Dec. 21, 1965 D. E. YADON ETAL 3,224,608

EARTH WORKING AND MATERIALS HANDLING MACHINE

Filed Jan. 15, 1963 10 Sheets-Sheet 1

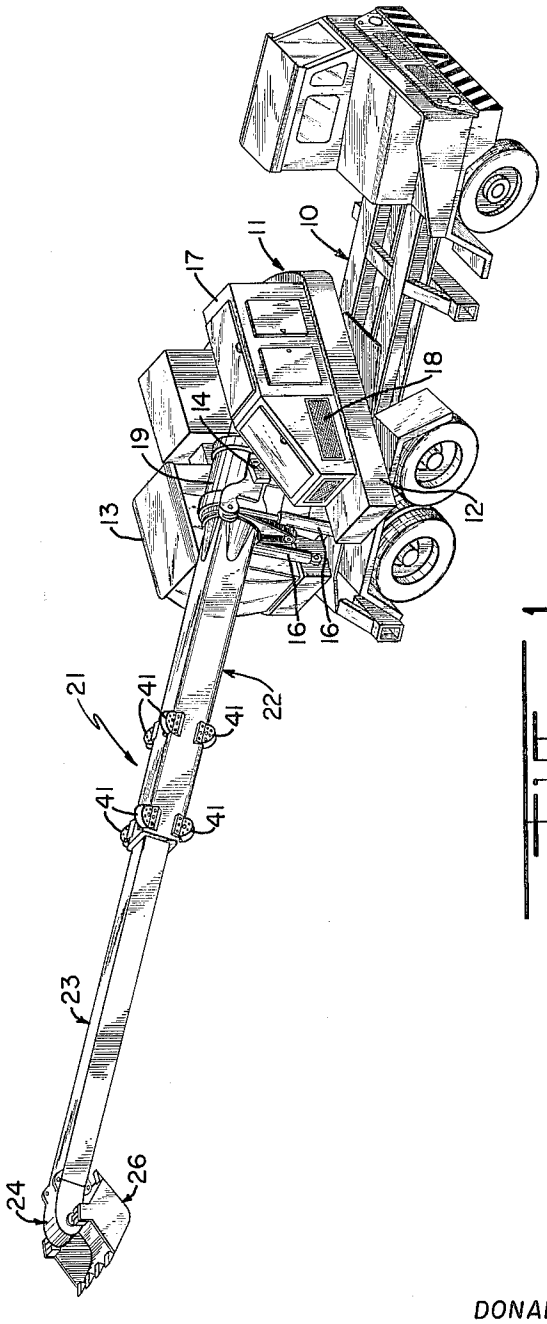


FIG. 1

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EARTH WORKING AND MATERIALS HANDLING MACHINE

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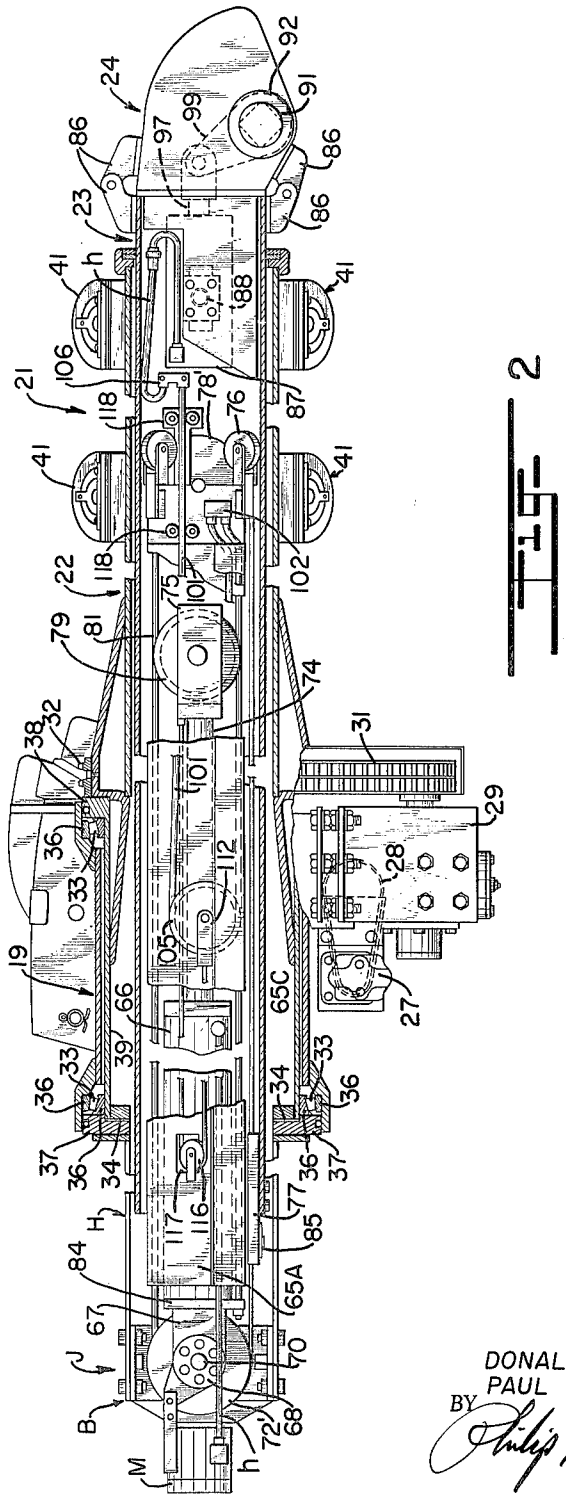


FIG. 2

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EARTH WORKING AND MATERIALS HANDLING MACHINE

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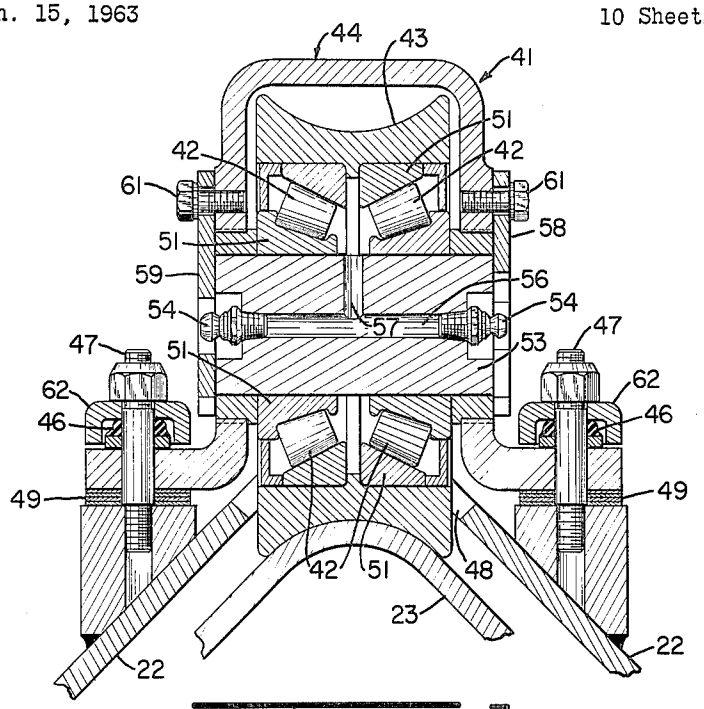


