

[54] **FIRE FIGHTING APPARATUS**
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 [22] Filed: **Oct. 12, 1970**
 [21] Appl. No.: **79,974**

[52] U.S. Cl. **169/24, 169/25, 239/587**
 [51] Int. Cl. **A62c 27/00**
 [58] Field of Search 169/24, 25; 239/160, 239/166, 587 X; 212/55; 52/115, 117, 118; 95/86; 285/190

[56] **References Cited**

UNITED STATES PATENTS			
3,243,123	3/1966	Inghram et al.	169/24 X
3,212,604	10/1965	Garnett	169/24 X
3,599,722	8/1971	Davidson	169/24
629,493	7/1899	Chazotte	169/25
3,585,903	6/1971	Parrett	212/55 X
2,173,095	9/1939	Byrne	52/115 X
2,729,295	1/1956	Edwards	169/25
3,346,052	10/1967	Moore et al.	169/25
1,562,669	11/1925	Weber	285/190

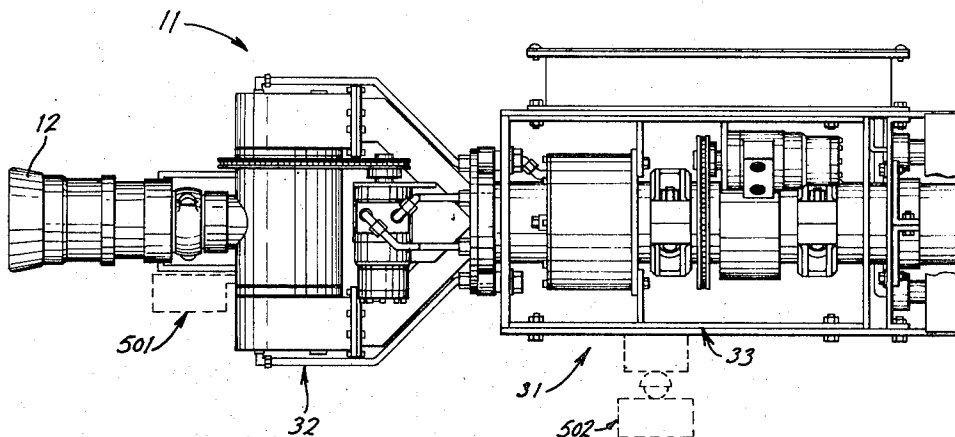
3,399,614 9/1968 Fischer 95/86
 2,834,416 5/1958 Becker 169/25
 3,101,175 8/1963 Brown 239/150

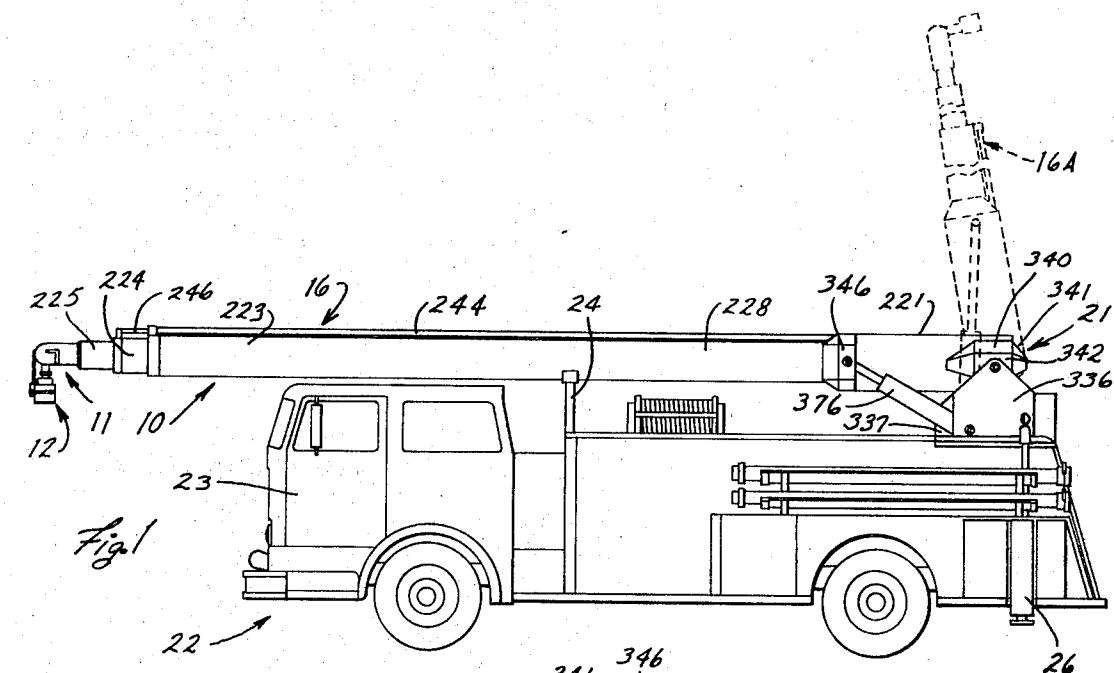
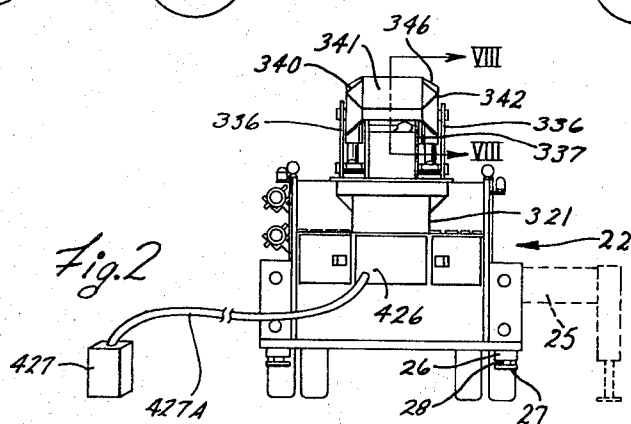
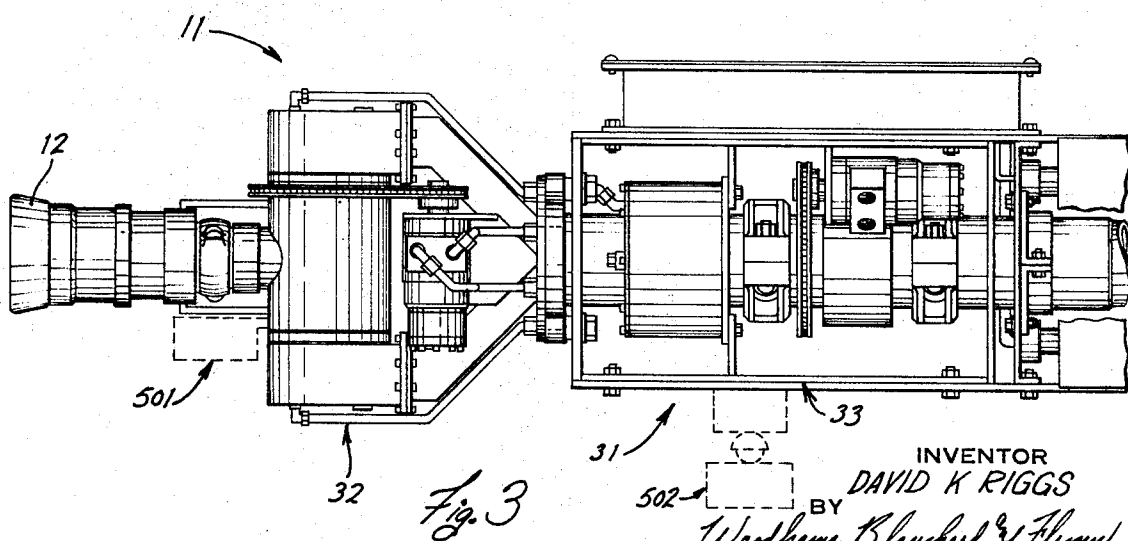
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[57] **ABSTRACT**

