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[54] **VERTICALLY ADJUSTABLE
COUNTERBALANCING X-RAY TUBE HEAD
SUSPENSION SUPPORT APPARATUS**
1 Claim, 4 Drawing Figs.

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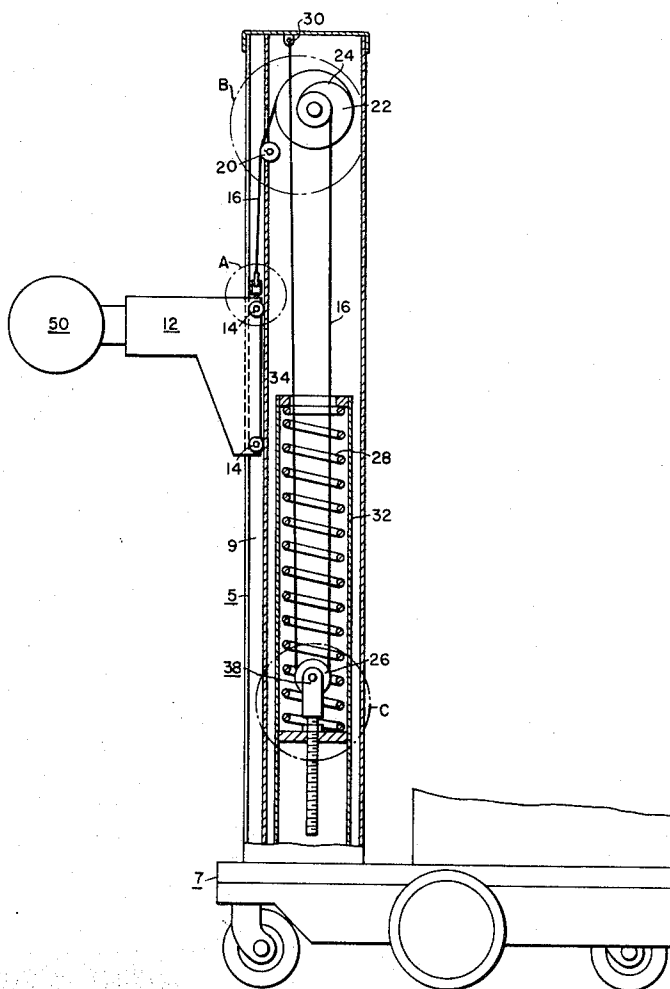
[50] Field of Search..... 248/162,
404, 123, 297, 292, 327, 328, 329, 330, 331, 332,
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ABSTRACT: Described is a vertically adjustable counterbalancing suspension support apparatus embodied in a floor mounted mobile X-ray tube column. The exemplified load, an X-ray tube head, is mounted on a vertical carriage movable along a mobile-based column containing an elongated circumferentially-encased helical compression spring extending vertically therein for counterbalancing the tube head and carriage. A dual suspension cable arrangement transmits the carriage load to the lower and live end of the compression spring via respective spring-pickup-compensating fuseses at the top of the column and a pair of spring-travel-reducing pulley arrangements at such live end. A combined tension-equalizing-and-safety-lock member connects the support cables to the loaded carriage.



