United States Patent [19]

Sterner

[11] **3,736,710**

[45] **June 5, 1973**

[54] FOUR-SECTION FULLY HYDRAULICALLY OPERATED CRANE BOOM HAVING THREE INDIVIDUALLY SUPPORTED SINGLE PISTON RAMS CONTAINED WITHIN FLY SECTION

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[73] Assignee: **Walter Kidde & Company, Inc.,** Clifton, N.J.

[22] Filed: **Dec. 3, 1970**

[21] Appl. No.: **94,812**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 75,886, Nov. 28, 1970.

[52] **U.S. Cl.** **52/115,** 52/114, 212/55, 52/731

[51] **Int. Cl.**.....**E04h 12/34,** B66c 23/04, B66c 23/54

[58] **Field of Search**.....52/114, 115, 731; 212/55; 91/167; 182/51; 214/141

[56] **References Cited**

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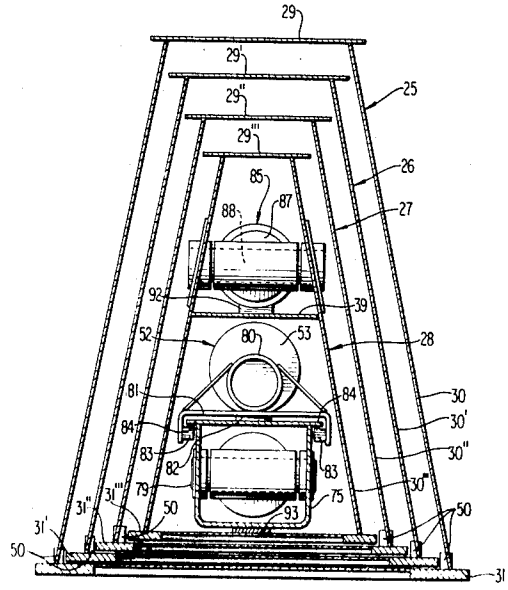
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Primary Examiner—Frank L. Abbott
Assistant Examiner—Leslie A. Braun
Attorney—Brady, O'Boyle & Gates

[57] **ABSTRACT**

A four-section fully hydraulically operated telescoping crane boom is constructed so that the three operating rams of the boom can be contained within the boom fly section and are independently supported and operated. Single piston rams are utilized throughout. The ram which interconnects the base section and the inner mid-section of the boom is reversed from the conventional arrangement with the rod end of this ram anchored to the base section and the cylinder end cantilevered forwardly from a rear pivotal connection with the inner mid-section of the boom and having a sliding support and guide means on its forward end engaging a core or box forming a part of the outer mid-section of the boom. As a result of the arrangement of the rams the vertical heights of the several boom sections can be made nearly equal and the amount of metal utilized in the boom is minimized while maintaining maximum rigidity.