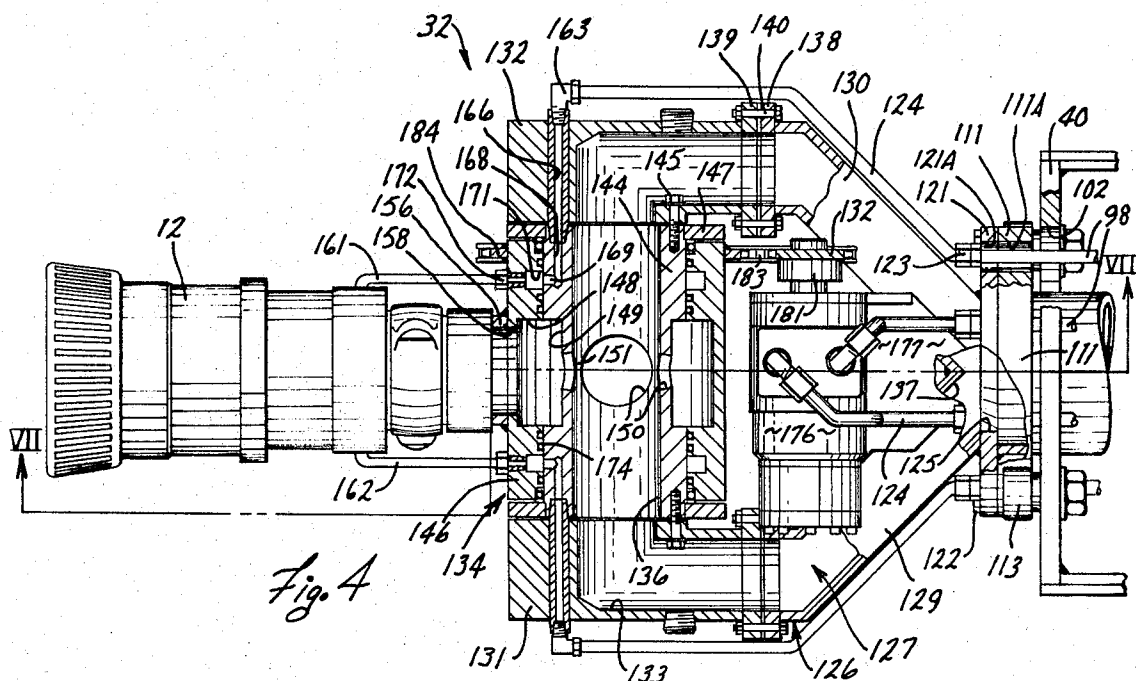
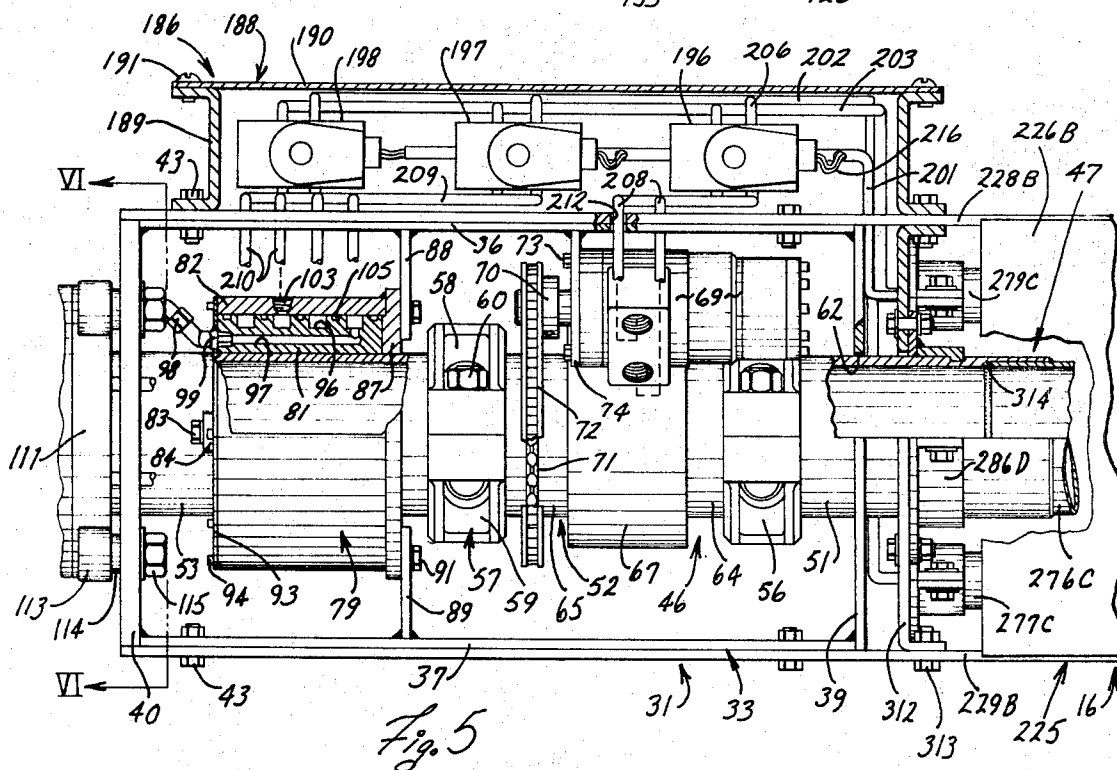
Apparatus adapted for fire fighting including a monitor unit for supporting a nozzle for continuous rotation in one plane and for pivotal motion through a wide arc in a further plane. Remotely electrically controlled hydraulic valves control such pivoting and rotation of the nozzle as well as the output stream pattern of the nozzle. A multisection telescoping boom supports the monitor unit at its upper end and contains telescoping slip tubes for delivering fire fighting fluid through the monitor unit to the nozzle as well as hydraulic and electrical lines for energizing and controlling the functions of the monitor unit. The boom is supportable on a truck for continuous rotation in one plane and for pivotal movement through a wide arc in a further plane, a pivoting joint being provided for allowing water flow to the boom at the pivot axis of the boom.

25 Claims, 18 Drawing Figures





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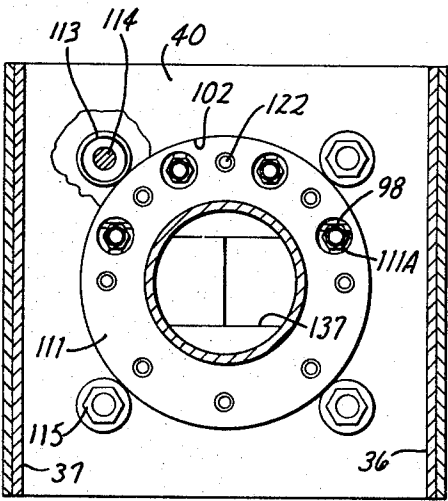


Fig. 6

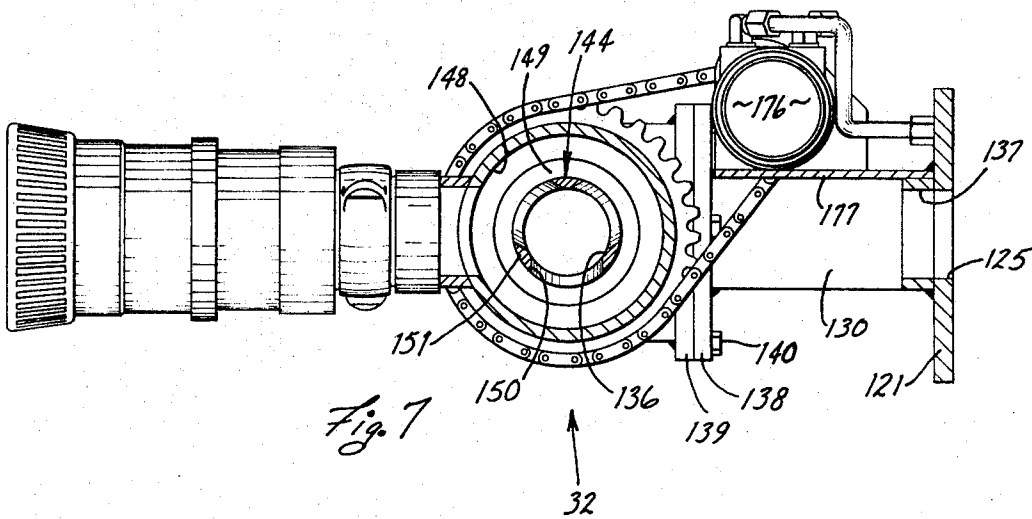


Fig. 7

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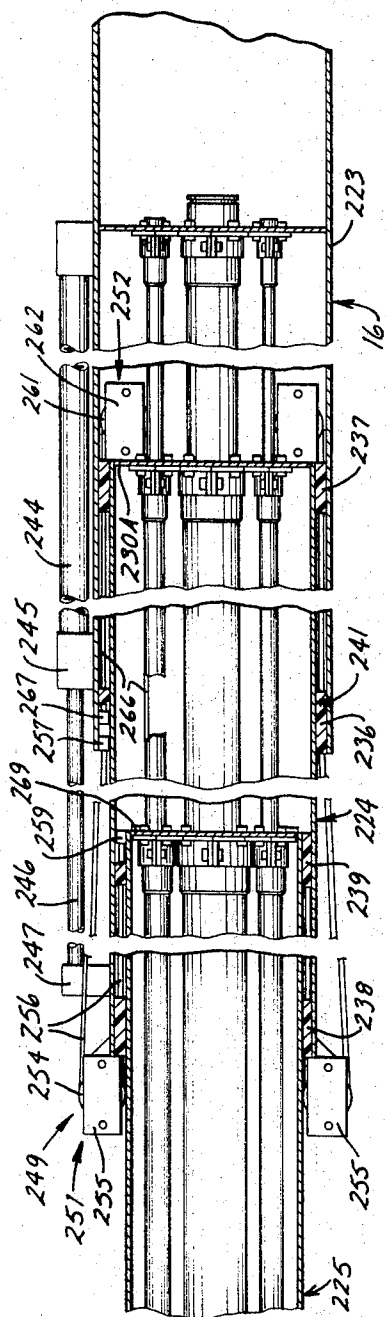