FIG 3

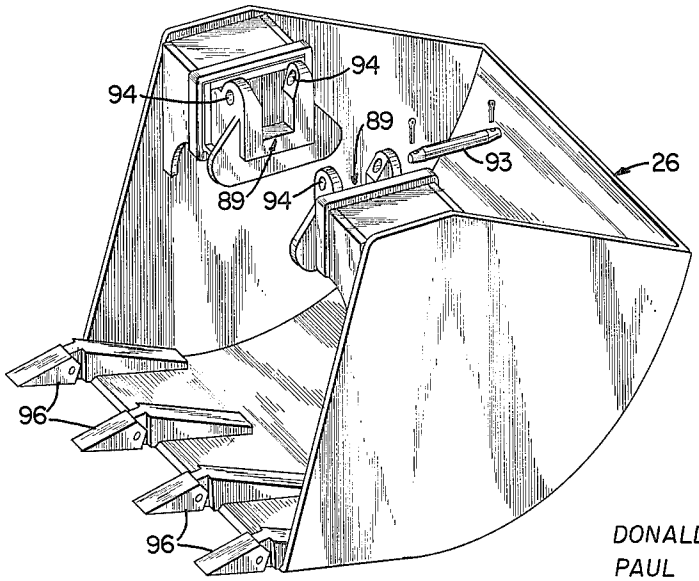


FIG 10

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EARTH WORKING AND MATERIALS HANDLING MACHINE

Filed Jan. 15, 1963 10 Sheets-Sheet 4

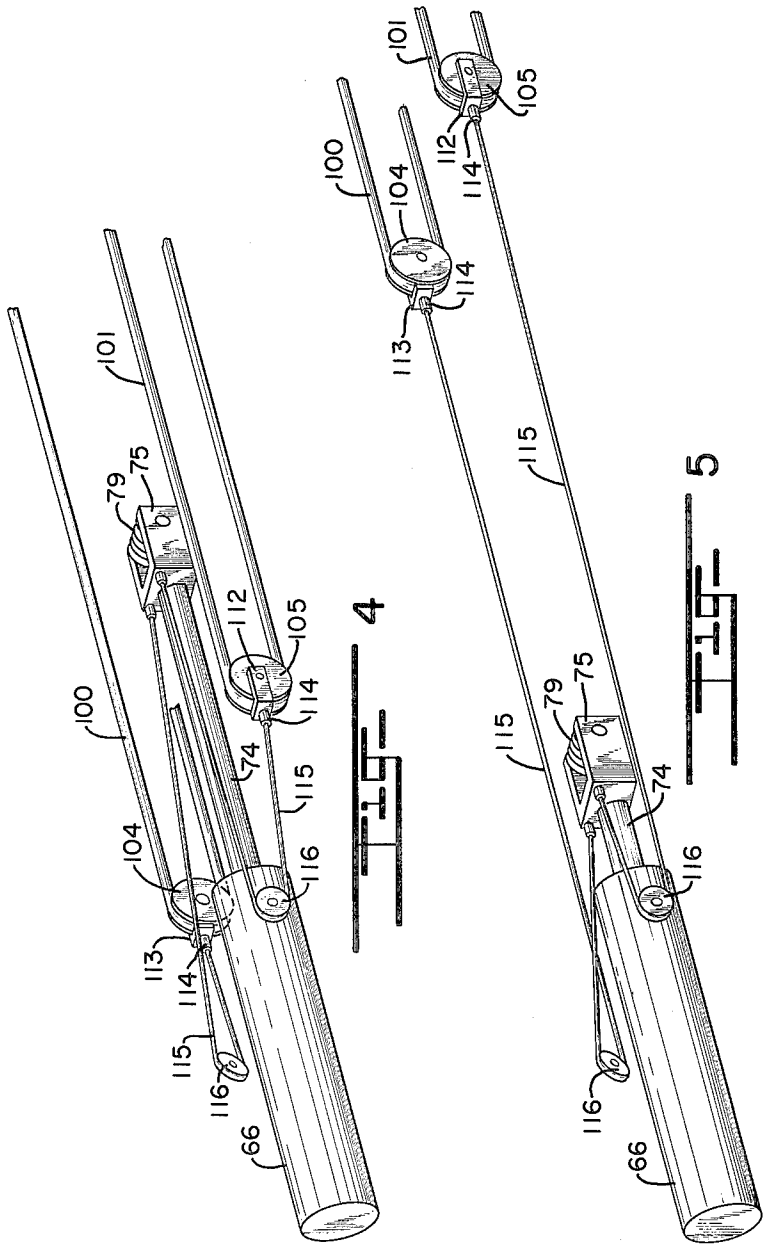


FIG. 4

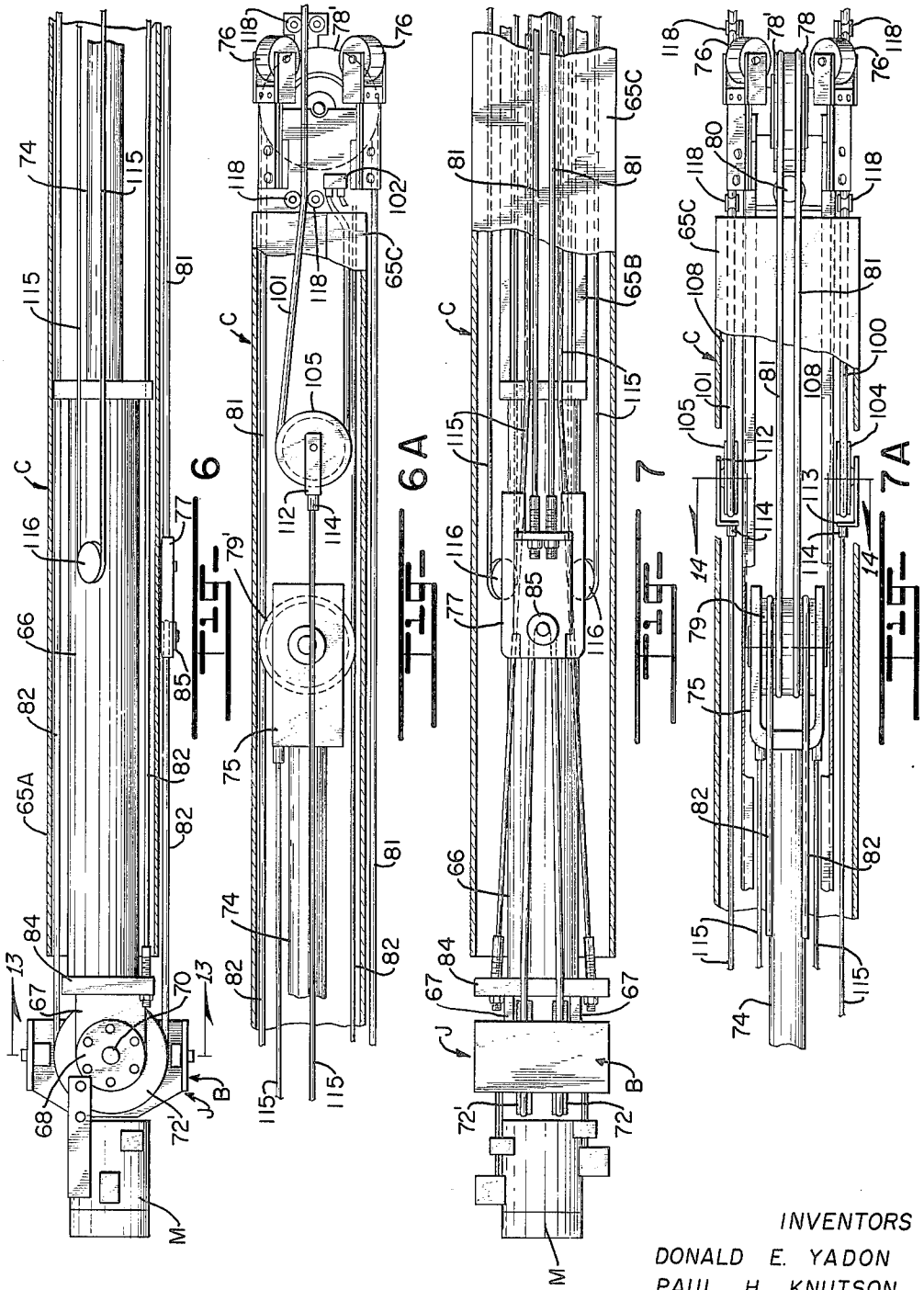
FIG. 5

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EARTH WORKING AND MATERIALS HANDLING MACHINE

Filed Jan. 15, 1963 10 Sheets-Sheet 5