12 Claims, 19 Drawing Figures



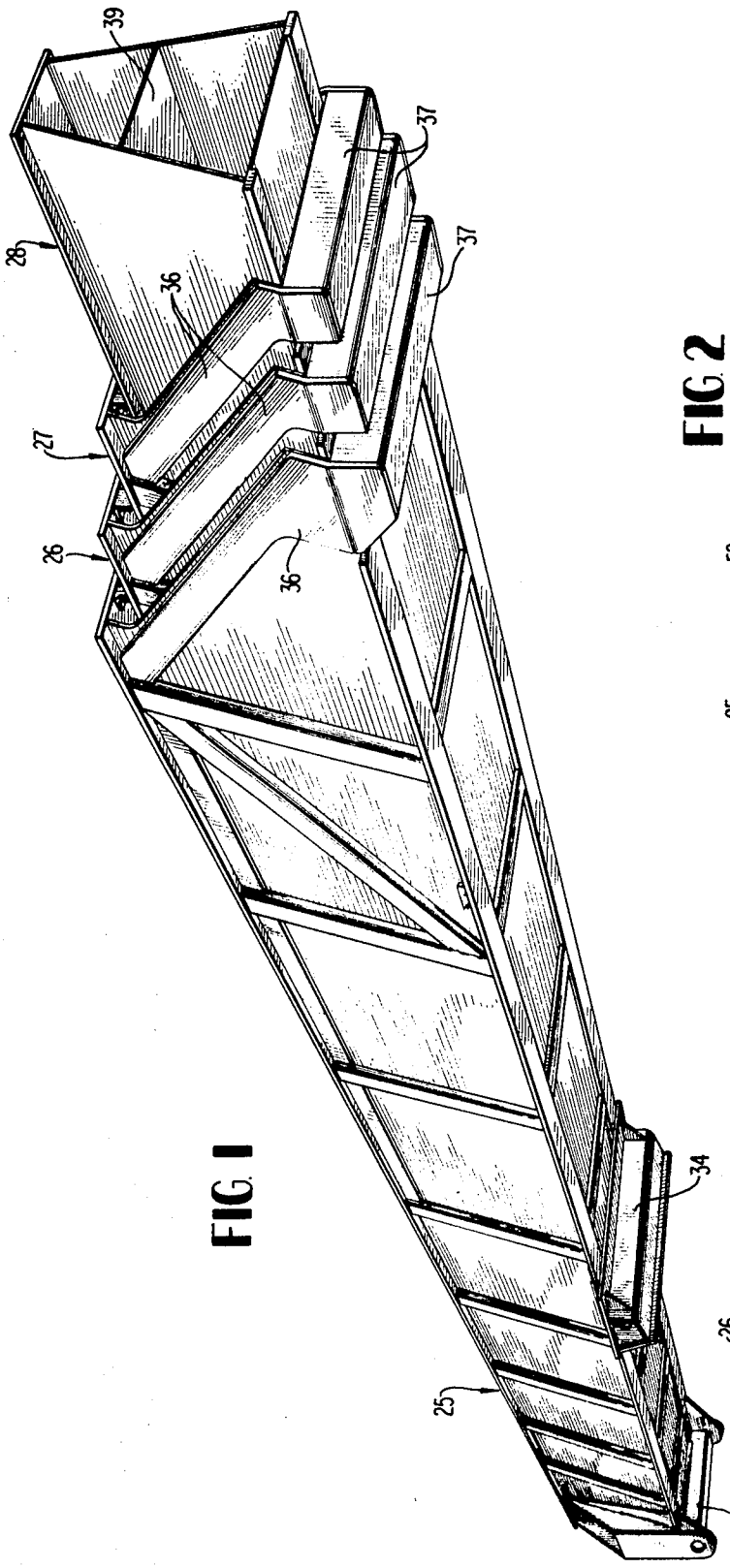

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FIG 1

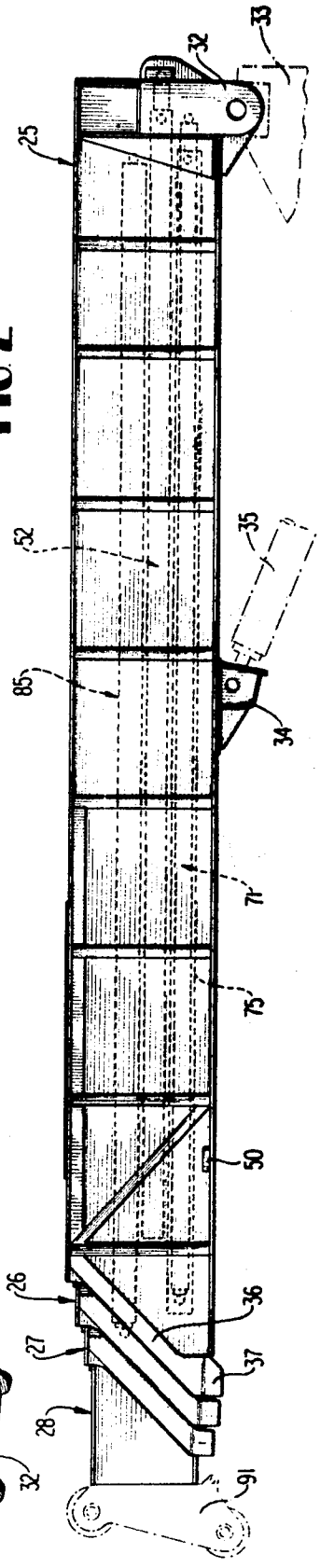

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FIG 2

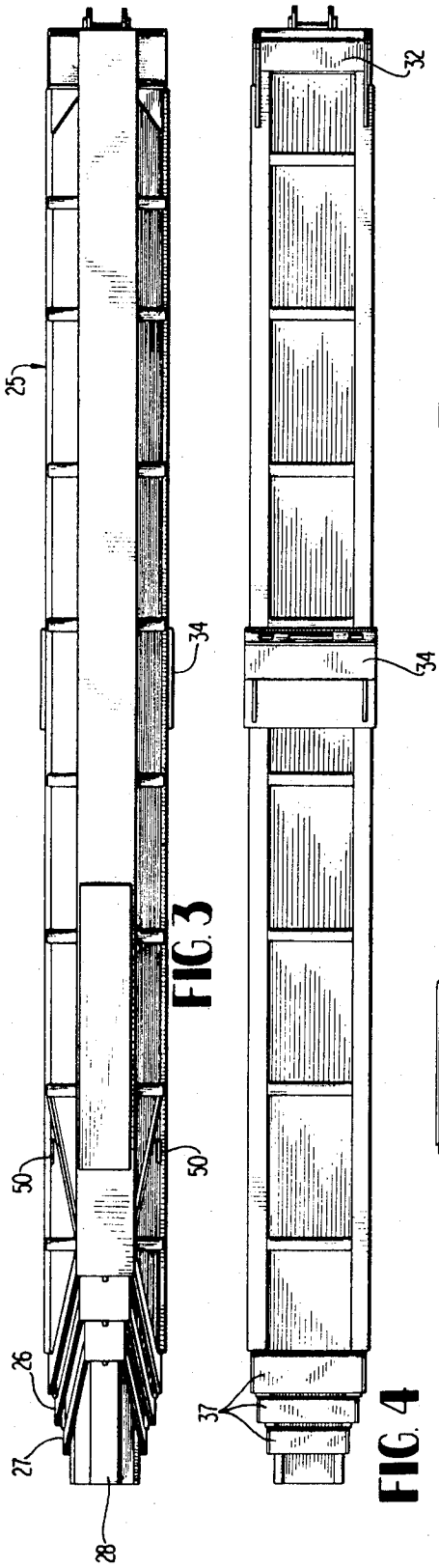


FIG. 3

FIG. 4

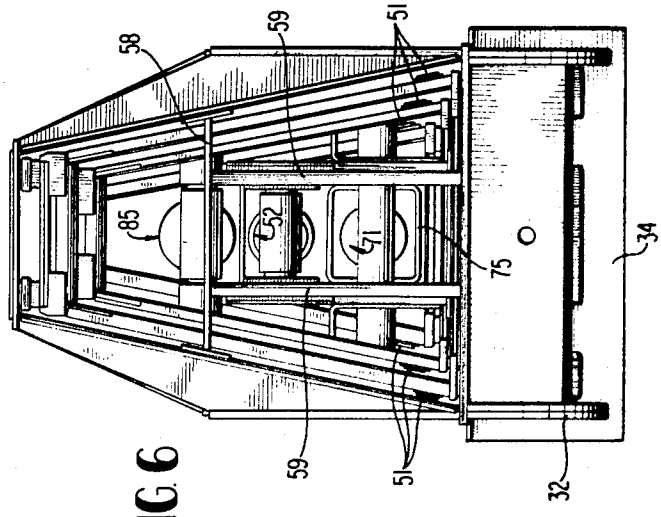