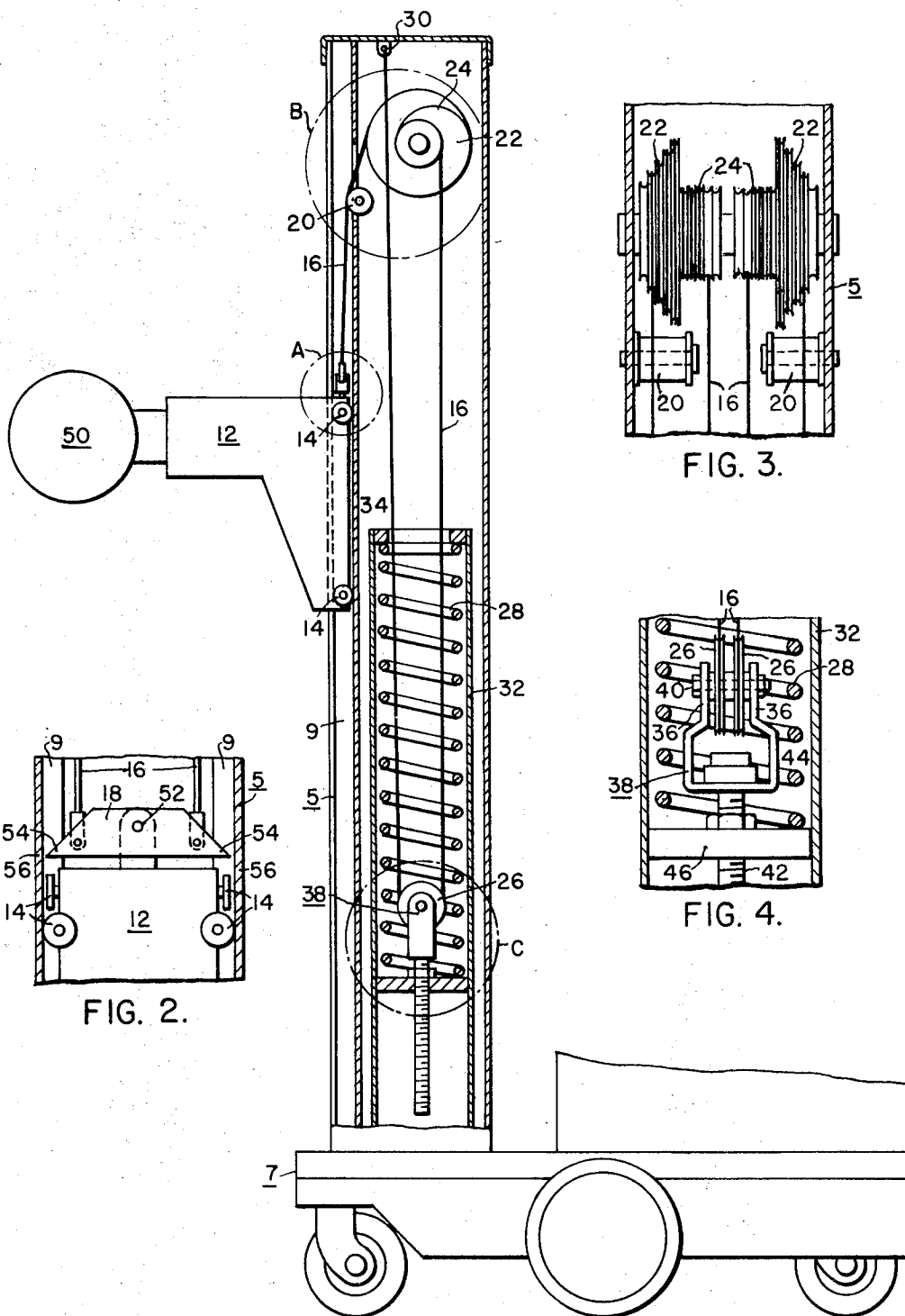


FIG. 2.

FIG. 3.

FIG. 4.

FIG. 1.

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VERTICALLY ADJUSTABLE COUNTERBALANCING X-RAY TUBE HEAD SUSPENSION SUPPORT APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention:

Vertically adjustable counterbalancing suspension support apparatus for devices, instruments, or the like, such as X-ray tube heads, mounted for guided travel vertically.

2. Description of the Prior Art:

Vertically adjustable counterbalancing suspension support apparatus employing flexible suspension cables for support of relatively heavy items such as X-ray tube heads mounted on vertical columns often are characterized by considerable bulk, complexity, and/or weight resultant from the nature of the construction of such apparatus under requirement for a high degree of assurance against failure of the apparatus to maintain support of the load over a prolonged period of time.

