downward movement of said object part and in position for engagement with each other during a subsequent portion of said downward movement of said object part, one of said members having resilient means stressed by said engagement for cooperation with the other of said members to supplement the counterbalancing action of said first means.

2. A mechanism for movably supporting an object comprising a supporting part, an object part to be supported, arm means having pivotal connections with said parts, respectively, extending substantially transversely to said arm part for supporting said object part for upward and downward movement in a substantially vertical plane, a first resilient counterbalancing means connecting said parts, respectively, and having a connection with one of said parts at a point thereof spaced from said connection of said part with said arm means, for counterbalancing said object part during an initial portion of downward movement thereof, and an auxiliary counterbalancing means having members located on said supporting part and arm means, respectively, in spaced inactive relation with each other during said initial portion of downward movement of said object part and in position for engagement with each other during a subsequent portion of said downward movement of said object part, one of said members having resilient means stressed by said engagement for cooperation with the other of said members to supplement the counterbalancing action of said first means.

3. A mechanism for movably supporting an object comprising a supporting part, an object part to be supported, an arm part having pivotal connections with said supporting and object parts, respectively, extending substantially transversely to said arm part for supporting said object part for upward and downward movement in a substantially vertical plane, a first counterbalancing device having spring and cylinder means continuously connecting two of said parts and having a connection with one of said parts at a point thereof spaced from said connection of said part with said arm part, for counterbalancing said object part during an initial portion of the movement thereof, and an auxiliary counterbalancing means having members located on two of said parts, respectively, in spaced inactive relation during said initial portion of downward movement of said object part and in position for engagement with each other during a subsequent portion of said downward movement of said object part, one of said members having spring and cylinder means stressed by said engagement for cooperation with the other of said members to supplement the counterbalancing action of said first means.

4. A mechanism for movably supporting an object comprising a supporting part, an object part to be supported, arm means having pivotal connections with said parts, respectively, extending substantially transversely to said arm part for supporting said object part for upward and downward movement in a substantially vertical plane, a first counterbalancing device having spring and cylinder means continuously connecting said parts and having a connection with one of said parts at a point thereof spaced

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from said connection of said part with said arm means, for counterbalancing said object part during an initial portion of the movement thereof and an auxiliary counterbalancing means having members located on said supporting part and arm means, respectively, in spaced inactive relation during said initial portion of downward movement of said object part and in position for engagement with each other during a subsequent portion of said downward movement of said object part, one of said members having spring and cylinder means stressed by said engagement for cooperation with the other of said parts to supplement the counterbalancing action of said first means.

5. A mechanism for movably supporting an object comprising a supporting part, an object part to be supported, an arm part having pivotal connections with said supporting and object parts, respectively, extending substantially transversely to said arm part for supporting said object part for upward and downward movement in a substantially vertical plane, a first resilient counterbalancing means continuously connecting two of said parts and having a connection with one of said parts at a point thereof spaced from said connection of said part with said arm part, for counterbalancing said object part during an initial portion of downward movement thereof, an auxiliary counterbalancing means having members connected with two of said parts, respectively, in spaced inactive relation with each other during said initial portion of downward

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movement of said object part and in position for engagement with each other during a subsequent portion of said downward movement of said object part, one of said members having resilient means stressed by said engagement for cooperation with the other of said members to supplement the counterbalancing action of said first means and means for adjusting one of said members to vary the resistance of said resilient means and coordinate the action of said auxiliary means with said first counterbalancing means.

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