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EARTH WORKING AND MATERIALS HANDLING MACHINE

Filed Jan. 15, 1963 10 Sheets-Sheet 6

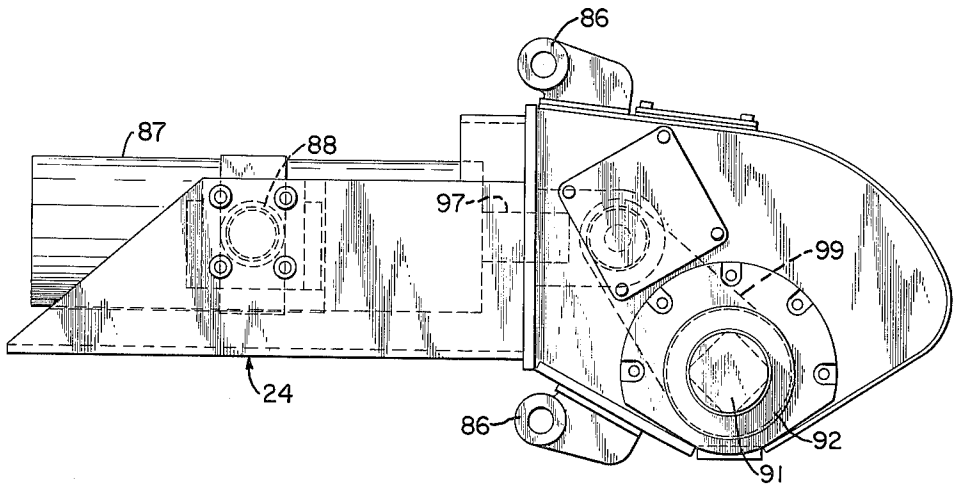


FIG. 8

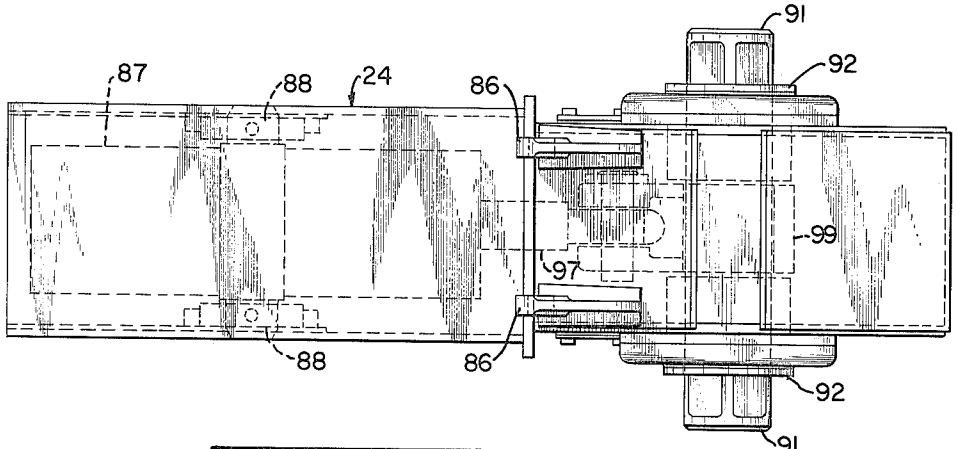


FIG. 9

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EARTH WORKING AND MATERIALS HANDLING MACHINE

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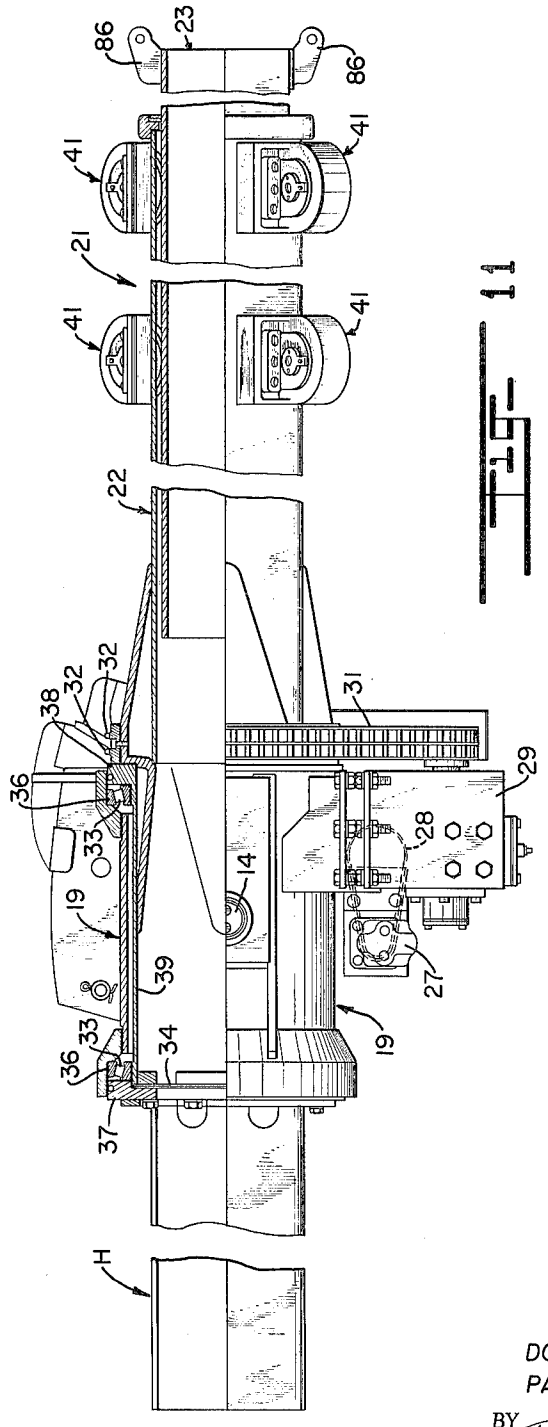