Fig. 8

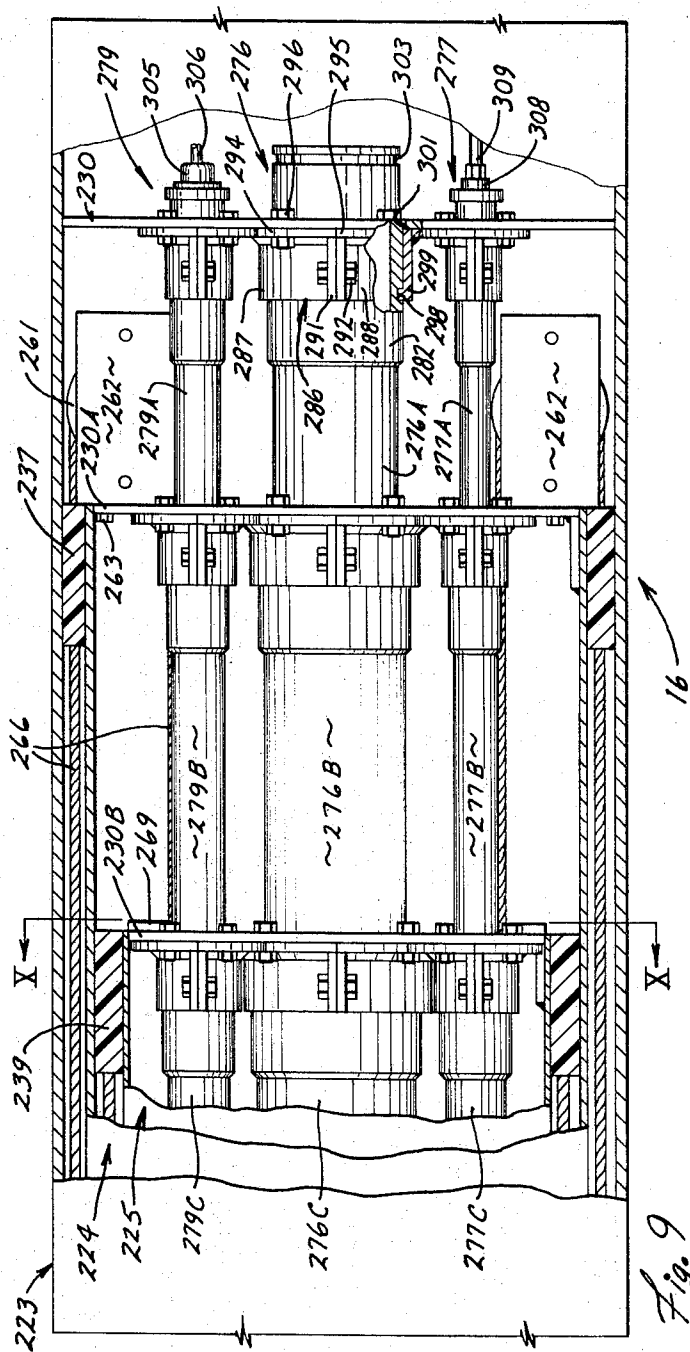
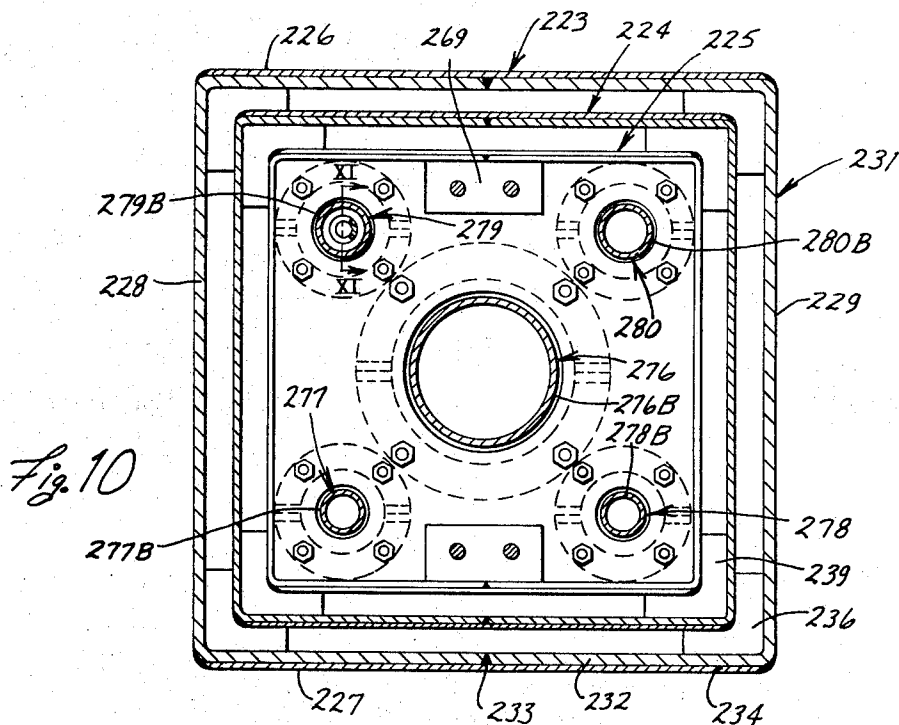
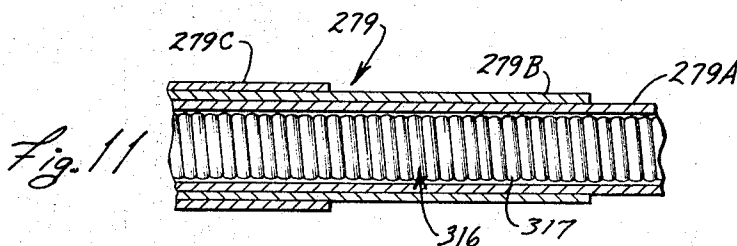
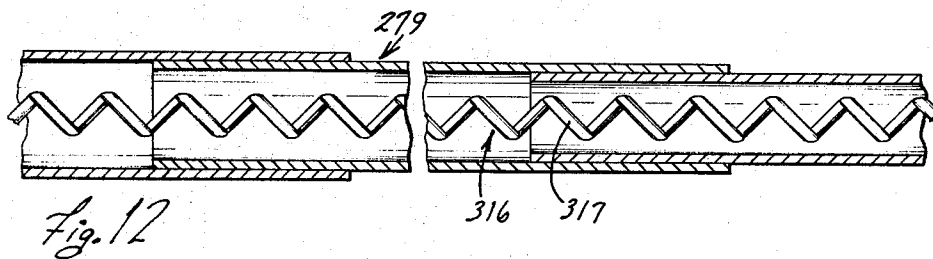
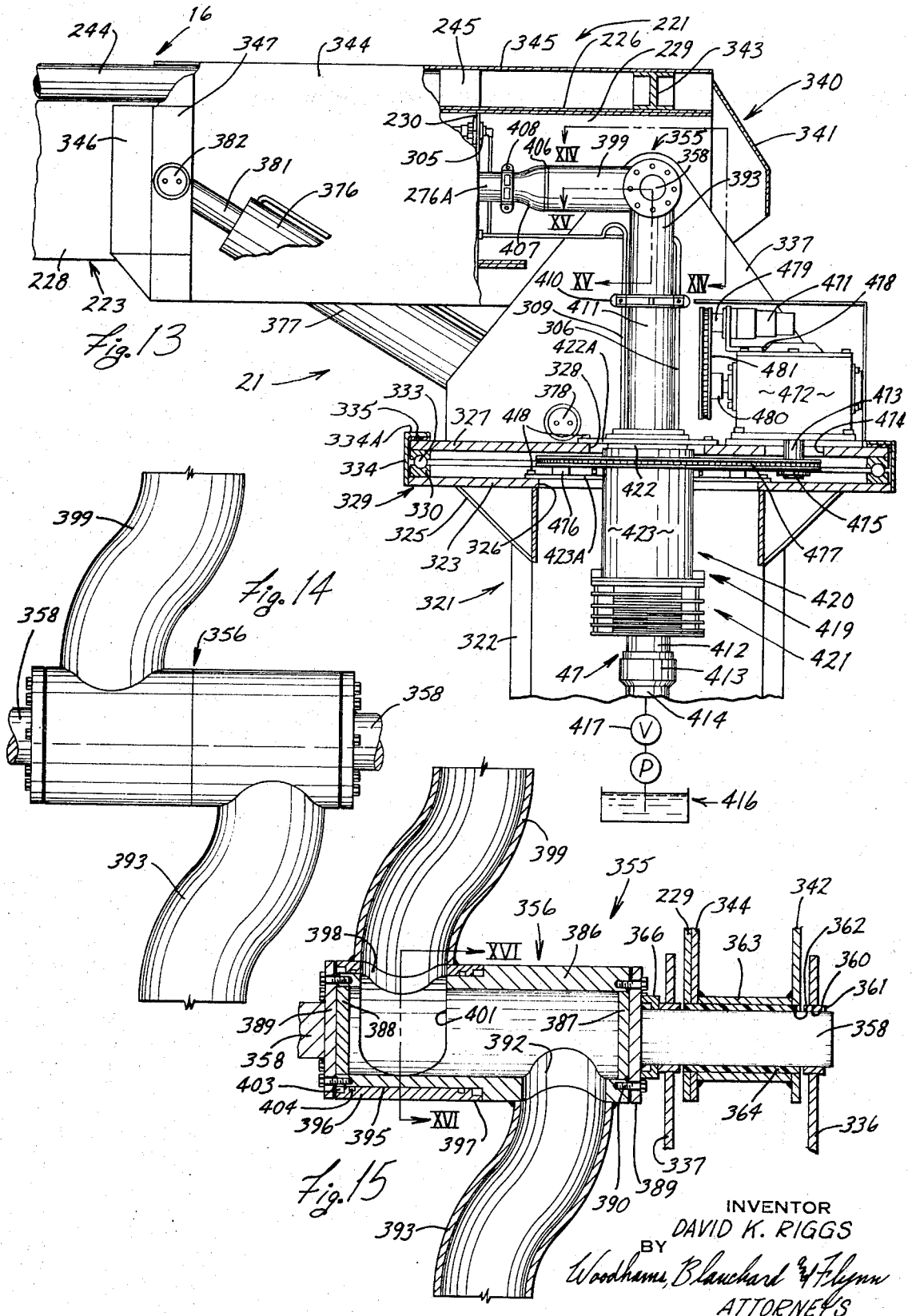


Fig. 9

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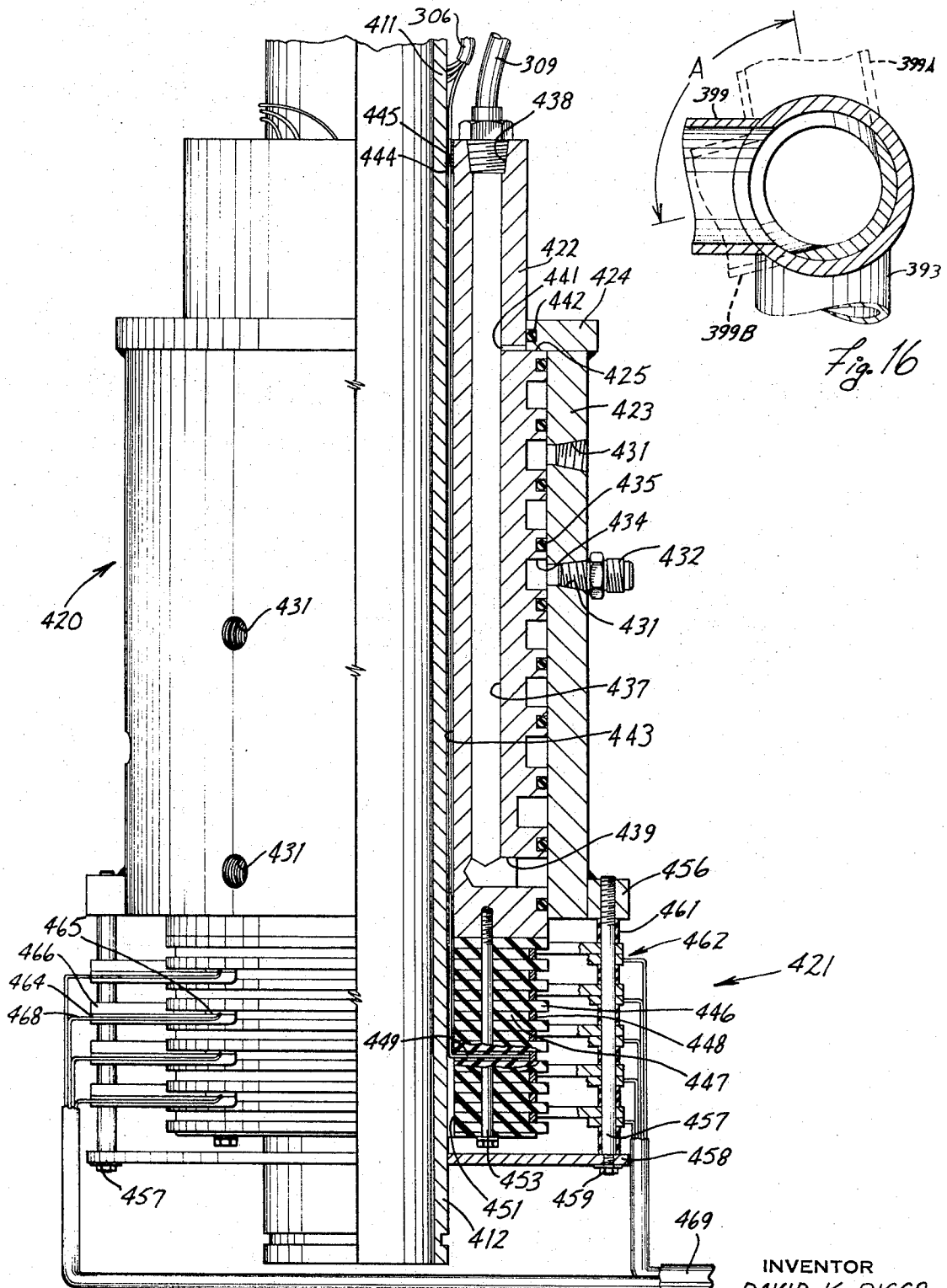
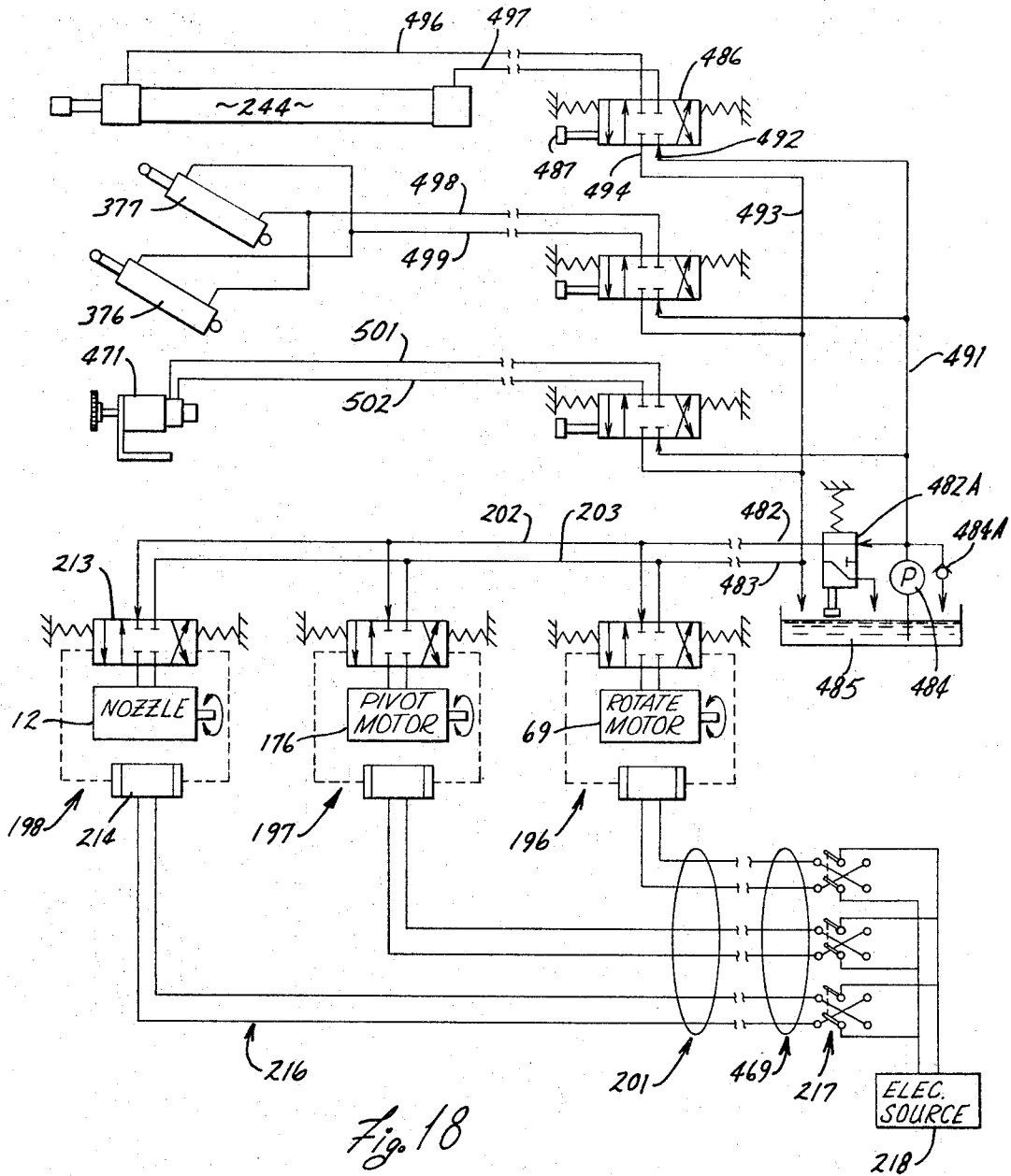