FIG. 6

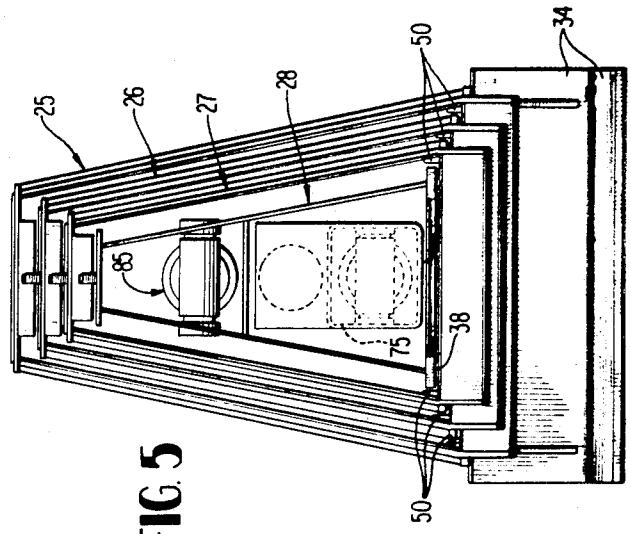


FIG. 5

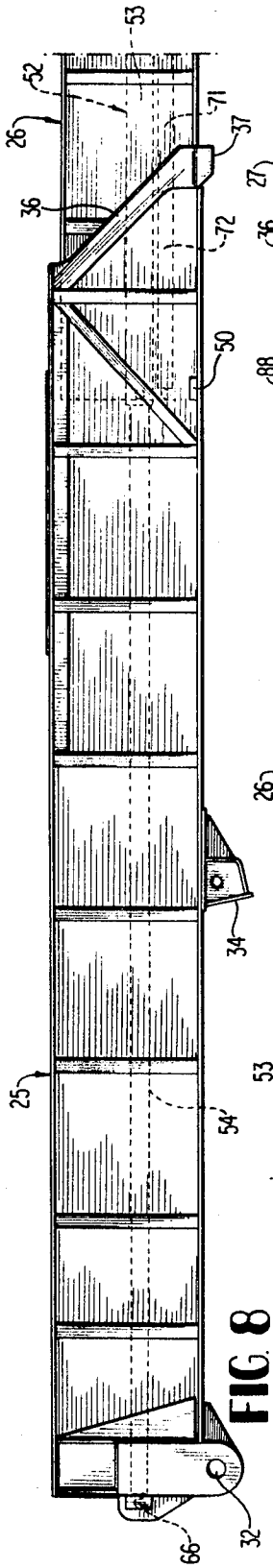


FIG. 8

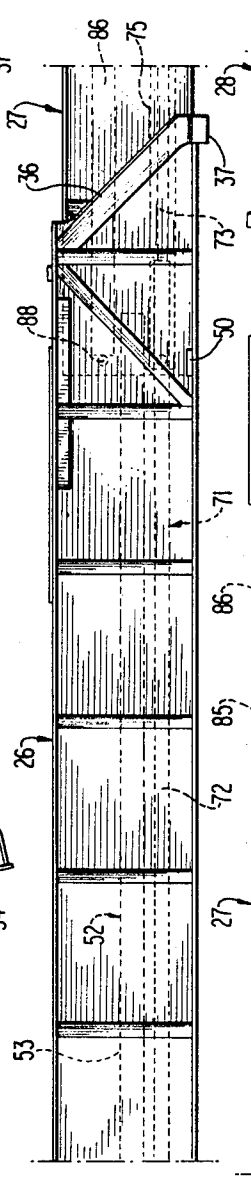


FIG. 9

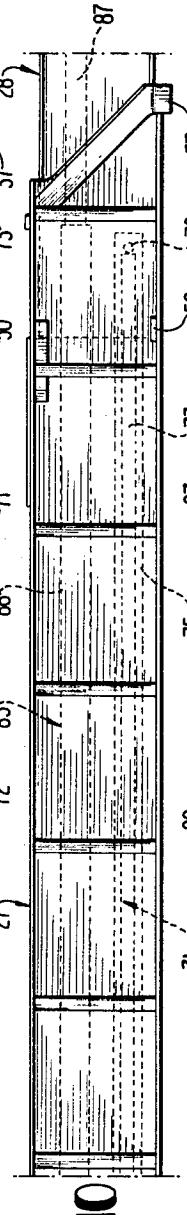


FIG. 10

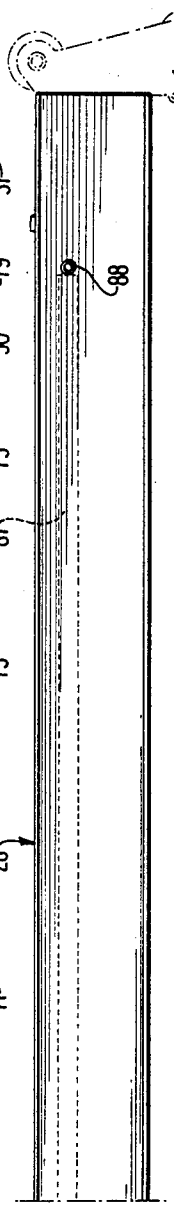


FIG. 11

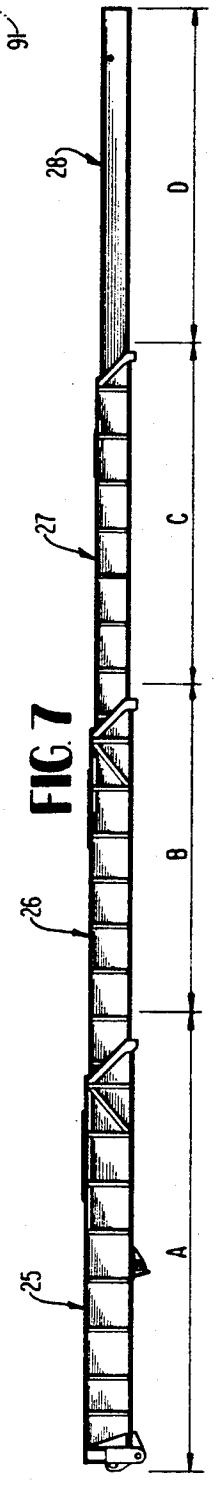