FIG. 11

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EARTH WORKING AND MATERIALS HANDLING MACHINE

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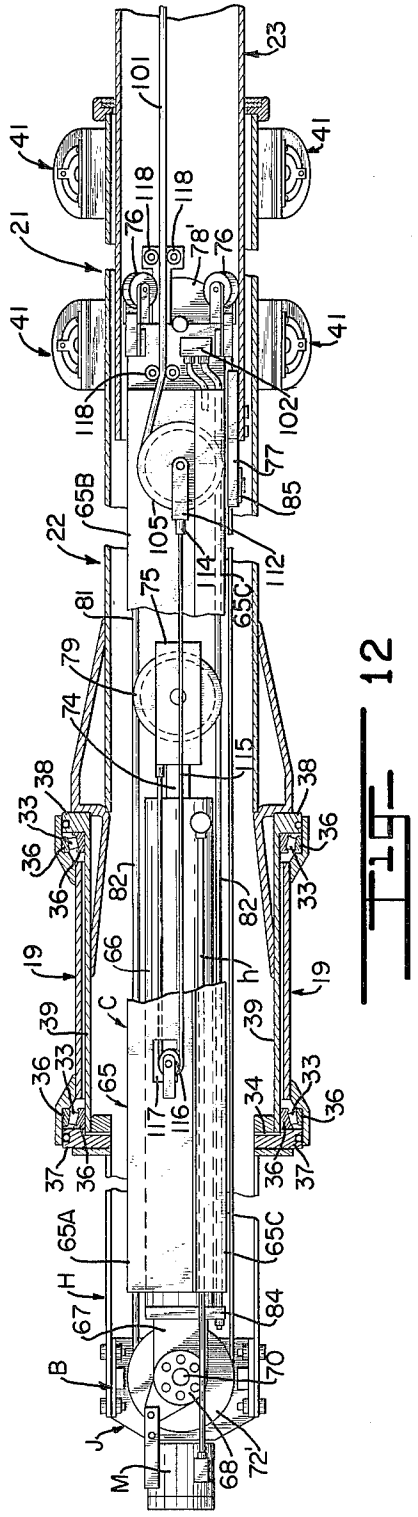


FIG. 12

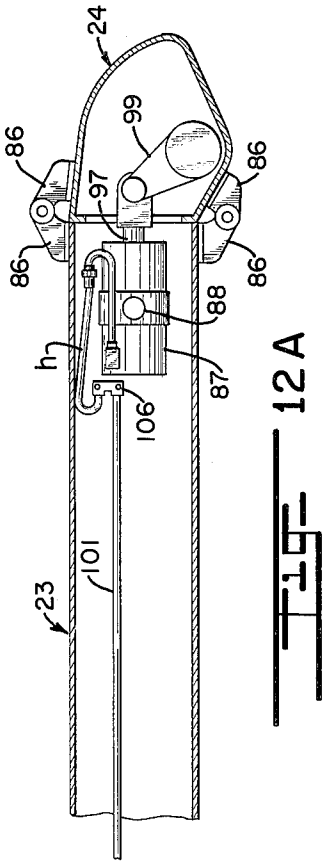


FIG. 12A

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EARTH WORKING AND MATERIALS HANDLING MACHINE

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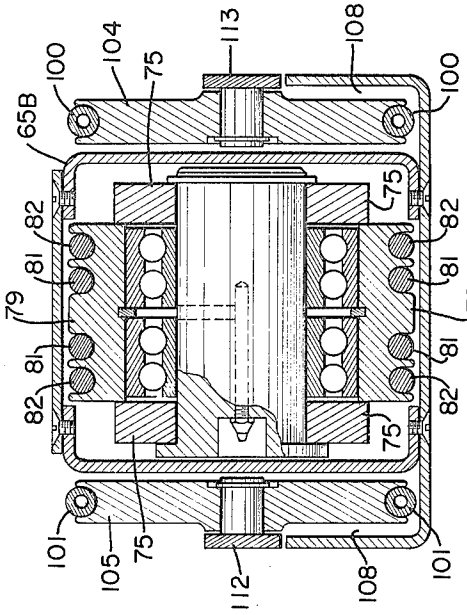