Fig. 17

Fig. 16

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FIRE FIGHTING APPARATUS

FIELD OF THE INVENTION

This invention relates to an apparatus adapted for fire fighting and more particularly relates to a telescopically extensible fluid supply boom or tower pivotally and rotatably mountable on a support such as a fire truck of the pumper type and a remotely controllable monitor unit mountable at the upper end of the boom which is capable of supporting a nozzle for continuous rotation in one plane and pivotal motion through a wide arc in a further plane.

A need has long existed for means for getting a fire fighting fluid to a fire in tall structures such as buildings, storage tanks, and so forth, or at locations wherein the fluid source, such as a conventional pumper truck or a man carrying a fire hose, cannot be brought within sufficiently close striking distance of the fire.

Among the earliest attempts to overcome this problem, particularly in fighting fires near the top of a tall structure, was to utilize a conventional hook and ladder truck having an extendable aerial ladder wherein a fireman would carry the hose to the top of the ladder and then manually operate the nozzle and train the stream of fire fighting liquid on the fire. However, this has proved to be quite unsatisfactory, there being a substantial safety hazard arising from the support of a high pressure fire hose by a single man clinging to the top of an extended aerial ladder, such a hose having a substantial, and often unpredictably variable, reaction force due to the high velocity, large flow stream from the nozzle. Thus, there is a substantial danger that the man will be dislodged from the ladder by the reaction force of the hose. Further, it is most difficult for the man to effectively control the nozzle and direct the stream while supporting the hose and maintaining himself on the ladder.

A variation of the above arrangement is to provide means for clipping the hose to the ladder. However, this still involves a substantial safety hazard in that a location of the top of the ladder and nozzle satisfactory for directing a stream of fire fighting liquid at the fire may subject the man to substantial danger of burns from the fire.

Moreover, the above approaches have not been effective for combating fires due, for example, to the delay in getting the man and hose up and down the ladder and the fact that the necessity for a man on the ladder limits the location of the nozzle with respect to the fire. Although various devices have been suggested over the years for improving on the above arrangements, same have not been entirely successful and as a result many fire departments still utilize the technique of placing a fireman with a hose and nozzle at the top of an aerial ladder for fighting fires in tall structures.

Among past suggestions for eliminating at least some of the objections to the above-mentioned arrangements has been the concept of mounting a nozzle atop a telescoping boom structure. However, past applications of this concept have been relatively crude in conception and have suffered from a number of disadvantages.

For example, it has been common to utilize the force of the fire fighting liquid, usually water, to extend the telescoping boom. In such a construction typically, the boom simply consists of a series of telescoping water conduits terminated at the upper end thereof by a fixed nozzle wherein extension and retraction of the boom is

dependent upon available water pressure and extension and retraction of the boom often cannot be carried out independently of the amount of water flow to the nozzle. Similarly, variation in the water pressure supplied to the nozzle may typically cause an unintended variation in the height of the boom. Moreover, no means are generally provided for control of nozzle spray pattern or orientation with respect to the boom which sharply limits the adaptability of the unit for fighting fires at different locations with respect to the means supporting the boom. Thus, adjustment of nozzle orientation and spray pattern may require retraction and lowering of the boom, causing substantial delays which may result in additional and unnecessary fire damage. Further, no provision has generally been made for transmission of power and control signals from the base of the tower to the nozzle area so as to enable control of the nozzle spray pattern and orientation from the ground or to enable operation and adjustment of further accessory devices atop the boom.

A more recent proposal of the prior art has been to provide means for mounting a nozzle on an articulated boom. However, this has suffered also from a number of disadvantages. For example, the articulation of the boom requires that pivots be provided intermediate the length of the boom, which pivots constitute weak spots in the boom. Generally then, the boom cannot withstand the same bending forces from all radial directions. This limits the useful range of orientation of the nozzle, since a high pressure stream from the nozzle when directed at right angles to the boom generates a substantial reaction force, tending to bend the boom.

Further, the articulated boom has proved difficult to extend when operated in a confined area, substantial room being required to unbend an articulated boom from its folded, rest condition.

Further, the fact that the boom must be unbent provides a substantial logistics problem in placing the nozzle on its desired position, it not being possible to merely aim the boom toward the point at which the nozzle is ultimately to be placed and simply extend the boom, as with a telescoping boom. Thus, a high degree of training for use is required for operators of such articulated booms and even given such training and skill, the high emotional stress on firemen in emergency fire fighting conditions may result in errors delaying proper placement of the nozzle thereby risking increase of fire damage.

In at least one prior art structure of this type the nozzle cannot be rotated 360° due to the tangling of hydraulic and electrical lines associated with the nozzle. Further, any such power and control lines provided to the nozzle area have generally been external to the boom and thus unprotected wherein they may be snagged and damaged, which may put the fire fighting apparatus out of operation or at least delay proper placement of the nozzle.

Moreover, such articulated booms have in the past required articulation of the conduit supplying fire fighting liquid to the nozzle or use of an external flexible hose. In the latter case, the hose may be snagged or damaged resulting in a delay or inoperability of the apparatus. In the former case, articulation of the liquid supply conduits complicates the mechanism, the provision of the large number of liquid pivots being expensive and giving a high opportunity for failure in operation. Further, the provision of a large number of such

pivots as required by a multisection articulated boom results in a quantity of bends or changes in the direction of fluid flow which increases liquid friction and thereby cuts down on liquid flow, reducing the liquid output of the nozzle.

Accordingly, the objects of this invention include provision of:

1. A fire fighting apparatus in which a monitor unit is provided for mounting a fire fighting fluid output device wherein the device may be continuously rotated through more than 360° in one plane and may be pivoted in a further plane substantially at right angles to the first mentioned plane through a relatively large angle approximating 270°.

2. An apparatus as aforesaid, which control devices are provided on the monitor unit for independently effecting such rotation and pivotal motion of the output device.

3. An apparatus as aforesaid, wherein the output device is a nozzle which may be of conventional type and is capable of being controlled to effect change in spray pattern, for example, from straight stream to fog.

4. An apparatus as aforesaid, wherein power and control signals are applied to the aforementioned control devices from a location remote from the monitor unit and wherein the power is hydraulic pressure and the control signals are electrical.

5. An apparatus as aforesaid, in which means for supplying fire fighting liquid power and control signals for the aforementioned control devices terminate at one end of the monitor unit, such end being remote from the nozzle or other output device, the monitor unit including transducers for controlling power flow to motors actuable for carrying out spray pattern changes rotation and pivoting of the nozzle, the transducers being responsive to the control signals, power flow across an interface between relatively movable members being accomplished in a manner that none of the power or control signal lines is subjected to twisting or bending as a result of nozzle pivoting or rotation.

6. An apparatus as aforementioned, in which power and control lines associated with the monitor unit are contained therein and protected from snagging or damage during use of the apparatus.

7. An apparatus as aforesaid, in which the monitor unit is adaptable for mounting accessory devices such as floodlights, television cameras and so forth, for movement with or independently of the nozzle and capable of providing power and control inputs therefor without causing twisting of power or control lines and while extending same through said monitor in enclosed and protected condition.