FIG. 7

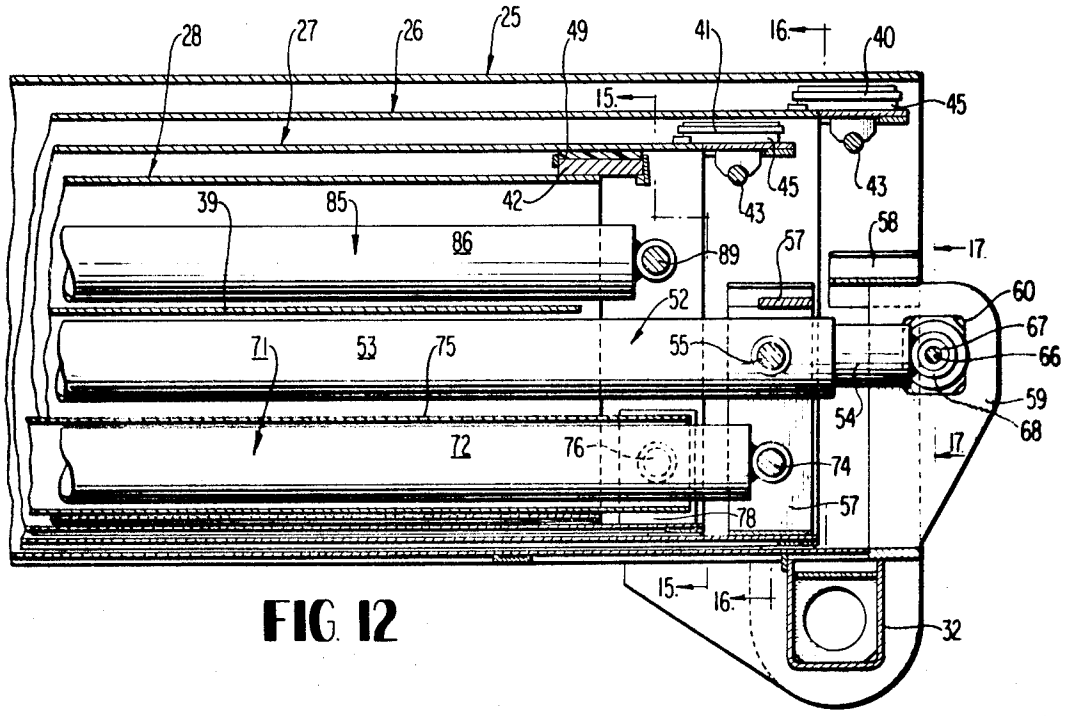

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FIG. 12

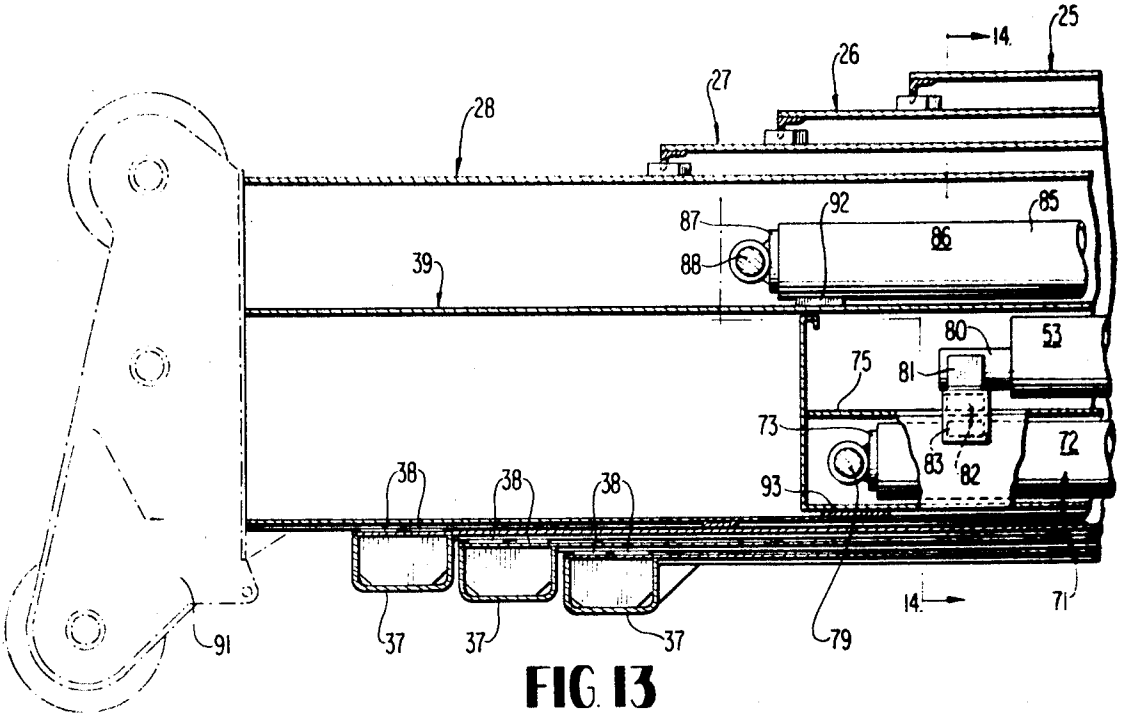

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FIG. 13

FIG. 15

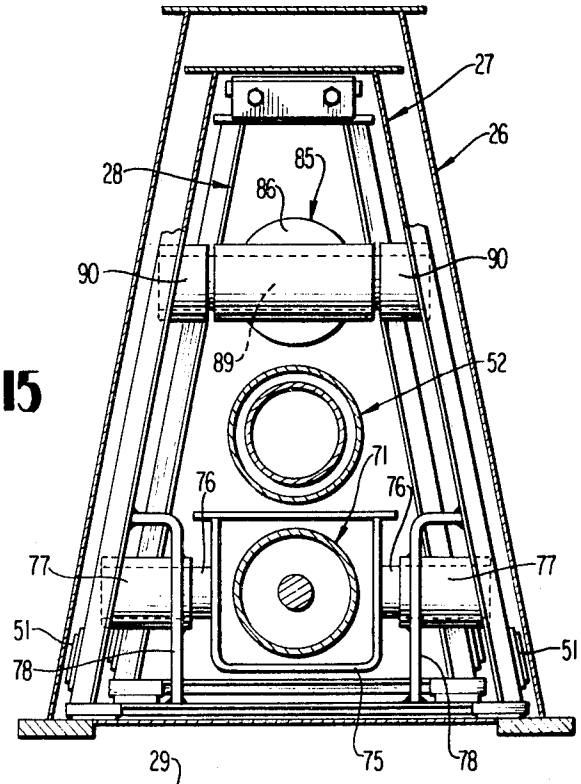
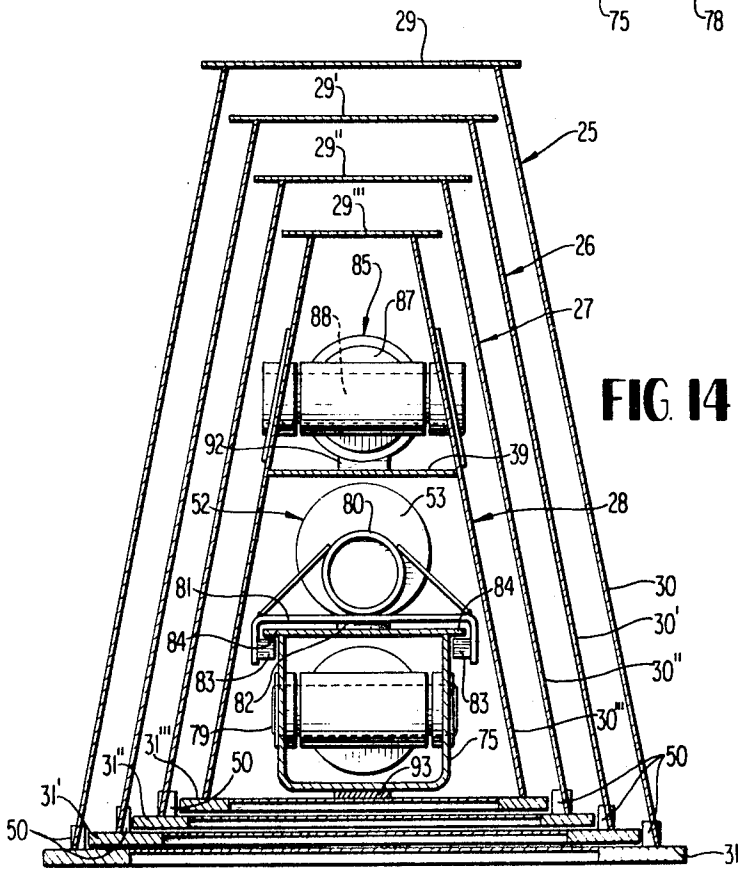