FIG. 14

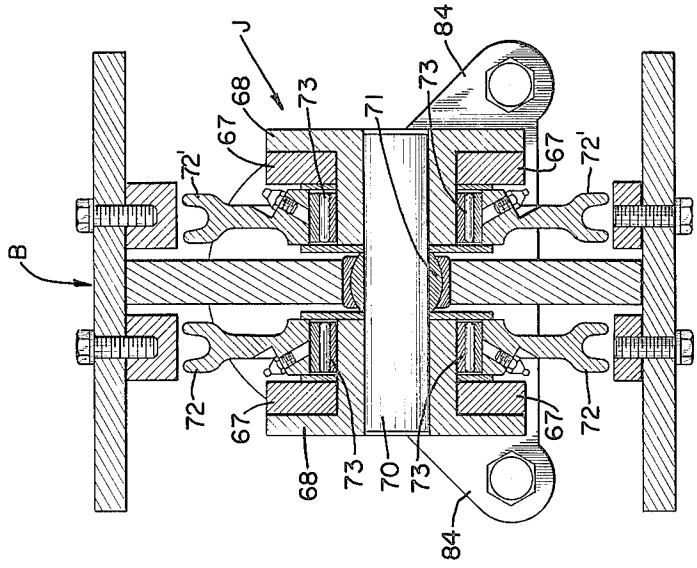


FIG. 13

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EARTH WORKING AND MATERIALS HANDLING MACHINE

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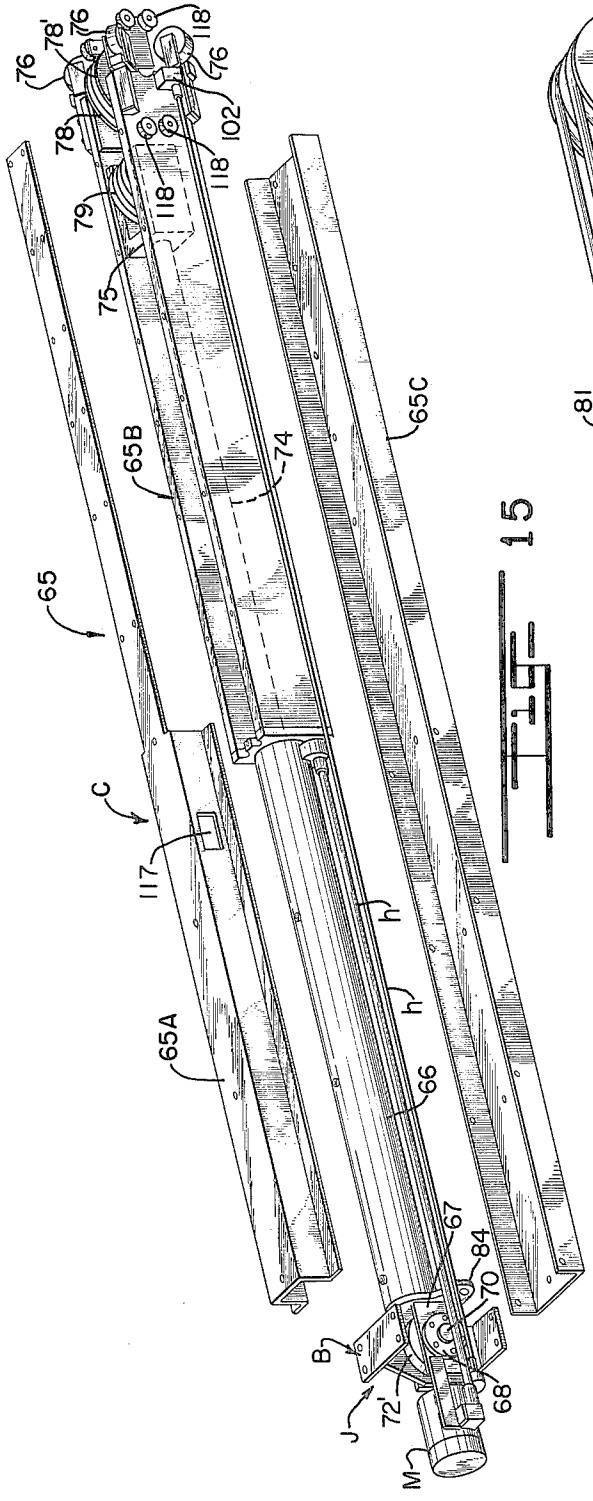


FIG. 15

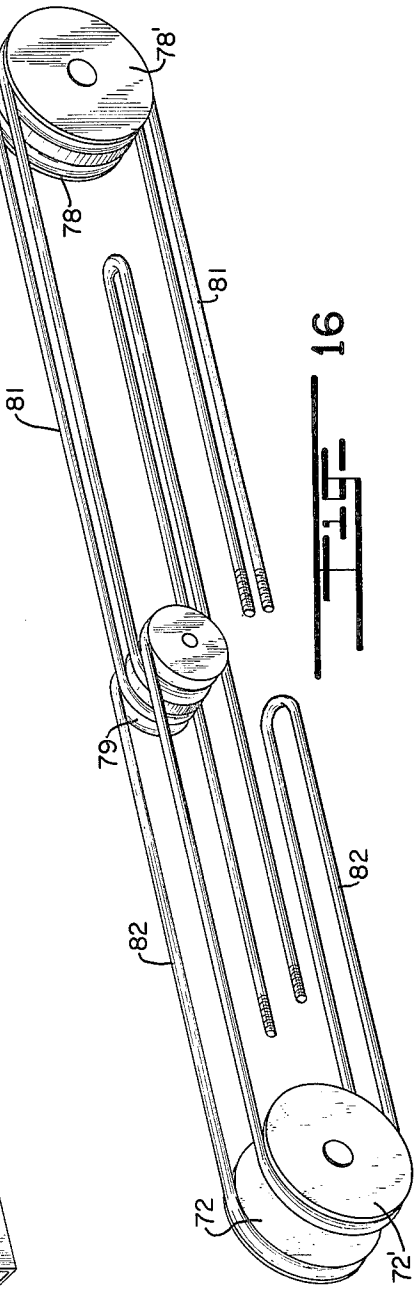


FIG. 16

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United States Patent Office 3,224,608 Patented Dec. 21, 1965

3,224,608

EARTH WORKING AND MATERIALS HANDLING MACHINE

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Filed Jan. 15, 1963, Ser. No. 251,525
7 Claims. (Cl. 214—141)

This invention relates to an improved telescopic boom assembly for multi-purpose earth working and materials handling machines of the type requiring efficient and vesatile boom movement and the mounting of various earth working and materials handling tools or attachments. More particularly, the improved telescopic boom assembly includes, to accomplish said efficiency and versatility, novel boom cartridge means, boom bearing means for the telescopic action, and a combined tool head and tool actuating means of special design.

Among the disadvantages experienced by prior art machines of this type are lack of efficiency and versatility in the boom assembly and the movement mechanism thereby. The mechanisms employed for these purposes are complex, prone to develop mechanical diffculties and defects and unduly cumbersome. Also, they require a considerable amount of servicing and repair. Operators have difficulty in learning to efficiently operate and use such prior art telescopic boom assemblies for the various and sundry jobs encountered by them. Still further, prior art telescopic boom assemblies have been cumbersome with respect to the tool head and tool actuating means.

Accordingly, it is an important object of this invention to provide a highly efficient and versatile telescopic boom assembly for an earth working and materials handling machine.

Another object of this invention is to provide an efficient, compact and versatile boom cartridge means forming a part of the telescopic boom assembly for causing telescopic action of the boom in such machines.

A still further object of this invention is to provide improved bearing means for the telescoping portion or section of the boom of said telescopic boom assembly.

Yet another object is to provide as a part of said improved telescopic boom assembly a combined tool head and tool actuating assembly which is relatively simple in construction, composed of a minimum of parts and with extreme versatility for accommodating numerous tools.

Finally, it is an object of this invention to provide a telescopic boom assembly of the type defined including novel boom cartridge means, boom bearing means and a tool head and tool actuating means which is constructed for easy maintenance and servicing and which will afford prolonged periods of trouble free, heavy duty use.

Additional objects of this invention will become apparent from the following description, which as given primarily for purposes of illustration, and not limitation.

Stated in general terms, the objects of this invention are attained by providing an improved telescopic boom assembly for a multi-purpose earth working and materials handling machine, of the type shown in FIGURE 1, which includes the following well-known major parts or assemblies. A mobile base or carrier **10** is employed which is powerful, of heavy duty construction, and capable of providing maximum, balanced performance. Mobile base **10** can be any type of carrier suitable for the terrain upon which it is to operate and the conditions under which the machine is to do its work. The mobile base **10**, instead of being the conventional form of wheeled, self-propelled vehicle shown, can be a track-type self-propelled vehicle, or it can be any other suitable type, such as made in the

form of a skid, ski mounted, a wheeled trailer, a track-type trailer, or any other suitable mobile base or carrier.