8. An apparatus as aforementioned, in which the monitor unit is mountable upon a multisection telescoping boom which is extendable and which may be supported for rotation and pivotal movement so as to place the monitor unit and devices such as a nozzle carried thereby in appropriate location for fire fighting and at a substantial distance from the base of the boom.

9. An apparatus as aforesaid, in which conduits for carrying fire fighting fluid, a power medium such as hydraulic fluid, and control signal lines such as electrical cables, is provided within and enclosed by the telescoping boom for protection against snagging and damage thereto, such conduits extending therethrough and terminating at or adjacent the ends of the telescoping boom.

10. An apparatus as aforementioned, in which the conduits are formed as multisection telescoping slip tubes, one group of such slip tubes being disposed within each section of the telescoping boom and being secured therewithin in a manner facilitating simplified and rapid disassembly for purposes of repair or replacement.

11. An apparatus as aforesaid, in which the telescoping slip tubes provided for each function are arranged in order of decreasing diameter within boom sections of increasing diameter whereby the largest diameter slip tube is disposed in the boom section of smallest cross-sectional width for enhancing boom stiffness and enhancing the flow capacity for fire fighting liquid of the boom.

12. An apparatus as aforesaid, in which quick release couplings are used to secure the slip tubes to their respective boom sections to facilitate rapid repair.

13. An apparatus as aforesaid, capable of placing a fire fighting nozzle at a substantial height above the boom base quickly and easily even under crowded conditions wherein movement of the nozzle away from the boom support requires no bending or unfolding of the boom but rather simply an aiming of the axis of the boom at the desired nozzle location and linear extension of the boom along its axis until the nozzle assumes such desired position.

14. An apparatus as aforesaid, in which travel of fire fighting liquid through the length of the boom is at all times linear and involves no bends requiring changes in flow direction which would tend to restrict fluid flow and create torque reactions on the boom.

15. An apparatus as aforesaid, in which a fire fighting nozzle is orientable with 3° of freedom and is variable as to spray pattern from a remote position wherein it is not necessary to provide a man at the location of the nozzle for controlling the orientation or spray pattern thereof, safety hazards are eliminated and more effective use is made of men and equipment in fire fighting.

16. An apparatus, as aforesaid, in which means are provided for mounting the boom for pivotal and rotative movement in two different planes and including a fire fighting fluid pivot arranged for continuous flow of fluid along a single, sinuous path through relatively pivotable parts of a fluid supply conduit system having a pivot axis corresponding to that of the pivotal boom support.

17. An apparatus, as aforesaid, which is readily manufacturable at relatively low cost and which is capable of reliable operation through extended periods of use under adverse conditions and which is readily maintainable by persons with only a general knowledge of an apparatus of this particular type.

Other objects and purposes of this invention will be apparent to persons acquainted with apparatus of this general type upon reading the following specification and inspecting the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a nozzle carrying monitor unit and telescopically extendible boom mounted on a pumper type fire truck.

FIG. 2 is a rear elevational view of the apparatus in FIG. 1.

FIG. 3 is an enlarged top view of the monitor unit of FIG. 1 and a nozzle supported thereby.

FIG. 4 is an enlarged, partially broken view of the leftward portion of FIG. 3.

FIG. 5 is an enlarged, partially broken view of the rightward portion of FIG. 3.

FIG. 6 is a partially broken, cross-sectional view taken along the line VI—VI of FIG. 5.

FIG. 7 is a sectional view substantially as taken along the line VII—VII of FIG. 4.

FIG. 8 is an enlarged sectional view substantially taken along the line VIII—VIII of FIG. 2 with the boom extended.

FIG. 9 is an enlarged, partially broken view of the boom as taken from the side thereof and generally corresponding to FIG. 8 but showing the boom in a substantially retracted condition.

FIG. 10 is a sectional view taken along the line X—X of FIG. 9.

FIG. 11 is an enlarged sectional view substantially as taken along the line XI—XI of FIG. 10 and showing the electrical slip tube in substantially retracted condition.

FIG. 12 is a view similar to FIG. 11 but showing the electrical slip tube and cable therein in an extended condition.

FIG. 13 is a partially broken side view of the boom mounting portion of FIG. 1.

FIG. 14 is an enlarged sectional view taken on the line XIV—XIV of FIG. 13.

FIG. 15 is an enlarged sectional view taken on the line XV—XV of FIG. 13.

FIG. 16 is a sectional view taken on the line XVI—XVI of FIG. 15.

FIG. 17 is an enlarged, partially broken view of a portion of the apparatus of FIG. 13.

FIG. 18 is a schematic diagram of electrical and hydraulic circuitry associated with the present apparatus.

Certain terminology will be used in the following description for convenience in reference only and will not be limiting. The words "upwardly," "downwardly," "rightwardly" and "leftwardly" will designate directions in the drawings to which reference is made. The words "upper" and "lower" will refer to the normally upper and lower ends of the boom when the latter is in an elevated position, such as being the leftward and rightward ends of the boom as shown in FIG. 1. The words "forwardly" and "rearwardly" will refer to the normal and reverse directions of travel of the truck upon which the apparatus embodying the invention may be mounted.

The words "inwardly" and "outwardly" will refer to directions toward and away from, respectively, the geometric center of the apparatus and designated parts thereof. Said terminology will include the words above specifically mentioned, derivatives thereof and words of similar import.

SUMMARY OF THE INVENTION

In general, the objects and purposes of the invention are met by providing an apparatus adapted for fire fighting including a monitor unit for supporting a nozzle for continuous rotation in one plane and for pivotal motion through a wide arc in a further plane. Remotely electrically controlled hydraulic valves control such pivoting and rotation of the nozzle as well as the output stream pattern of the nozzle. A multisection telescoping boom supports the monitor unit at its upper end and contains telescoping tubes for delivering fire fighting liquid to the monitor unit and nozzle as well as hydrau-

lic and electrical lines for energizing and controlling the functions of the monitor unit. The boom is supportable, as on a truck, for continuous rotation in one plane and for pivotal movement through a wide arc in a further plane, a pivoting joint being provided for allowing liquid flow to the boom at the pivot axis of the boom.

DETAILED DESCRIPTION

FIGS. 1 and 2 disclose a preferred embodiment of the invention comprising an apparatus 10. The apparatus 10 includes a monitor unit 11 capable of supporting a nozzle 12 of any conventional type for rotation and pivotal movement as hereinafter described. Although the monitor unit 11 may be supported independently of the remainder of the apparatus 21 hereinafter described, it is preferably supported on the upper (leftward as seen in FIG. 1) end of a multisection, telescoping boom 16. The lower (rightward as seen in FIG. 1) end of the boom 16 is supported for pivotal movement in a vertical plane and continuous rotation in a horizontal plane by a base unit 21.

The base unit 21 may be mounted in a variety of ways, dependent upon the particular use to which the apparatus is intended to be put. For example the base unit 21 may be mounted in a fixed location, for example, on a concrete foundation. The base unit 21 may also be mounted on a portable adapter for quick interchangeability between various vehicles and/or stationary locations or for semi-permanent installation on new or existing vehicles. The base unit 21 is, however, particularly adapted for installation on fire trucks. Thus, in FIG. 1 the base unit 21 is mounted on the pumper truck 22 adjacent the rearward end thereof, the boom extending, when in its rest position, forwardly along the length of the truck and over the cab 23 thereof. A support 24 on the truck supports the boom, when in its rest position, adjacent the midpoint thereof.

Extensible jack legs 26 are mounted on opposite sides of the truck 22 adjacent the base unit 21 on transversely extensible beam elements 25. The jack legs 26 may be of any conventional type, preferably hydraulically operated, and are provided with feet 27 engagable with ground adjacent the truck, upon extension of piston rods 28 thereof, for steadying the truck when the boom is in use.

The monitor unit 11 (FIGS. 3-7) comprises a rotational section 31 and a pivotal section 32, said sections being axially aligned.

The rotational section 31 comprises a substantially rectangular framework 33 having a pair of parallel, platelike sidewalls 36 and 37 normally disposed in a vertical plane and terminated by parallel, platelike endwalls 39 and 40 spaced axially along the monitor unit and fixed to the sidewalls 36 and 37, as by welding. Where the monitor unit 11 is supported atop the boom 16, the framework 33 is preferably supported by extensions of the sideplates, hereinafter described, of the upper section of the boom 16 and is removably secured therebetween as by nut and bolt connections 43. Preferably centrally located within the framework 33 is a conduit assembly 46 which extends axially of the framework 33 between the sidewalls 36 and 37 thereof. The conduit assembly 46 is hollow for passage of fire fighting fluid therethrough. Although a variety of fire fighting fluids may be utilized, a common one is water and for purposes of convenience in reference, the conduit assembly 46 and connecting conduit systems here-

inafter described will also be referred to as and comprise a waterway 47. The conduit assembly 46 comprises three coaxial segments, a lower (rightward as seen in FIG. 5) section 51 a center section 52 and an upper (leftward as seen in FIG. 5) section 53. The center conduit section 52 connects to the lower and upper sections 51 and 53 respectively, by conventional couplings 56 and 57, respectively. The couplings 56 and 57 rigidly connect the conduit sections 51-53 and prevent leakage at such connections. The couplings 56 and 57 are preferably of the split ring type, each having a pair of hemispherical parts 58 and 59 releasably joined by any convenient means such as nut and bolt connections 60. Provision of such couplings facilitates disassembly of the monitor unit for maintenance by allowing removal of the center conduit section 52 transversely from the framework 33 and, thereafter, removal of the lower upper sections 51 and 53.

The lower conduit section 51 extends rightwardly from the coupling 56 loosely through an opening 62 in the lower (rightward) end wall 39 of the framework 33 for connection through portions of the waterway 47 hereinafter described to a suitable source of fire fighting liquid under pressure.

The center section 52 of the conduit assembly 46 comprises two coaxial and relatively rotatable conduit subsections 64 and 65, which respectively connect to the aforementioned couplings 56 and 57. The center conduit section includes a relative rotation coupling 67 of any conventional type for sealingly joining the conduit subsections 64 and 65 for relative rotation. A reversible rotation drive motor 69 has a drive sprocket 70 and a driven sprocket 71 is fixedly secured, as by welding, to the upper (leftward in FIG. 5) conduit subsection 65. A chain 72 connects the driven and drive sprockets 70 and 71. The motor 69 is fixed by any convenient means, such as cap screws 73, to a bracket 74 fixed, as by welding, to the interior face of the framework sidewall 36, the bracket 74 extending inwardly to a point adjacent the relative rotation coupling 67. Although the rotation drive motor 69 may be of any convenient type, such as electric or pneumatic, it is preferred that same be powered by a substantially incompressible fluid, such as conventional hydraulic fluid. Hydraulic power is preferred for the motor 69 and for the other motors associated with the monitor unit hereinafter described, since such power is capable of providing precisely controlled incremental rotation while being free of electrical shock hazards and detrimental effects due to heat of nearby fires which may require special precautions to be avoided when utilizing electrical or pneumatic power. Moreover, suitable hydraulic power is normally available on a conventional fire truck.