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FIG. 14


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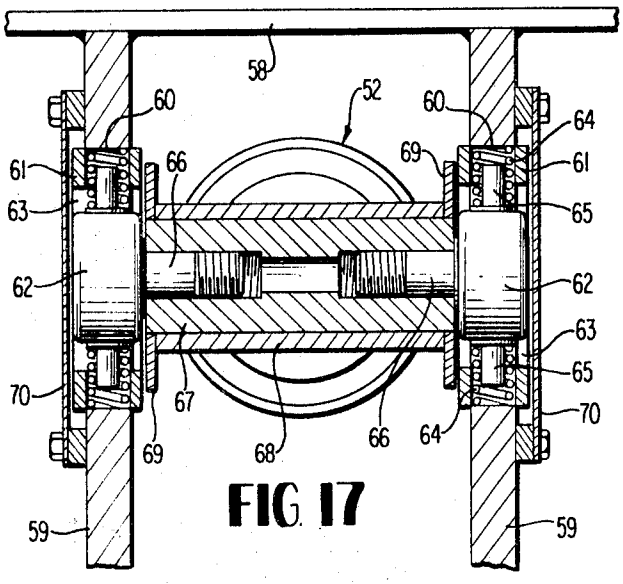


FIG. 17

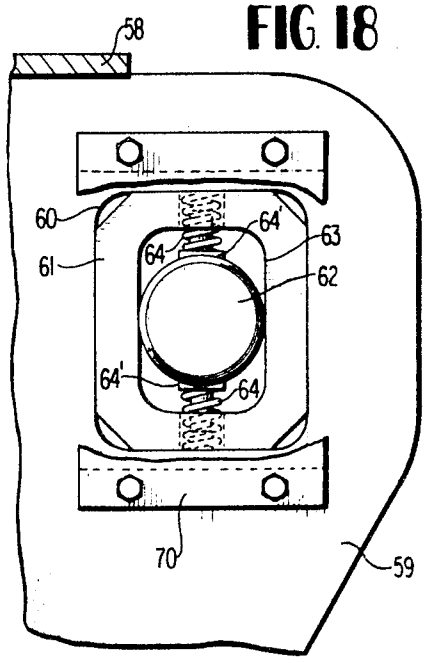


FIG. 18

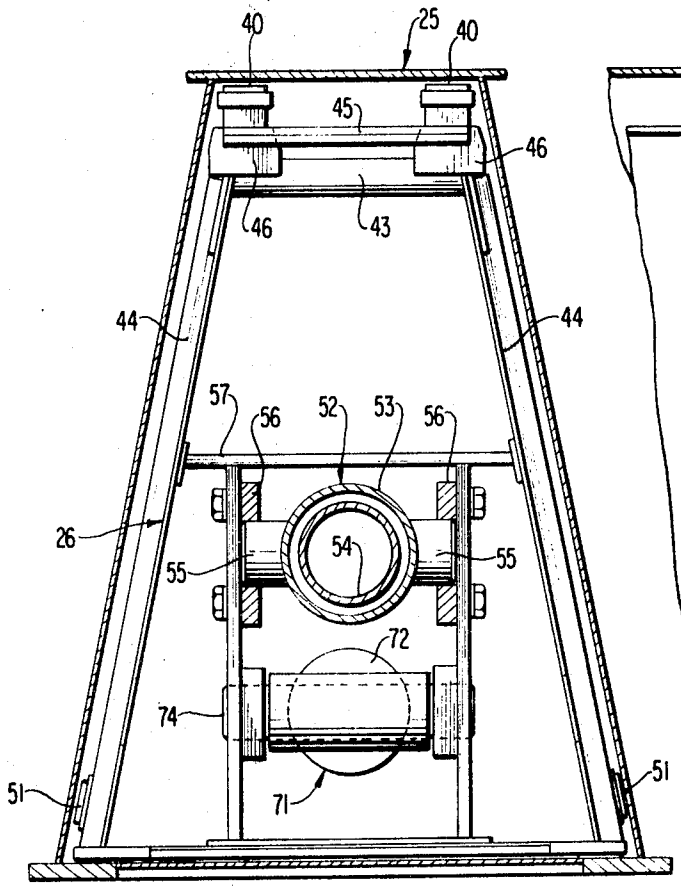


FIG. 16

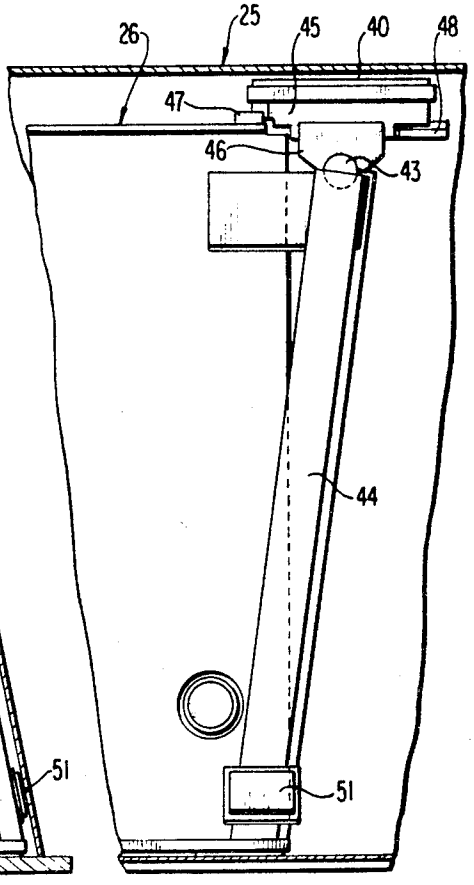


FIG. 19

FOUR-SECTION FULLY HYDRAULICALLY OPERATED CRANE BOOM HAVING THREE INDIVIDUALLY SUPPORTED SINGLE PISTON RAMS CONTAINED WITHIN FLY SECTION

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of prior copending application Ser. No. 75,886 filed Sept. 28, 1970 for "Trapezoidal Telescoping Crane Boom."

BACKGROUND OF THE INVENTION

The present invention arises as a result of a need in the crane boom art for increasingly strong telescoping boom structures and increased flexibility of operation. While plural section hydraulically operated telescoping crane booms including four-section booms are known in the prior art, these have possessed certain disadvantages from the standpoint of economy and strength for a given amount of material utilized in their construction.