A revolving superstructure **11** is mounted upon the mobile base **10**. It includes a platform **12**, which can be revolved continuously, with the aid of power-driven turntable arrangement, through a complete revolution or 360 degrees, in either direction, about a vertical axis passing through the mobile base **10**. This permits picking up a load and dropping a load, respectively, at any points on a circle. The platform **12** supports the operator's cab **13**, boom cradle mounting trunnion **14**, boom cradle elevating cylinders **16**, engine **17** shown enclosed in a housing, pumps **18** shown enclosed in a cover, a control system operated from within operator's cab **13** and related auxiliary parts.

The boom cradle **19** is a framework which is pivotally mounted to pivot vertically about the axis of trunnion **14**. Its angular position with respect to its vertical axis of revolution is variable by means of the two boom cradle elevating cylinders **16**. The boom cradle **19** contains two coaxial bearings, described in detail below, which serve to support the telescopic boom assembly **21**. The two coaxial bearings also permit continuous rotation of the boom assembly **21** about its own longitudinal axis. This is accomplished with the aid of a driving mechanism mounted in the boom cradle **19** which serves to rotate the improved boom assembly **21** in either the clockwise or counterclockwise direction.

As to the improvements of this invention, such relates to the telescopic boom assembly generally represented at **21** and in particular the novel boom cartridge means C thereof, the bearing assembly means **41** thereof for the telescopic sections **22** and **23**, and the combined tool head and tool actuating assembly **24** thereof. As will be apparent, various tools or attachments, such as bucket **26**, can be fitted to tool head **24** at the end of boom section **23** to accomplish various specific types of digging, grading, materials handling, and other functions. These are operated through a remote control system by an operator located inside operator's cab **13**.

A more detailed description of specific embodiments of the invention are given below with reference to the appended drawings, wherein like numerals are used throughout and wherein;

FIGURE 1 is a perspective view of an earth working and materials handling machine incorporating an embodiment of the telescopic boom assembly of this invention;

FIGURE 2 is a side elevational view, partly in longitudinal section, showing the telescopic boom assembly in retracted position and including many of the details of the power cartridge means;

FIGURE 3 is a side elevational view showing details of the boom bearing means;

FIGURE 4 is an isometric, partial, schematic view showing the boom hydraulic cylinder and location of some of the mechanical linkage thereof as in the case when extensible boom section **23** is retracted;

FIGURE 5 is a view similar to that of FIGURE 4 but showing the location of parts when extensible boom section **23** is extended;

FIGURES 6 and 6*a* are side elevational views showing boom power cartridge assembly C;

FIGURES 7 and 7*a* are plan views showing the assembly C of FIGURES 6 and 6*a*;

FIGURE 8 is a side elevational view showing tool head assembly **24**;

FIGURE 9 is a plan view of the assembly of FIGURE 8;

FIGURE 10 is an isometric view showing a trenching bucket;

FIGURE 11 is a side elevational view illustrating, partially in longitudinal section, the boom assembly **21** and particularly the rotative drive means therefor;

FIGURES 12 and 12*a* are side elevational views, partly in longitudinal section, showing the telescopic boom assembly in extended position;

FIGURE 13 is a sectional view taken along the lines **13—13** of FIGURE 6;

FIGURE 14 is a sectional view taken along the lines **14—14** of FIGURE 7*a*;

FIGURE 15 is an exploded view of the boom power cartridge means; and

FIGURE 16 is a schematic view of a portion of the cabling system of the cartridge means.

The novel features of this invention, as emphasized, reside in the boom assembly and particularly the boom cartridge means thereof, the bearing means thereof between boom sections **22** and **23** and the combined tool head and actuating means, these specific elements being generally represented at C, **41** and **24**. The advantages of such elements as a part of the boom assembly will become apparent from the following detailed description, it being understood that such represent specific embodiments thereof and of course the invention is only to be limited in accordance with the scope of the appended claims.

As shown in FIGURES 1, 2, 11 and 12, the boom base section **22** is mounted for continuous rotation in either direction in the boom cradle **19**. This is accomplished by known means of a hydraulic or electric powered motor **27** mounted on boom cradle **19** and interconnected with base section **22** of the boom assembly **21** by drive chain **28**, a gear train housed in gear box **29** and a boom rotating sprocket chain **31** meshed with sprockets **32** fixed annularly to boom base section **22**. When the operator, through a control in cab **13** actuates motor **27**, boom assembly **21** is rotated continuously either in a clockwise or counterclockwise direction, as desired by the operator.

Coaxial boom rotation thrust bearings **33** are used to facilitate such continuous rotation of boom assembly **21**. Bearings **33** are tapered thrust roller bearings which permit a single adjustment of boom assembly **21** in boom cradle **19**. This single adjustment is made through an adjustable shim means **34** to take care of adjustment of bearings **33** in all directions simultaneously to permit uniform preloading of all of the bearings. Boom base section **22**, as shown in FIGURES 2 and 11, is automatically centered within the bore of boom cradle **19**. In this manner brinnelling of bearings **33** is eliminated and any rattling of the fixed boom base section **22** in boom cradle **19** is prevented. Tapered roller bearings **33** are mounted in bearing cups **36**, which in turn are enclosed by bearing caps **37** and **38**. Thus bearings **33** are mounted within a precision bored cradle **19** and precision machined boom spindle **39**. As shown in FIGURE 1, boom assembly **21** is pivotally mounted with boom cradle **19** in trunnion **14**, in the manner mentioned hereinabove.

The rear end of cradle **19** includes a rearwardly extending hood H, FIGURES 2 and 11, which is secured to cradle **19** by standard means and which supports an I-like support B more clearly shown in FIGURE 13. Extending from the hood H and support B is a manifold M, of conventional construction, for cooperation with hydraulic lines, many of which are not illustrated as such is not believed necessary, throughout the boom power cartridge system to be described. As is clear from FIGURE 2, boom section **22** is fixed with extensible section **23** being arranged, through actuation of the boom power cartridge C, for movement relative thereto from the fully retracted position of FIGURE 2 to the fully extended position of FIGURE 12 and, of course, intermediate positions.

Extensible section **23** of boom assembly **21** telescopes in and relative to base section **22** on eight boom extension roller bearings **41**, as shown in FIGURES 1, 2, 3, 11 and 12, it being noted that the periphery of tubular section **23** is spaced from the interior of fixed section **22** a suitable amount. Boom roller bearings **41**, heretofore referred

to as the boom bearing means and constituting one of the features of this invention, facilitate this telescopic action. Each boom roller bearing assembly **41**, as best shown in FIGURE 3 consists primarily of two steep angle tapered roller bearings **42** made into a single assembly to thrust toward each other. The outside diameter of hardened roller or race **43** is grooved to a radius of curvature corresponding to the radius of curvature of the four corners of the extensible section **23**. The roller bearings **42** are mounted inside a protective, domed housing **44** which is, in turn, mounted on boom base section **22** with the aid of rubber mounts **46**. Eight bearings **41** are bolted by bolts **47**, to the corners of boom base section **22**, which has cut-outs **48** to allow the tapered roller bearings **42** to extend inside base section **22** and ride on the four corners of extensible boom section **23**.