SUMMARY

The present invention, is suspending the vertically adjustable load-bearing carriage or mounting means by a pair of cables, either of which alone is capable of supporting such loaded carriage, together with inclusion of a safety lock for the carriage which is effectuated responsively to loss of support by either cable, fail-safe operation of the support apparatus with respect to suspension cable failure is assured. By virtue of employment of a single elongated helical compression spring in conjunction with fusees for counterbalancing the load-bearing carriage, the weight of the apparatus can be made significantly less than where a counterweight means is employed. By virtue of circumferential encasement of the compression spring, its reliability is assured against separation at any of its turns and a degree of simplicity relative to use of a plurality of parallel-arranged tension springs is afforded. And, by virtue of connecting the cables to the live end of the compression spring via jockey pulleys, the travel required for spring compression is one-half that of the load-bearing carriage, thus affording use of a relatively short spring and thereby contributing to a saving in space requirement for such spring.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view, partly in outline and partly in section, of a floor-mounted mobile X-ray column embodying the invention;

FIG. 2 is a front elevation view of the portion of the apparatus within the dot-dash circle A in FIG. 1;

FIG. 3 is a front elevation view of the portion of the apparatus within the dot-dash circle B in FIG. 1; and

FIG. 4 is a front elevation view of the portion of the apparatus within the circle C in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of the invention is exemplified in conjunction with a floor mounted mobile X-ray column 5 projecting vertically from a wheel-supported base 7, as shown in FIG. 1. The column 5 is constructed of metal, is hollow, and of generally rectangular cross section, with oppositely-facing guide channels 9 formed therein which extend along its length for directing vertical movement of a tube head carriage 12 via carriage rollers 14 disposed in such channels. For suspension support of the carriage 12, one end of a spaced-apart pair of flexible plastic-covered aircraft cables 16 about one-eighth inch in diameter, only one of which is shown in FIG. 1, are anchored to the tube head carriage 12 via a combined tension-equalizing and safety lock member 18 extending between the guide channels, as shown in FIG. 2. These support cables 16 in turn extend upwardly along the carriage guide channels 9, across respective relatively wide cable guide pulleys 20 on the column 5 onto the spiral grooves of respective fusees 22, thence around multigrooved drums 24 affixed to the fusees, thence downwardly within the column around a pair of

respective jockey pulleys 26 coupled to a lower and live end of a helical compression spring 28 within the column, and then upwardly through such spring to cable anchors 30 at the top of the column.

The compression spring 28 is cylindrical and encased about its periphery in a hollow tubular spring housing member 32 attached at its lower end to the wheel-supported base 7 at the bottom of the column 5. An inwardly-extending annular stop member 34 affixed to the upper end of the spring housing member 32 forms a shoulder against which the upper end of the compression spring 28 abuts, and the outer periphery of such spring is in slidable engagement with the inner surface of such housing member.

Referring to FIGS. 1 and 4, jockey pulleys 26 are rotatably carried between the arms 36 of a clevis 38 on a common shaft 40, and the clevis has a thrust transmitting rotary connection with the upper end of a threaded spring adjustment screw 42 via a swivel member 44. The adjustment screw in turn extends centrally through and is in screw-threaded connection with a disc-shaped thrust member 46 which abuts the lower end of the compression spring 28.