An example of a prior art four-section fully hydraulically operated boom is shown in U.S. Pat. No. 3,315,821 to Grove issued Apr. 25, 1967. While the structure in this patent has proved very adequate in general, the arrangement of the hydraulic rams in the structure causes one ram to lie outside of the fly section of the boom in a separate housing near the upper side of the boom between its base section and inner mid-section. This arrangement results in a substantial difference in the vertical cross sectional height between the base section and the inner mid-section of the boom, with a corresponding lessening of overall boom strength and lifting capacity for a given amount of metal employed in the construction.

Another prior U.S. Pat. No. 3,419,157 to Brady issued Dec. 31, 1968, achieves a more nearly uniform vertical height between the four box like telescoping sections and also achieves the placement of all rams within the fly section of the boom. However, these features have been achieved in the Brady patent only by employing an unusual tandum arrangement of rams and also rams which require plural telescoping piston and cylinder sections. It is well known that such rams are more likely to leak than the simpler single piston types and are subject to a greater degree of sagging or flexure when fully extended.

The present invention satisfies the need in the art for a fully hydraulically operated four-section telescoping crane boom having only single piston rams which are all contained inside of the fly section and individually supported therein when the fly section is retracted. The three rams are independently operable so that the several sections of the boom can be extended or retracted in any sequence desired or selected by the operator. The crane boom so constructed can have the maximum lifting capacity for a minimum amount of metal employed in the structure and the several telescoping boom sections can be made in nearly uniform height in cross section for maximum strength. In summary it can be stated that the present invention increases the overall efficiency of operation of the crane boom and improves the economy of construction thereof, and these factors are achieved primarily by a unique simplified arrangement of the operating rams as compared to the prior art.

The boom of this invention possesses a number of other features and advantages which will appear during the course of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

FIG. **1** is a front perspective view of a four-section hydraulically operated telescoping crane boom in accordance with the invention;

FIG. **2** is a side elevational view of the crane boom with the several sections thereof retracted into the base section;

FIG. **3** is a top plan view of the retracted crane boom;

FIG. **4** is a bottom plane view thereof;

FIG. **5** is a front end elevational view of the boom;

FIG. **6** is a rear end elevation thereof;

FIG. **7** is a side elevation on a reduced scale of the crane boom in an extended condition;

FIG. **8** is an enlarged fragmentary side elevation of the portion A shown in FIG. **7**;

FIG. **9** is a similar elevational view of the portion B in FIG. **7**;

FIG. **10** is a similar view of the portion C in FIG. **7**;

FIG. **11** is a similar view of the portion D in FIG. **7**;

FIG. **12** is an enlarged fragmentary longitudinal vertical section through the rear end portion of the boom in a retracted condition;

FIG. **13** is a similar section through the front end portion of the boom;

FIG. **14** is an enlarged transversed vertical section taken on line **14—14** of FIG. **13**;

FIG. **15** is a similar section taken on line **15—15** of FIG. **12**;

FIG. **16** is a similar section taken on line **16—16** of FIG. **12**;

FIG. **17** is a similar section on an enlarged scale taken on line **17—17** of FIG. **12**;

FIG. **18** is a fragmentary side elevational view of the pivotal ram mounting shown in FIG. **17**; and

FIG. **19** is a fragmentary side elevational view partly in section of rear wear pad means and supporting elements.

DETAILED DESCRIPTION

Referring to the drawings in detail, wherein like numerals designate like parts throughout, a four-section crane boom embodying the invention is shown in its entirety in a retracted condition in FIGS. **1** through **6**. As shown, the boom comprises a base section **25**, inner and outer mid-sections **26** and **27** and a fly section **28**. In the embodiment of the invention illustrated herein, the several telescopically fitting boom sections are trapezoidal in transverse cross section, and each boom section comprises a top plate **29**, **29'**, **29''** and **29'''**, upwardly converging side webs, **30**, **30'**, **30''** and **30'''** and bottom plate assemblies **31**, **31'**, **31''** and **31'''** as clearly shown in FIG. **14**. It should be mentioned that while the arrangement of rams and associated elements forming the heart of this invention is well suited to a trapezoidal boom structure, nevertheless, the invention is not limited to this boom configuration and may be employed with facility on rectangular cross-section booms or other conventional shapes.

The details of construction of the trapezoidal crane boom are covered in the mentioned parent application, Ser. No. 75,886, and it is not necessary to a fully understanding of the invention to completely describe these

details of construction herein, and a brief description of the boom structure should be sufficient. In this connection the boom base section 25 is provided at its rear end and lower side with a heavily reinforced transverse main pivot unit 32 for connection with the usual boom support 33, FIG. 2, on the turntable of the mobile crane carrier, not shown. Forwardly of the pivot unit 32, the base section 25 is further equipped on its bottom with a reinforced connector 34 for the usual boom lifting cylinders 35 shown in FIG. 2. At its forward end the base section 25 has a reinforcing collar 36 including a bottom transverse section 37 which serves to house lower forward wear pads 38 and their retainer means, as fully disclosed in said prior application. Similar reinforcements 36 and wear pad housings 37 are also provided on boom sections 26 and 27. As shown in the drawings, at least the boom sections 25, 26 and 27 have certain side web and bottom plate reinforcing members thereon at spaced intervals and these details are fully covered in said prior application and need not be repeated herein. The fly section 28 of the boom is provided generally near its vertical center with an internal transverse reinforced web 39 extending substantially the length of the section.

With the exception of the boom base section 25, each telescoping boom section is equipped at its rear end and top side with wear pads, and these are indicated at 40, 41 and 42 in FIG. 12. The inner and outer mid-sections 26 and 27 have their rear upper wear pads 40 and 41 mounted for pivotal movement on transverse cylindrical bearing bars 43, secured to and supported by the tops of upwardly converging support bars 44, suitably anchored by welding to the opposite side and rear end of the next interior boom section, see FIGS. 16 and 19. The retainer means 45 for wear pads 40 and 41 includes shoe elements 46 which rest rockably on the bearing bars 43. As best indicated in FIG. 19 the wear pad retainer means 45 is effectively located in an opening in the top wall of the next interior boom section 26 or 27 and fore and aft stop elements 47 and 48 on such top walls limit the pivoting movement of the rear upper wear pads 40 and 41. The rear upper wear pad 42 of fly section 28 may be a non-pivoting wear pad having a low friction facing element 49 as indicated in FIG. 12.