Bearing assemblies **41** are adjustable to maintain proper preload and to compensate for manufacturing variations of the extensible boom section **23** and for wear of its rounded corners. This adjustment is made by means of shims **49** under rubber mounts **46**. When properly shimmed and torqued down, roller bearings **42**, through races **43**, are in full contact with extensible boom section **23** at the points where the cross-sectional dimensions thereof are the smallest. Rubber mounts **46** eliminate or minimize boom rattle or bounce. As a result of these features, a rolling action rather than a sliding action is provided between sections **22** and **23** of boom **21**. This results in a smoother operation and reduced wear. Also, because of this arrangement, rubber mountings **46** are under heavy compression, but are not fully compressed. For these reasons, roller bearings **42** and races **43** are capable of passing over the inherent irregularities of an unmachined extensible boom section **23** of boom **21**.

Furthermore, hardened rollers or races **43**, because of the preloading of roller bearings **42**, due to the compressed rubber mountings **46**, have a tendency to cold work the rounded corners of extensible boom section **23**. In so doing, races **43** gradually size the unmachined boom section **23** into a perfectly shaped boom. Any irregularities, such as dents, nicks, scratches, etc., caused in the boom section **23** by accidentally striking sharp objects, pass under bearing races **43** without overstressing roller bearings **42**, or their mounting **51**. Resilient rubber mountings **46** permit the boom roller bearings **41** to raise and roll over the irregular surfaces without sticking or jamming the boom section **23**, and the irregular surfaces of the rounded boom corners are automatically reformed back to their proper shape and smoothness.

By virtue of the continual preloading of roller bearings **42**, as described above, boom section **23** is free from annoying rattles and denting caused by a loose boom hammering on its rollers. In addition, boom section **23** is protected by rubber bearing mounts **46**, from any shocks that might occur to it during its rough usage. Roller bearings **42** and races **43** are capable of carrying radial or thrust loads. As a result, boom roller bearing assemblies **41** can carry the full load exerted on the boom assembly **21** regardless of the angle of rotation of the boom, or the direction from which the load is applied to the boom. In addition, the tapered rollers **42** of the boom roller bearing assembly **41**, are capable of being adjusted by bearing adjusting nut **52** to compensate for wear.

In each boom roller bearing means **41**, tapered roller bearings **42** in their mountings **51** and races or rollers **43**, are mounted on a shaft **53**. Shaft **53** is provided with grease fittings **54** communicating with axial grease channel **56** and radial grease channel **57** for lubricating the roller bearings **42**. Shaft **53** is locked in position in the boom roller bearing assembly **41** by shaft locks **58** and **59** retained in position by cap screws **61**. Resilient rubber mountings **46** are protected by caps **62**.

The hydraulic and mechanical linkage for moving extensible boom section **23** in and out relative to base sec-

tion 22 is made in removable cartridge form, as shown in FIGURES 2, 4, 5, 6 and 6*a*, 7 and 7*a*, 12 and 12*a*, 15 and 16. This constitutes one of the most important features of this invention and the boom cartridge generally connoted at C, includes as shown specifically in the exploded view of FIGURE 15, a housing 65 consisting of portions 65A, 65B and 65C. Permanently affixed within housing 65, at the rear thereof, is a cylinder 66 having, as illustrated particularly in FIGURE 13, rearwardly extending spaced tangs 67 that are supported within the members 68 of the rear joint J forming a pivot mounting for the entire cartridge C. More specifically this joint J includes the supporting block B, shaft 70 which cooperates with elements 71 to form a self-aligning bearing mount for the entire cartridge C. Of note is the fact that block B also supports sheaves 72 and 72' of cable mechanism to be described hereafter.

The cylinder 66 hydraulically actuates single ram 74 which, together with the cable mechanism to be described, results in extension and retraction of boom section 23. In FIGURES 2, 4, 6 and 6*a*, the ram 74 is fully extended and this results in fully retracted position of boom section 23. Carried by the foreward end of ram 74 and integral therewith is a yoke 75 which forms a sheave support. As will be apparent, maximum power is developed when boom section 23 is being retracted and maximum speed is developed when boom section 23 is being extended, due to the position of parts as in FIGURES 4 and 5. Extending from cartridge housing 65B are four spaced spring mounted rubber wheels 76 which ride on the interior surface of section 23 to maintain centralization and support of the cartridge C and section 23 relative to each other. Keyed to the cartridge C and connectable to the rear of section 23 as shown in FIGURES 2 and 12 is a "flying" block 77 which actually forms the driven member of the cable mechanism to be described to cause extension and retraction of section 23.

Now with respect to the cable mechanism which operates in conjunction with ram 74, reference is made to FIGURE 16 and of course to FIGURES 2, 6, 6*a*, 7, 7*a*, 12 and 15, and such cable mechanism includes the permanently affixed sheaves 72 and 72' at the rear end of cartridge C and sheaves 78 and 78' permanently supported and secured at the front of cartridge C. Mounted within yoke 75 is sheave 79 and adjacent the front of cartridge C, as shown in FIGURE 7*a*, is a terminal 80 mounted integrally with the cartridge. The schematic of FIGURE 16 illustrates said sheaves and terminal and the cables cooperating therewith. Cable 81 is keyed at each end to flying block 77 and is trained over sheaves 78, 78' and 79 and terminal 80. Cable 82 is keyed at both ends to bracket 84 permanently fixed to the rear of cartridge C, see FIGURE 2, and is trained over sheave 79, fixed sheaves 72 and 72' and a terminal integrally supported by block 77 and represented at 85 as shown specifically in FIGURE 7*a*. The cable mechanism functions, as should be apparent from the mechanism described whereby when the ram is extended, as in FIGURE 2, the block 77 is as in FIGURE 2 with the section 23 being fully retracted and vice versa as in FIGURE 11.

A tool head or tool actuating head assembly 24, another feature shown in FIGURES 2, 8 and 9, is mounted on the outer end of extensible boom section 23, by means of cooperating members 86 of the tool head and section 23. Tool head 24, including hydraulic operating cylinder 87 which is swivelly mounted to head 24 at 88, constitutes a fully enclosed and removable assembly unit which can be removed and replaced by various devices, or tools, for different applications and purposes. Examples of such other tools are an auger, pile driver, tamper, logging tongs, hoist head, scraper blade, pavement ripper, pavement remover, fork, various types of buckets, etc. In addition, tool head 24 can be removed and placed on the outer end of various length boom extensions, thus keeping hydraulic cylinder 87 at the extreme end of boom assembly 21, at all times. Prior art machines of this type keep the hydraulic tool operating cylinder in a fixed position in the boom, and thus require complicated linkages in the boom extension section to transmit the operating cylinder forces to the working tool.