In normal operation of the apparatus, in any given vertical position of the carriage 12, the degree of compression of the spring 28 commensurate with such position creates a tension in the cables 16 which is transmitted to the carriage via the drums 24 and fusees 22 adequate to suspend such carriage and its tube head 50 load. As the tube head carriage 12 is moved downwardly, the cables 16 will unwind from the fusees 22 and leave same at progressively decreasing diameter portions of the spiralling fusee grooves as the cables wind upwardly onto the drums 24 and pull the lower end of the compression spring 28 upwardly via the jockey pulleys 26 an amount equal to one-half the downward travel of the carriage. Such increased longitudinal compaction of the spring 28 increases tension of the cable portions passing around the pulleys 26 and winding onto the drums 24. Such increased tension, however, in accord with the well-known characteristics of fusees, is compensated for by the fusees 22 which maintain tension of the cables playing out from such fusees constant and collectively equal to the load imposed thereon by the carriage 12 and its load 50. When the tube head carriage 12 is moved upwardly, the cables 16 will wind onto progressively larger diameter portions of the fusees 22 as a result of the compression spring 28 unwinding the cables 16 from the drums 24 attached to such fusees, and the resultant diminished spring force is compensated for by the fusees to maintain the counterbalancing support of the tube head carriage 12, and its load 50. It will be understood that the fusees 22 and the drums 24 attached thereto are so constructed and arranged as to accept storage of the cable lengths necessary to accommodate vertical travel of the carriage 12 for substantially the entire length of the column 5, and that the cables 16 are suitably secured against slippage on the fusees and drums.

In accord with a feature of the invention, the combined tension-equalizing and safety lock member 18 via which the cables 16 are connected to the tube head carriage 12 is simply in the form of a substantially flat metal plate, FIG. 2, which is pivotally connected at 52 near its top edge midway between its ends which are tapered downwardly, as viewed in the drawing, to relatively sharp edges 54 that are disposed with slight clearance adjacent to the sidewalls 56 of the carriage guide channels 9 at the forward edges of the column 5. During normal operation of the apparatus, with both cables 16 intact, the member 18 is free to tilt slightly about its pivotal connection 52 with the carriage 12 in the presence of a moderate degree of difference in cable lengths which are anchored to such member equal distances at opposite sides of such pivotal connection. However, the member 18 is so proportioned that the distance from the pivotal connection 52 to either sharp edge 54 is greater than the distance from such pivotal connection to either guide channel wall 56, so that upon separation of one of the cables 16, the torque reaction

between the horizontally constrained vertically movable pivotal connection 52 and the nonseparated one of the cables causes the member 18 to turn about such connection and bring the corresponding sharp edge 54 of the member into locking engagement with the respective guide channel wall 56 and prevent the carriage 12 and its load 50 from being lowered, even though the remaining intact cable is capable of alone supporting the load and affording opportunity for raising the carriage. Such lockout against downward movement serves as indication of the existence of a faulty cable in a manner that requires attention before the apparatus can be operated in a useful manner.

We claim:

1. A vertically adjustable counterbalancing X-ray tube head suspension support apparatus, comprising:
 - a an X-ray tube head to be positioned selectively at different elevations;
 - a floor-mounted hollow vertical column of rectangular cross section having oppositely facing horizontally spaced-apart exterior guide channels extending lengthwise along its one rectangular side at respective edges thereof;
 - a vertical carriage supporting said X-ray tube head and having rollers thereon in rolling contact with said guide channels;
 - a pair of fusees and respective attached drums disposed within said column near its top for rotation about fixed horizontal axes;

- a tubular spring housing member fixed relative to said column and extending upwardly therewithin;
- an inwardly extending stop member affixed to the upper end of said spring housing member;
- an elongated helical compression spring disposed in said spring housing member with its upper end abutting said stop member;
- a pair of pulleys disposed within said helical compression spring in upwardly exerting thrust-transmitting connection to its lower end;
- a pair of parallel-arranged flexible cables anchored at their one end to said column above said spring housing member, extending downwardly therefrom to and around said pulleys, thence upwardly to and around the respective drums and fusees in continuously wound relationship, thence downwardly to said carriage; and
- an elongated horizontal rockable member extending laterally between said guide channels, having opposite pointed ends normally disposed in proximity to walls of said guide channels extending perpendicular of said member, pivotal suspended connections with said cables at opposite sides of its mid length, and a laterally constrained pivotal support connection with said carriage at a location separated from such pointed ends a distance greater than the mid distance between such perpendicular guide channel walls.

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