The upper (leftward in FIG. 5) conduit section 53 supports a hydraulic relative rotation unit 79 comprising a rotatable, inner annular shell 81 which snugly surrounds the upper conduit section 53 and a fixed, outer annular shell 82 which snugly surrounds the inner shell 81. Both shells are generally cylindrical in configuration and are coaxial with the upper conduit section 53. The inner shell 81 is fixed by screws 83 to lugs 84 welded to the exterior of the upper conduit section 53.

A thrust ring 87 surrounds the upper conduit section 53 and is fixed as by welding to the rightward end of the outer shell 82, the thrust ring 87 extending radially inwardly toward the upper conduit section 53 and bear-

ing against the rightward end of the inner shell 81 in relatively rotatable relation thereto. The thrust ring 87 is supported by plates 88 and 89 extending inwardly from and secured as by welding to the sidewalls 36 and 37 of the framework 33. The thrust ring 87 is releasably secured to the plates 88 and 89 by any convenient means such as cap screws 91. The thrust ring 87 and plates 88 and 89 transfer to the framework 36 rightward axial thrust loads imparted to the upper conduit section 53 by reasons of the weight of the pivotal section 32 of the monitor unit and the nozzle 12 supported thereby and by reason of any rightward axial components of the reactive force generated by fire fighting liquid leaving the nozzle at a high velocity. A keeper ring 93 is affixed to the leftward end of the outer shell 82 by screws 94 and extends radially inwardly in overlapping relation to the inner shell 81 for preventing unintended shifting of the upper conduit section 53 and inner shell 81 leftwardly with respect to the framework.

The hydraulic relative rotation unit allows relative rotation between two sets of communicating hydraulic lines, hereinafter described, the relative rotation occurring at the interface of the inner and outer shells 81 and 82. To this end, the opposed faces of the shells 81 and 82 are preferably polished. Further, the outer circumferential face of the inner shell 81 is provided with a series of axially spaced, annular grooves 96, each communicating with a respective axial passageway, one of which is shown at 97, such passageways opening at the leftward end of the inner shell 81. The leftward end of each of the passageways 97 is coupled to a respective hydraulic conduit 98 through a fitting 99. The upper conduit section 53 and the hydraulic conduits 98 pass leftwardly out of the framework 33 toward the pivotal section 32 of the monitor unit through a central opening 102 (FIG. 4) in the leftward endwall 40 of the framework 33. The opening 102 is of sufficient size as to allow free passage of the hydraulic relative rotation unit including the thrust ring 87 therethrough so as to permit easy disassembly of the monitor unit 11.

The outer shell 82 of the hydraulic relative rotation unit 79 (FIG. 5) is provided with a series of radial through openings, one of which is shown at 103, which are spaced axially along the outer shell 82 in radial opposition to respective ones of the grooves 96. The openings 103 are preferably circumferentially displaced with respect to each other to avoid crowding. The openings 103 communicate with hydraulic conduits hereinafter described which are fixedly located with respect to the framework 33. To prevent leakage along the interface between the inner and outer shells 81 and 82, suitable annular seals 105 of any conventional type are disposed on both sides of each of the grooves 81 for sealingly engaging the outer shell 82.

The leftward end of the upper conduit section 53 is provided with a radial flange 111 (FIGS. 4 and 5). A plurality, here four, of evenly circumferentially spaced rollers 113 are evenly radially spaced from the central axis of the conduit section 53 and flange 111 and bear in rolling relation on the circular peripheral face of the flange 111. The rollers 113 are supported on stub shafts 114 which extend through the endwall 40 of the framework 33 and are secured thereto by nuts 115. Thus, the rollers and flange 111 define a radial thrust bearing for supporting the upper conduit section 53 with respect to the framework 33. The relative rotation coupling 67 and, to a lesser extent, the interface between the inner

and outer shells 81 and 82 act as secondary radial thrust bearings.

The radial flange 111 further serves to couple the portion of the waterway 47 in the rotative section 31 of the monitor unit with corresponding waterway portion in the pivotal section 31 of the monitor unit 11 and also serves to couple hydraulic conduits from the rotative to the pivotal portions of the monitor unit 11, both as hereinafter described in detail.

Turning now to the pivotal section 32 of the monitor unit, same comprises a radial flange 121 (FIGS. 4 and 7) releasably securable to the flange 111 by screws 122. The hydraulic conduits 98 extend through openings 111A and 121A in flanges 111 and 121, respectively, and connect to further hydraulic conduits 124 through conventional fittings 123. The flange 121 has a central opening 125 coaxial with and communicating with the interior of conduit section 53.

The pivotal portion 32 includes a waterway loop 126 comprising an initial, generally V-shaped section 127 defined by divergent conduits 129 and 130. The loop 126 further includes an intermediate section comprising a pair of blocks 131 and 132, each having a substantially L-shaped passage 133 therein, and a center section 134 having a substantially linear passage 136 therein joining the output ends of the passages 133.

The rightward ends of the conduits 129 and 130 are joined to form an input chamber 137 which communicates with the central opening 125 to the flange 121. The conduits 129 and 130 are welded to each other and to the flange 121. The conduits 129 and 130 diverge at about a 90° angle in the present embodiment and are symmetrically located with respect to the axis of the flanges 111 and 121. The leftward end of the conduits 129 and 130 are angled and parallel the axis of the monitor unit. The leftward ends of the divergent conduits 129 and 130 are fixed to the rightward ends of the blocks 131 and 132 by any convenient means, for example, abutting flanges 138 and 139 joined by screws 140. The blocks 131 and 132 and the divergent conduits 129 and 130 thus form a substantially V-shaped yoke, the arms of which are hollow for permitting flow of fire fighting fluid therethrough.

The center section 134 of the loop 126 comprises a cylindrical, tubular member 144, the interior wall of which defines aforementioned passages 136. The cylindrical member 144 is secured to and between the blocks 131 and 132 by any convenient means such as screws 145, a sealed interface being provided between the waterway passages in the tubular member 144 and blocks 131 and 132 by any convenient means (not shown). At least the exterior face of the cylindrical member 144 is circular in cross-section. The cylindrical member 144 is snugly surrounded by an external shell 146 which is pivotable with respect thereto. Spacer rings 147 are provided at each end of the shell 146 to snugly but rotatably locate same between the blocks 131 and 132 and to maintain same preferably axially centered on the tubular member 144.

The cylindrical member 144 and shell 146 are provided with opposed annular grooves 147 and 148, respectively, for defining an annular fluid passage. A plurality, preferably three, of evenly spaced openings 150 in the peripheral wall of the tubular member 144 communicate between the interior passage 136 thereof and the grooves 147 and 148. The openings 150 and grooves 147 and 148 are preferably centered on the

axis of the monitor unit. The openings 150 are separated from each other by relatively narrow wall sections 151 and are sized to provide for maximum fluid flow therethrough.

A relatively short nozzle mounting tube 156 is fixed, preferably by welding, to the peripheral wall of the shell 146 and communicates with the annular chamber defined by the grooves 147 and 148 through an opening 158 in the shell 146. The nozzle mounting tube 156 and opening 158 are preferably centered on the opposed grooves 147 and 148.

The nozzle 12 is releasably connectable to the mounting tube 156 in any conventional manner. The nozzle 12 may be of any conventional type, preferably one capable of variation of spray pattern and more particularly one wherein the spray pattern may be varied by suitable actuation of an internal hydraulic motor (not shown) by hydraulic lines 161 and 162.

For supplying hydraulic fluid to the lines 161 and 162 to the nozzle 12, a pair of the hydraulic lines 124 from the flange 121 are led along and beside the divergent tubes 129 and 130 and blocks 131 and 132 and terminate in suitable fittings 163. The blocks 131 and 132 are each provided with a sleeved passage 166 which extends through said blocks in parallel offset relationship to the outlet portion of the L-shaped passages 133 therein, the sleeve defining the sleeved passages 166 extending into coaxial blind openings 168 in the cylindrical member 144. The blind openings 168 communicate through the peripheral wall of the tubular member 144 by means of holes 169. A pair of annular grooves 171 in the interior wall of the shell 146 communicate with the aforementioned holes 169. The hydraulic lines 161 and 162 to the nozzle 12 communicate through suitable fittings 172 with the grooves 171. Thus, for varying the spray pattern of the nozzle 12, hydraulic fluid is transferred through the conduits 124, passages 166, openings 168, holes 169, grooves 171 and the conduits 161 and 162 of the nozzle 12.

To prevent fluid leakage from and/or between the grooves 148 and 171, suitable seals, such as O-rings, are provided in the interface between the shell 146 and tubular member 144. In the particular embodiment shown, such seals are provided in suitable grooves in the interior wall of the shell 146 as indicated at 174. Thus, at least one seal is provided between the groove 148 and the grooves 171 and further seals are provided between the grooves 171 and the ends of the shell 146. In the particular embodiment shown, two such seals are provided in each of the named locations.

The interrelation of the nozzle supporting shell 146 and the tubular member 144 allows pivoting of the nozzle 12 on the tubular member 144 through a predetermined arc while continuously supplying pressurized fire fighting fluid to the nozzle through the conduits 129 and 130, blocks 131 and 132, tubular member 144 and shell 146 while simultaneously allowing variation of the spray pattern of the nozzle 12 by hydraulic fluid flow to the nozzle in the manner above described.

A motive source, preferably a reversible hydraulic motor 176 of any conventional type is supported by a bracket 177 fixed, as by welding, to the divergent tubes 129 and 130. Rotational energization is taken from the output shaft 181 of the motor 176 through a drive sprocket 182 and chain 183 to a driven sprocket 184 secured, as by welding, coaxially to the shell 146. Thus, actuation of the motor 176 results in rotation of the

shell 146 with respect to the tubular member 144 through an arc dependent upon the time length of actuation of the motor 176 and in a direction determined by the direction of rotation of said motor. Actuating hydraulic fluid is supplied to the motor 176 through the remaining pair of the aforementioned conduits 124 extending leftwardly from the flange 121.

Thus, as seen in FIGS. 4 and 5, hydraulic fluid is supplied to the rotation motor 69 which is fixedly located with respect to the framework 33, to the pivot motor 176 which is rotatably mounted with respect to the framework 33 and to the spray pattern control mechanism in the nozzle 12 which is both rotatably and pivotally mounted with respect to the framework 33, in each case through substantially rigid conduits, none of which are required to flex during pivotal and rotational movement of the nozzle. Further, said conduits are either located within the framework 33 or closely adjacent to other rigid portions of the monitor apparatus in such a way as to be substantially free from danger of snagging or damage when the monitor unit is being operated near adjoining structures.