The various working tools, such as trenching bucket 26 shown in FIGURE 10, are coupled to the tool head 24 through square, three-sided sockets 89 on the tool. The tool head 24 has a shaft 91 running through the tool head and extending out from each side thereof. Shaft 91 is linked, as shown, to hydraulic operating cylinder 87 through ram 97 which drives chain 99 connected as shown in dotted lines in FIGURES 8 and 9 to drive shaft 91. The outer extensions of shaft 91 are square with a shoulder 92 on each side of the square cross-section. When the tool head 24 is lowered onto the tool, such as trenching bucket 26, the square cross-sections of the extending portions of shaft 91, on both sides of the tool head 24, slip into the sockets 89. An attaching pin 93 is inserted through aligned eyes 94 to secure the tool by completing the fourth side of the socket 89. The tool head 24 then becomes an integral structural part of the work tool 26. The shoulders 92, next to the square cross-section of the shaft 91, act to prevent any spreading or closing of the work tool 26; that is, the sides of the bucket 26 cannot spread or close up because they are rigidly locked by the cross shaft 91 of the tool head 24.

In addition, the tool head 24 permits the mounting angle of the tool, such as bucket 26, to be varied by merely rotating the shaft 91 through 90° in either direction, and reinserting the shaft into the tool sockets 89. This same feature eliminates any front or rear, side or end, to any tool attachments, or work tools, because they can be attached to the tool head 24 from either side or end; that is, a bucket can be attached to tool head 24 with its teeth 96 pointed toward the machine for back-hoe operation, or in reverse order for front end loading, scooping, or shovel work. Similarly, a scraping or cutting blade can be used in either direction, that is, to pull or to push material. It will be seen that this arrangement provides an extremely rapid, convenient and flexible means for changing and varying work tools.

Reference is now made in particular to FIGURES 2, 4, 5, 14 and 15 with respect to the hydraulic hoses 100 and 101 for driving cylinder-ram 97, only one of these hoses being illustrated in FIGURE 2. Mechanism must be provided for maintaining these hoses taut during movement of the extensible section 23 and yet sufficient hose must be provided to accommodate the movements of section 23. To this end hoses 100 and 101 are connected to manifold 106 affixed to section 23 and then continue through guide and locating rollers 118 to pass over sheaves 104 and 105 respectively (see FIGURE 14) from whence they travel to the manifold 102 integral with cartridge 1, manifold 102 being in fluid relationship with manifold M through conventional means such as necessary hoses *h*.

As previously mentioned, the cartridge C includes a housing 65 formed of sections 65A, 65B and 65C in FIGURE 15 and such coact to form the troughs 108, in FIGURE 14, to accommodate floating sheaves 104 and 105 which are adapted to move in accordance with boom extension as shown in FIGURES 2 and 12. Thus, the hoses 100, 101 and sheaves 104 and 105 and associated parts are all exterior of cartridge housing 65. To accomplish the tautness and movement described, there is provided in connection with each sheave 104 and 105 a bracket 112 and 113 to each of which is fixed the terminal portion of a cable, such as at 114 as shown in FIGURE 5.

The latter cables 114 in turn are trained about pulleys supported by housing section 65A, one of which is shown in FIGURES 2, 4 and 5 at 116. Each pulley 116, by means of a window 117 in section 65A is positioned partly within and partly without section 65 whereby from each pulley 116 the cable 114 passes inside of the

cartridge C and the other terminal end thereof is keyed to yoke 75. Since as previously described yoke Y moves with ram 74 it can be appreciated that the taut condition and movement described with respect to hoses 101 and 102 is achieved.

Among the uses for which the machine incorporating this invention is intended are excavation and earth moving operations such as trenching, foundation excavating, backfilling and slope grading; materials handling jobs such as loading, snow removal, precision handling and positioning of liquefied gas containers and containers of radioactive materials; and miscellaneous tasks such as fire fighting, rescue work, construction work and maintenance work, among others. The movements of the machine and its components or parts are controlled hydraulically through suitable control levers located in the operator's cab 13. A single aircraft type stick multiple control arrangement can be used, if desired.

From the foregoing, it should be clear that the objects of this invention are achieved and that there is provided an improved telescopic boom assembly including the features emphasized, namely a removable cartridge having the efficiency and versatility mentioned, improved bearing means for the sections of the boom and a combined tool head and tool actuating structure having the advantages outlined. Obviously, with respect to the novel features herein, structural modifications and variations thereof are possible in light of the specific teachings given hereinabove. As stated, therefore, it is to be understood that, within the scope of the appended claims, the invention can be practiced otherwise than as specifically described.

What is claimed is:

1. In a telescopic boom assembly including an outer section having rearward and forward ends and an extensible inner section telescopically movable relative thereto for extension and retraction through the forward end of said outer section, a removable elongated cartridge positioned within said sections with one end secured to the rearward end of said outer section against longitudinal movement relative to said outer section and with the other end free with respect to said boom sections, said cartridge including means for causing said relative movement of said sections, a combined tool head and tool actuating means carried by one end of said movable section for releasably engaging tools and attachments and bearing means cooperatively associated with said sections for facilitating telescopic movement of said sections relative to each other.

2. A combined tool head and tool actuating means for a telescopic boom assembly including a longitudinally fixed section and an extensible section telescopically movable relative thereto, said combined means being mounted on the outermost end of the extensible section and comprising a housing having a rearwardly extending portion slidably received within the outermost end of said extensible section, mounting means carried by said housing outwardly of the outermost end of said extensible section for releasably connecting said housing to the outer face of said extensible section, a hydraulic cylinder and ram within the housing, means to actuate said ram, and rotatably mounted shaft means within the housing linked to said ram such that movement of said ram rotates said shaft, said shaft having portions extending exterior of said housing at its forward exposed end for releasably engaging work tools and attachments.

3. Apparatus as defined in claim 2 wherein said cylinder is swivelly mounted within the housing.

4. In a telescopic boom assembly according to claim 1 wherein said means for causing the relative movement of said boom sections includes a hydraulic power cylinder and ram assembly mounted within said cartridge and cable means connecting the free end of said ram to the rearward end of said inner boom section.

5. In a telescopic boom assembly according to claim 4 wherein said hydraulic cylinder is pivotally mounted adjacent the rearward end of said outer boom section.

6. In a telescopic boom assembly according to claim 5 further including means carried by the free end of said cartridge and slidably engageable with said extensible section for supporting and centralizing the cartridge with respect to said extensible section.

7. A telescopic boom assembly comprising a cradle, an outer boom section having rearward and forward ends mounted within said cradle against movement along the longitudinal axis of said boom and an extensible inner boom section having rearward and forward ends slidably received within said outer section for movement from a retracted position where the rearward end thereof extends behind the rearward end of the outer section to an extended position where the rearward end thereof is positioned within said outer section adjacent its forward end, support means extending rearwardly of said outer boom section, a removable cartridge power unit operatively connected between said inner and outer boom sections for reciprocating said inner boom section between said retracted and extended positions, said cartridge unit including a hydraulic cylinder connected to said support means, a reciprocably mounted piston rod having a free end extending outwardly of said cylinder and into said boom sections and cable means connecting the free end of said piston rod to the rearward end of the inner boom section.

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