The inner and outer mid-sections 26 and 27, FIG. 13, are also equipped at their forward ends and bottoms with the wear pads 38 and retainer means held within the bottom section 37 of reinforcing collar 36 substantially as described previously for the base section 25. Additionally, lateral stability and guidance between the telescoping boom sections is achieved near the forward ends thereof by side lateral guidance elements 50 on the boom sections 25, 26 and 27, FIG. 14. Toward their rear ends, the moveable telescoping boom sections are further equipped near and above their bottoms with side wear pads 51 which further guide and stabilize the boom sections laterally.

As previously discussed, the essence of the present invention resides in the arrangement and mounting of the hydraulic rams which impart movement to the telescoping boom sections. A first ram 52, FIG. 12, has its cylinder portion 53 arranged forwardly and its rod portion 54 extending rearwardly, and this is the reverse of the conventional arrangement for crane boom rams. The cylinder portion 53 of the ram 52, FIG. 16, carries side trunnions 55 which are pivotally received by bearing plates 56, carried by a rigid support frame 57 provided in the rear end portion of inner mid-section 26.

The rear end of rod portion 54 of ram 52 is pivotally secured to the base section 25 in the following manner shown particularly in FIGS. 12, 17 and 18. In these figures a rear supporting frame 58 including space vertical walls 59 is secured fixedly in the rear end of base section 25. The vertical walls 59 have openings 60 which receive vertical guide elements 61 for ball roller bearings 62. The outer races of the ball bearings 62 engage moveably for rolling action in vertically elongated guide slots 63 in the elements 61. The ball bearings are cushioned in their vertical rolling movement by top and bottom opposing springs 64 engaging over top and bottom pin extensions 65 on the shoe elements 64' which are in sliding contact with the outer races of the roller bearings 62. The inner races of ball bearings 62 receive shafts 66, FIG. 17, having threaded engagement within openings of a sturdy cross sleeve 67 and rigid therewith thus providing rotative movement between the sleeve 67 and the outer rolls of the ball roller bearings 62. A cylindrical bushing 68 engages rotatably over the sleeve 67 and includes end flange plates 69 rigid therewith which cover the interior sides of the slots 63. These elements in FIGS. 17 and 18 constitute the floating or self adjusted cushioned pivotal connection between the rod portion 54 of ram 52 and the relatively stationary base section 25 of the crane boom. The springs 64 are sized to carry the weight of the rod and normally keep it centered in slot 63. When the rod is stressed during extension or retraction or due to misalignment caused by wear in the boom, during extension and retraction the rod is free to move slightly up or down to relieve the stress or to prevent binding. Removable cover plates 70 are provided on the vertical walls 59 to retain and enclose the bearings 62 and associated parts. It may be observed in FIGS. 12 and 13 that the cylinder 53 of ram 52 extends forwardly of the trunnions 55 and is cantilevered forwardly of this point. Means yet to be described are provided on the forward extremity of the ram 52 to support and stabilize the cantilevered cylinder 53. Extension and retraction of the ram 52 serves to extend and retract the inner mid-section 26 relative to base section 25 when conventional controls on the crane are utilized.

A second ram 71 interconnects the rear end of inner mid-section 26 with outer mid-section 27. This second ram is conventionally arranged in that its cylinder portion 72 is rearmost and its rod 73 extends forwardly. The rear end of cylinder 72 is pivotally secured at 74 on the same rigid frame 57 which supports the trunnions 55, FIG. 16. The ram 71 extends forwardly through a box or core member 75 whose rear end is equipped with side trunnions 76 pivotally supported in sleeves 77, in turn rigidly held in braces 78, FIG. 15, on the rear end and bottom of outer mid-section 27. The rod 73 of ram 71 has its forward end pivotally secured at 79 to the forward end of box or core member 75. Thus when ram 71 is extended the forward movement of piston rod 73 will correspondingly move the box or core 75 which is tied pivotally to the rear end of outer mid-section 27 through trunnions 76, and the outer mid-section can therefore be extended or retracted relative to the inner mid-section 26 at the will of the operator since the several hydraulic rams of the boom are separately supported and independently operable

through the use of conventional controls in the cab of the crane.

As previously suggested the forward cantilevered end of cylinder 53 is stabilized and supported. An extension 80 projects from the forward end of cylinder 53 and has secured to it a bracket structure 81, FIG. 14, said bracket structure overlying the top wall of box or core 75 and having a wear pad 82 slidably bearing thereon. Side stabilizing guide shoes 83 on the bracket 81 engaged beneath top flanges 84 on the core 75 and engage closely outside of the core sidewalls. Thus, when there is relative movement between the box or core 75 and the cylinder 53 of ram 52 caused by extension or retraction of ram 71 the wear pad 82 will slide over the top wall of core 75 and support the forward end of cylinder 53 at all times. The shoes 83 will guide and stabilize the cantilevered cylinder 53 of ram 52 laterally at all times. The box or core 75 is similarly supported and carries a wear pad 93 on its bottom at its forward end engaging slidably upon the inner surface of the bottom wall of fly section 28.

A third hydraulic ram 85 interconnects the rear end of outer mid-section 27 with the forward end portion of fly section 28. This third ram is conventionally installed with its cylinder 86 rearmost and its rod 87 forwardmost. The forward end of the rod 87 is pivoted at 88 to the fly section 28 above the transverse web 39 thereof. The rear end of cylinder 86 is similarly pivoted as at 89 to the rear end of outer mid-section 27, which mid-section, FIG. 15, is equipped with sleeve elements 90 to receive the pivot element 89 or pin. The front end and bottom of cylinder 86 has a wear pad 92 secured to it and slidably engaging the top of the web 39 of fly section 28 to support the ram 85 when it is extended. Consequently extension or retraction of the third ram 85 will produce corresponding movement of the fly section 28 relative to outer mid-section 27. As indicated in FIG. 13 the forward end of fly section 28 carries the usual boom nose assembly 91.

The means for extending or retracting independently and selectively the three boom sections 26, 27 and 28 relative to the base section 25 in any sequence or order have now been described in connection with the three rams 52, 71 and 85. The disclosed arrangement renders it practical to place all three hydraulic rams bodily inside of the boom fly section 28, whereby the same in effect can telescope over the three rams when retracted, FIG. 12. The use of the core or box 75 in conjunction with the ram 71 and the arrangement of the cylinder 53 of ram 52 forwardly with the rod portion 54 rearmost allows the use throughout the boom of single cylinder-piston hydraulic rams instead of rams containing multiple piston and cylinder sections, the latter being more complicated and costly and also having a much greater tendency to leak because of sagging when extended. The provision of the cushioned vertically shiftable pivot for the rear facing piston rod 54 of cantilever ram 52 and the additional pivoting at 55 of the cylinder 53 plus the supporting of the forward end of this cylinder by the bracket structure 81 and wear pad 82 and associated elements greatly relieves the ram 52 from bending stresses which could be imparted thereto by the flexure of the boom under load and cocking of the boom sections when they are extended as the distance between their upper and lower wear pads is greatly lessened.