Moreover, provision of hydraulic power to the motive means causing rotation at the relative rotational coupling 67 (FIG. 5), pivoting at the interface of the tubular member 144 and shell 146 (FIG. 4) and spray pattern control within the nozzle 12 in no way impedes or limits the extent of the pivoting and rotation of the nozzle 12. In consequence, the nozzle 12 may be continuously rotated through any desired number of full 360° circles or increments thereof in either rotative direction. Further, pivoting of the nozzle is limited only by potential interference between said nozzle and the apparatus of the pivotal section 32 in the region of the divergent tubes 129 and 130 and in the particular embodiment shown a full 270° of pivotal movement is available to the nozzle.

Under certain circumstances, and particularly in the preferred embodiment shown wherein the monitor unit is mounted atop the telescopically extensible boom 16 and thus at a location remote from hydraulic source, it is desirable that hydraulic fluid flow to the motors 169 and 176 and to the nozzle 12 be controlled from a location remote from the hydraulic source and more particularly from a location closely adjacent the monitor unit 11 itself. Failure to provide such remote control for such hydraulic fluid flow would require provision of numerous hydraulic lines (in the particular embodiment shown, six) extending throughout the length of the boom in order to satisfy the control and power requirements for the aforementioned motor units 69 and 176 and nozzle 12, greatly complicating the construction of the boom 16.

Thus, in the preferred embodiment shown, an electrical hydraulic transducer assembly, generally indicated at 186, (FIG. 5) is provided as a part of the monitor unit 11. The transducer assembly 186 includes a protective housing 188 comprising substantially channel-shaped sidewalls 189 and a removable cover plate 190 fixed to the sidewalls by any convenient means such as screws 191. The housing 188 is fixed with respect to the framework 33 of the monitor unit and in the preferred embodiment shown is fixed to one of the extended sidewalls of the upper boom section, hereinafter described, at the location of the attachment of the framework 33 thereto, such connection being by any convenient means, such as the aforementioned nut and bolt con-

nections 43. The transducer assembly includes a plurality, here three, of electro-hydraulic transducers 196-198 fixed by any convenient means (not shown) with respect to the housing 188. A control cable 201 carrying multiple electrical conductors extends into the housing 188 and past transducers 196-198, and pairs of conductors from the cable connect to respective ones of the transducers 196-198. Preferably flexible or bendable hydraulic supply and return conduits 202 and 203, respectively, also extend into the housing 188 and connect to each of the transducers 196-198, as indicated for example at 206. The cable 201 and hydraulic lines 202 and 203 preferably extend from the housing 188 through a suitable opening (not shown) into the interior of the upper boom section to the right of the framework 33 for connection to means within the boom 16 as hereinafter described.

The transducer 196 controls hydraulic flow, from supply line 202 and to return line 203, to and from the hydraulic rotational motor 69 through a pair of hydraulic lines 208. In a similar manner, transducers 197 and 198 each control hydraulic fluid flow in pairs of hydraulic lines 209 and 210, respectively, line pairs 209 and 210 being connected to the outer shell 82 of the hydraulic relative rotation unit 79 at ones of the above described openings 103 therein. The lines 208 through 210 pass through the sidewalls of the upper boom section and the monitor framework 33 through suitable openings therein, one of which is indicated at 212.

The transducers 196-198 may be of any convenient electrohydraulic type capable of producing forward, reverse or no flow in their respective output line pairs 208-210 in response to electrical signals applied thereto from conductor pairs connected thereto from the cable 201.

Suitable transducers are indicated schematically in FIG. 18 wherein each of the transducers 196-198 comprises a three-position valve 213. The valves 213 are spring biased to a central position and are shown by way of example as being of the "center closed" type whereat when in their central position they prevent connection between the supply and return line 202 and 203 and the one of the motive power units 69, 176 and 12 to be energized. The valves 213 also have a rightwardly shifted position for transmitting hydraulic fluid to the corresponding motive power unit in one direction and a leftward or reverse position whereat hydraulic fluid is provided to the corresponding motive power unit in the reverse direction. Thus, the selection of the appropriate one of the three valve positions leaves the corresponding motive power unit at rest, causes motion thereof in one direction or causes reverse motion.

Shifting of each of the valves 213 is accomplished by a corresponding three-way or reversable solenoid 214 which is connected to a corresponding wire pair 216 of the cable 201 and which responds in a conventional manner to electrical energization of the pair 216 to control the positioning of the valve 213. More particularly, non-energization of the pair 216 causes the solenoid 214 to allow the valve 213 to remain in its central or non-connecting position, current flow through the pair 216 in one direction energizes the solenoid 214 to move the valve 213 rightwardly to effect flow to the motive power unit in one direction and reverse electrical flow through the pair 216 energizes the solenoid 214 in the opposite direction to effect leftward movement of the valve and reverse hydraulic flow to the mo-

tive power unit. Electrical current flow through the pairs of the cable 201 can be effected at any remote location by actuation of suitable switching, for example, double pole double throw switches 217, having a connection to a suitable electrical power source 218, for example a vehicle battery or vehicle generator. The switches 217 are capable of positioning in any of three operative positions, namely, one wherein the corresponding pair 216 connected thereto is non-energized, one wherein current flow pass through said pair in one direction and, a third in which reverse current flow through the pair occurs. Connections between the switches 217 and cable 201 are discussed hereinafter in detail.

The boom 16 comprises a base portion 221 (FIG. 1) and a plurality, here illustrated as three, of telescoping boom sections 223-225 of progressively decreasing cross-section, the outermost boom section 223 being fixed at its lower (rightward as seen in FIG. 1) end on the leftward end of the base portion 221 by any convenient means.

The boom sections 223-225 (FIGS. 8-10) are preferably identical in cross-sectional configuration and, although other shapes such as circular or rectangular are contemplated, the boom sections are preferably of substantially square cross-section. The square cross-sectional shape has been found to be advantageous in that it inherently resists relative twisting motion between boom sections and allows room within the boom 16 not only for the waterway 47 but for slip tube sets, hereinafter described, for power and control signal means passing from the base of the boom to the monitor unit 11.

The construction of the boom sections 223-225 is preferably similar and a description of the wall structure of the lower or outer boom section 223 will suffice for the boom sections 224 and 225 as well. Portions of the boom sections 224 and 225 will be referred to by the same reference numerals as corresponding portions of the boom section 225, with the suffixes A and B, respectively, added thereto. The boom section 225 is defined by an enclosing wall structure having a top wall 226 (FIG. 10) and a bottom wall 227 and sidewalls 228 and 229. In the preferred embodiment disclosed, the wall structure of the boom section is formed of a pair of opposed channels 231 each having legs 232 joined by a bight portion, the bight portions being defined by the sidewalls 228 and 229 above mentioned, respectively. The free edges of the legs 232 of the channel 231 abut to form the square cross-section of the boom section and are joined by any convenient means. Although it is contemplated that the boom sections may be made of any of a variety of materials, it is desirable that the individual sections be constructed of a material which if at once relatively strong and yet of reasonably light weight. Thus, the various boom sections may be formed of steel and in such event the free edges of the legs 232 of the channel 231 may be joined by butt welding as indicated at 233. In addition, a cover plate 234 covers the legs 232 and is joined thereto, again as by welding, to further strengthen the top and bottom walls of the boom section.

The boom sections 223-225 have rightward endwalls 230, 230A and 230B, respectively, the endwall 230 being located near the rightward end of the outer boom section and the endwalls 230A and 230B being located preferably at the ends of their respective intermediate

and inner boom sections. As above generally discussed with respect to the monitor unit 11, the sidewalls 228B and 229B of the inner boom section 225 extend beyond the top and bottom walls 226B and 227B thereof for allowing attachment of the monitor framework 33 and transducer housing 186 thereto.

The boom sections 223-225 are preferably dimensioned in cross-section so that, when in their telescoped condition, the spacing between the outer and middle sections 223 and 224 is substantially the same as the spacing between the middle and inner sections 224 and 225. The boom sections 223-225 are preferably coaxial whereby each of the boom sections is evenly spaced at all of its walls from the opposed wall of adjacent boom sections. The boom sections are maintained coaxially aligned by guide block sets 236-239 (FIGS. 8-10). The guide block sets 236-239 also function as low friction sliding bearings to enable telescoping movement of the boom sections with respect to each other and the guide blocks are preferably of a low friction synthetic organic plastic material such as nylon. The guide blocks of each set are preferably generally L-shaped and disposed at each of the four corners of the respective boom section carrying same for slidable engagement with the opposed corner portions of the adjacent boom section. The blocks 236-239 are preferably relatively short with respect to the length dimension of the boom sections. As seen in FIG. 8, the outer boom section 223 has attached to the interior thereof the set of guide blocks 236 at the leftward end thereof for slidably supporting the intermediate boom section 224. The intermediate boom section 224 has the set of guide blocks 237 located at the rightward end thereof and affixed to the exterior wall faces thereof for sliding movement along the interior of the outer boom section 223. The intermediate boom section 224 is provided with the further set of guide blocks 238 secured to the interior thereof at the leftward end thereof for slidably supporting the inner boom section 225. The remaining set of guide blocks 239 is secured to the exterior of the inner boom section 225 adjacent the rightward end thereof for sliding movement along the interior face of the intermediate boom section 224.

At least those of the guide blocks fixed at the leftward ends of the several boom sections are preferably removably affixed thereto as by screws, one of which is indicated at 241 to allow removal of such guide blocks to facilitate disassembly of the boom sections from one another, as for repair.

Turning now to the means for causing extension and retraction of the boom 16, an elongate pressure fluid cylinder, preferably a hydraulic cylinder, 244 is secured, as indicated at 245 (FIG. 8) to the outer face of the outer boom section 223 in parallel relation therewith. The cylinder 244 is preferably secured to the top face of the boom section 223. The pressure fluid cylinder 244 has a piston rod 246 which extends leftwardly from the cylinder 244 and is affixed adjacent its free end as indicated at 247 to the leftward end of the intermediate boom section 224. Thus, extension and retraction of the piston rod 246 with respect to the cylinder 244 results in a corresponding extension and retraction of the intermediate boom section 224 with respect to the outer boom section 223.

Although a corresponding extension and retraction of the inner boom section 225 with respect to the intermediate boom section 224 may be carried out in any of

several convenient ways, it is preferred that a slave system 249 (FIGS. 8 and 9) be used, whereby the innermost boom section 225 will extend and retract simultaneously with and to an extent proportional to the extension of the intermediate boom section 224. The slave system 249 comprises an extension pulley and cable set 251 and a retraction cable and pulley set 252.