Most importantly the ability to mount the three single piston rams compactly inside of the fly section 28 allows the several sections of the boom to approach uniform height in cross-section as best depicted in FIG. 14. This is in contrast to the prior art where there must be a considerable space between the top wall of the base section and the next innermost section of the telescoping boom, as discussed previously. By virtue of the invention a much stiffer boom can be constructed from a given amount of metal and economy of materials is obtained while actually increasing the efficiency of operation of the boom.

The ram arrangement whereby the retracted fly section 28 may telescope over all three rams is rendered possible by having the three rams individually and separately supported. That is to say, no one hydraulic ram is secured to or supported by another ram.

The terms and expressions which have been employed herein are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof but it is recognized that various modifications are possible within the scope of the invention claimed.

I claim:

1. A four-section fully hydraulically operated crane boom comprising inner and outer mid-sections, and a fly section all telescopically inter-fitting within a base section, a first ram having its rod end connected with the base section and its cylinder connected with the inner mid-section of the boom near the rear ends of the cylinder and inner mid-section, said cylinder extending substantially forwardly of its point of connection with the inner mid-section, a second ram having connections with the inner and outer mid-sections, a core member extending over said second ram and connected with the outer mid-section near the rear ends of the outer mid-section and core member, the rod end of the second ram connected with the core member near the forward end of the core member, a third ram having connections with the outer mid-section and the fly section of the boom, said rams individually supported and independently operable, a rest structure for the forward end portion of said cylinder of the first ram slidably contacting the core member, the vertical height of all said boom sections being nearly equal, and said fly section constructed to telescope over all of the rams in the retracted positions thereof to substantially enclose them.

2. A four-section fully hydraulically operated crane boom comprising

inner and outer mid-sections, and a fly section all telescopically inter-fitting within a base section,

a first ram having its rod end pivotally secured to said base section near the rear end of the base section and having its cylinder end pivotally connected with the inner mid-section near the rear ends of the cylinder and inner mid-section,

the cylinder of said first ram extending substantially forwardly of its point of connection with the inner mid-section,

a second ram having connections with the inner and outer mid-section,

said second ram having its cylinder end connected to the inner mid-section,

a hollow core member engaging over the second ram and connected near its forward end to the rod end

of the second ram and connected near its rear end to the outer mid-section near the rear end of the outer mid-section,

a third ram connected between the outer mid-section and the fly section of the boom,

said rams individually supported and independently operable,

a rest structure for the forward end portion of said cylinder of the first ram slidably contacting the core member,

whereby retraction of said rams allows the fly section to telescope over all of the rams to substantially enclose them.

3. The structure of claim 2 and said connection between the rod end of the first ram and said base section being a resilient pivotal connection with restrained freedom of movement in the vertical direction, the connection between the rear ends of the core member and outer mid-section also being a pivotal connection.

4. The structure of claim 2 in which said rest structure comprises a wear pad on the cylinder of the first ram near the forward end of the cylinder having sliding engagement with the core member and supporting the cantilevered end of the cylinder of the first ram in all operative positions of the boom.

5. A crane boom as set forth in claim 4 and another wear pad on said core member near its forward end having sliding engagement with a part of the fly section.

6. The structure of claim 2 and said hollow core member including a substantially flat top wall having side longitudinal edge portions which project outwardly of the opposite side walls of the core member, and said rest structure comprising a bearing and guide unit on the cylinder of the first ram near the forward end of the cylinder and including a wear pad slidably engaging the top wall of said core and a pair of laterally spaced opposed guide shoes engaging below said longitudinal edge portions in close proximity to the side walls of said core.

7. A crane boom as set forth in claim 2 in which said third ram has its rod end connected to said fly section and its cylinder end connected with the outer mid-section, and said first ram disposed bodily between the second and third rams in vertically stacked relation.

8. A crane boom as set forth in claim 2, and a wear pad on the cylinder of said third ram having sliding engagement with a part of said fly section.

9. A four-section fully hydraulically operated crane boom comprising

inner and outer mid-sections,

and a fly section all telescopically inter-fitting within a base section,

a first ram having its rod end resiliently pivotally connected with restrained freedom of movement in the vertical direction with the base section and its cylinder connected with the inner mid-section of the boom near the rear ends of the cylinder and inner mid-section,

the cylinder of said first ram extending substantially forwardly of its point of connection with the inner mid-section,

a second ram having connections with the inner and outer mid sections,

a core member extending over said second ram and pivotally connected with the outer mid-section near the rear ends of the outer mid-section and core member,

the rod end of said second ram connected with the core member near the forward end of the core member,

a rest structure for the forward end portion of said cylinder of the first ram slidably contacting the core member,

a third ram having connections with the outer mid-section and the fly section of the boom,

said rams individually supported and independently operable,

said resilient pivotal connection comprising a cross pin element,

a sleeve on the cross pin element,

ball bearings supporting the opposite ends of the cross pin element,

guide elements having vertical guide slots for said ball bearings,

and cushioning springs above and below the ball bearings in said guide elements,

whereby retraction of said rams allows the fly section to telescope over all of the rams to substantially enclose them.

10. The structure of claim 9 and said cushioning springs secured to top and bottom portions of said guide elements, and friction shoes connected with said springs and slidably contacting the peripheries of said ball bearings and urged yieldingly against the peripheries by said springs.

11. A four-section fully hydraulically operated crane boom comprising

inner and outer mid-sections,

and a fly section all telescopically inter-fitting within a base section,

a first ram having its rod end resiliently pivotally connected with restrained freedom of movement in the vertical direction with the base section and its cylinder connected with the inner mid-section of the boom near the rear ends of the cylinder and inner mid-section,

said cylinder extending substantially forwardly of its point of connection with the inner mid-section,

a second ram having connections with the inner and outer mid-sections,

a third ram having connections with the outer mid-sections and the fly section of the boom,

said rams individually supported and independently operable,

said resilient pivotal connection comprising a cross pin element, a sleeve on the cross pin element,

ball bearings supporting the opposite ends of the cross pin element,

guide elements having vertical guide slots for said ball bearings,

and cushioning springs above and below the ball bearings in said guide elements,

whereby retraction of said rams allows the fly section to telescope over all of the rams to substantially enclose them.

12. A crane boom as set forth in claim 11 and said cushioning springs secured to top and bottom portions of said guide elements, and friction shoes connected with said springs and slidably contacting the peripheries of said ball bearings and urged yieldingly against the peripheries by said springs.

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