The extension set 251 includes pulleys 254 rotatably supported on mounting blocks 255 fixedly secured by any convenient means to the leftward end of the intermediate boom section 224. It is preferred that a pair of pulleys 254 be disposed on the top side of the boom section 224 and a further pair of pulleys 251 be disposed on the bottom side thereof, the pulley pairs being diametrically opposed to each other. Cables 256 extend from fixed mountings 257 at the leftward end of the outer boom section 223 leftwardly around their respective pulleys and thence rightwardly between the inner and intermediate boom sections 225 and 224 to further fixed mountings 259 on the outer face of the inner boom section 225 adjacent the rightward end thereof.

The retraction set 252 preferably comprises similar pairs of pulleys 261 rotatably mounted on blocks 262 secured to the rightward end of the intermediate boom section 224 by any convenient means such as screws 263. Cables 266 extend from mountings 267 at the leftward end of the outer boom section 223 rightwardly or downwardly between the walls of the boom sections 224 and 223, around the pulleys 261 and thence through suitable openings (not shown) in the rightward end wall 230A of the intermediate boom section 224 leftwardly to a fixed mounting 269 of any convenient type on the rightward end wall 230B of the inner boom section 225.

Thus, upon extension of the intermediate boom section 224 by the pressure fluid cylinder 244, the extension set 251 causes a corresponding extension of the inner boom section 225 as a result of leftward movement of the pulleys 254 with the intermediate boom section 224, which in turn tensions the cable 256 and thereby causes mounting 259 to be drawn leftwardly to extend the inner boom section 225. Similarly, upon retraction of the pressure fluid cylinder 244 and hence of the intermediate boom section 224, corresponding rightward movement of the pulleys 261 with the intermediate boom section tensions the cables 266 to draw the mounting 269 and inner boom section 225 rightwardly.

The mounting of the blocks 255 and 262 and of the ends of the cables 256 and 266 are preferably of any conventional removable type of facilitate disassembly of the boom by allowing complete separation of the boom sections 223 through 225.

Plural, in the present embodiment five, sets 276-280 (FIGS. 5, 8 and 9) of slip tubes are disposed within the boom 16. The slip tube sets extend substantially through the length of the boom 16 being terminated adjacent the ends thereof. The slip tube set 276 is of larger diameter than the remaining slip tube sets 277-280 and comprises the boom portion of the waterway 47 above discussed. The waterway slip tube set 276 is preferably coaxial with the boom. The remaining slip tube sets 277-280 are evenly radially spaced from the waterway slip tube set 276 and preferably equally circumferentially spaced from each other, being located at the corners of the boom sections. The slip tube

sets 277-280 are provided for transmitting power and control signals to the monitor unit 11. More particularly, slip tube sets 277 and 278 are utilized as hydraulic supply and return conduits, respectively, and connect to the lines 202 and 203 (FIGS. 5 and 18). The slip tube set 279 is utilized for housing an electrical cable in a manner hereinafter described. The slip tube set 280 is an extra set provided for supplying power or additional control signals to the top of the boom, for example, for powering and/or controlling orientation of accessory devices such as flood lights, television cameras and the like. Thus, depending on the particular use to which it is to be put, the slip tube set 280 may be similar to the electrical slip tube set 279 or the hydraulic slip tubes 277 and 278 or may be some additional variation to accomplish the particular result desired.

However, it will be noted that any additional need for hydraulic input can, in a particular embodiment shown, be satisfied by the existing hydraulic slip tube sets 277 and 278, additional transducers being providable, for example in the housing 186, to control pressure fluid flow to any such additional accessories mounted in the region of the monitor unit 11. Similarly additional cable conductors may be supplied in the electrical slip tube set 279 for providing any additional control signal leads as may be required. Thus, many types of accessories may be adequately handled by the slip tube sets 277-279 used in the present embodiment for operating the monitor unit 11 and nozzle 12. In consequence it will normally be unnecessary to utilize the spare slip tube set 280 for most accessory needs, leaving same free for unusual accessory needs such as air or another compressible fluid under pressure, high amperage electrical power, a secondary fire fighting fluid (in addition to the particular type conveyed by the waterway slip tube set 276) or a wide variety of other uses. Thus, extreme versatility can be achieved in remotely controllable accessories locatable at the top of the boom 16 by use of existing slip tube sets within the boom and without the necessity of providing unprotected hoses, cables or conduits along the outside of the boom.

Seals (not shown) are provided in the waterway slip tube set 276 and in the hydraulic slip tube sets 277 and 278 to prevent leakage of the fluids carried thereby. Although these seals may be of any conventional type, it has been found that grease seals may be used in the waterway slip tube set and that because of the normally higher pressure, O-ring seals may be used in the hydraulic slip tube sets 277 and 278. Fluids are not carried by the electrical slip tube set 279, obviating the need for fluid seals therein. If desired, dust seals of any conventional type may be provided therein, but such is not essential.

Each of the slip tube sets 276-280 comprises a plurality of individual slip tubes equal in number to the number of sections in the boom, in the disclosed embodiment three. The individual slip tubes of each set are telescopically receivable within each other in series and differ in diameter. The individual slip tubes of each set will be referred to by the reference numeral applied to that set, with the suffixes A, B, and C added thereto, the rightwardmost or inner slip tube of the set being referred to by a reference numeral carrying the suffix A, the reference numeral of the intermediate slip tube carrying the suffix B and the reference numeral of the leftwardmost or outer slip tube carrying the suffix C. In each set, the rightwardmost slip tube is the smallest in

diameter, the slip tubes increasing in diameter toward the left as seen in FIGS. 8 and 9, or in other words toward the upper end of the boom. Thus, the smallest diameter slip tube of a set is associated with the largest cross-section boom section.

Several important advantages are provided by reduction of slip tube diameters in the direction opposite to that of reduction of boom section diameters, that is, providing the largest diameter slip tubes in the smallest cross-section boom section and the smallest diameter slip tubes in the largest diameter boom sections.

First, such arrangement allows each slip tube of each set to be rigidly affixed at at least one end thereof to its corresponding boom section and thus provides for rigid support of each slip tube by the boom. This eliminates the problem that occurs where the slip tubes and boom both diminish in size in the same direction, that being the inability to support intermediate slip tube sections rigidly on the boom, so that such intermediate slip tube sections are supported only by communicating, coaxial slip tubes. Such is undesirable in that it renders the slip tube sets mechanically weak and also tends to induce leaks or at least requires unduly complex, strong, expensive and perhaps space consuming sealing means to curb leakage.

Further, the ability to independently support each slip tube of a set on its corresponding boom section increases boom strength and resistance to bending, the slip tubes reinforcing the connection of the boom sections. Thus, it is possible to reduce the strength of the individual boom sections and impart a portion of the load ordinarily carried thereby to the slip tube sets.

Further, with respect to the fluid carrying slip tube sets, and particularly the waterway slip tube set 276, the smallest diameter slip tube and hence the one responsible for the major portion of the pressure drop along the length of the boom will be located nearest the pressure source. Thus the remaining slip tubes extending out toward the upper end of the boom, being of increasingly larger diameter, have increasingly less effect on the flow through the waterway.

Moreover, the overall cross-section of the boom at any point therealong is normally determined by the cross-sectional area required in the uppermost or inner boom section 225 to contain the slip tubes located therewithin, the remaining boom sections being of progressively larger diameter toward the bottom of the boom. The result then normally is a boom of substantial strength and one capable of sustaining bending forces generated by a high flow, high pressure water output from the nozzle even when the nozzle is directed at right angles to the axis of the boom and regardless of the particular circumferential orientation of the nozzle.

Thus, each slip tube of each of the slip tube sets 276-280 is rigidly fixed at or adjacent the rightward end thereof to the rightward end wall 230, 230A or 230B of the particular boom section in which it is disposed. The means for coupling the slip tubes to the respective base walls above mentioned are preferably of identical type, differing only in size in correspondence to differences in diameters of the slip tubes. Thus, a description of the connection of one such slip tube to its corresponding boom section end wall will suffice for all. Turning then, for example, to the mounting of the rightwardmost waterway slip tube 276A of the slip tube set 276, said slip tube has an increased wall thickness portion 282 (FIG. 9) adjacent its lower or rightward

end resulting in an increased outside diameter which increases the strength of the slip tube adjacent its point of connection and support to the boom section end wall 230 and prevents any tendency of the means connecting same to said end wall, hereinafter described, to crush or deform such slip tube while allowing the remainder of the slip tube to be relatively thin wall construction for reducing the weight of the boom assembly and the cost of slip tube materials. A collar 286 of the diametrically split type surrounds the enlarged portion 282 of the slip tube 276A and comprises two opposed and connectible hemispherical portions 287 and 288. The hemispherical portions 287 and 288 are provided with opposed radial flanges 291 at the opposite circumferential ends thereof which are removably connectible in abutting relationship by a nut and bolt connection 292 and rigidly surround and clamp the enlarged portion 282 of the slip tube 276A. The hemispherical portions 287 and 288 are equipped at one axial end thereof with hemispherical radial flanges 294 and 295, respectively, adapted to abut the leftward face of the boom section end wall 230 and to be secured rigidly removably thereto as nut and bolt connections 296. In the case of each of the slip tube sets 276-280, that the coupling collar 286 is disposed inside of the corresponding boom section and secured to the inner or leftward face of the end wall 230, 230A or 230B thereof.

Although the collar 286 resists cocking of the slip tube 276A away from parallelism with the axis of the boom and prevents radial displacement thereof, it is further desirable to positively preclude axial slippage of the tube through the collar. To this end, the enlarged increased thickness portion 282 of the slip tube is provided with an annular groove 298 in which a radially inwardly directed annular flange 299 on the collar 287 is engaged, thereby positively locking the slip tube 276A against unintended axial movement.

As stated, the connection of the slip tube 276A to the end wall 230 above described is preferably similar to the corresponding connections of the remaining slip tubes to their respective end walls 230, 230A and 230B which further connections thus need not be described in detail.

It may be noted however that with respect to the slip tubes 276A-280A terminating and supported on the end wall 230, that such slip tubes may extend rightwardly beyond said end wall whereas it is not required nor indeed desirable that the remaining slip tubes 276B-280B and 276C-280C extend rightwardly beyond the corresponding boom section end walls 230A and 230B. Thus, the rightward end of the innermost or lower waterway slip tube 276A extends beyond the end wall 230 and is provided with an annular groove 303 adjacent the rightward end thereof for connection to the remainder of the waterway 47 disposed in the base portion 221 as hereinafter described. The rightward ends of the remaining innermost slip tubes 278-288 also extend rightwardly beyond the wall 230 and are provided with suitable connectors for engaging corresponding electrical or hydraulic supply lines or the like in the base 221. Thus, the electrical slip tube 279 is provided with, for example, a suitable plug and socket connector generally indicated at 305 for terminating a suitable flexible cable 306. The hydraulic slip tubes 277A and 278A may be terminated at their rightward ends in suitable hydraulic connectors one of which is

shown at 308 connecting to a flexible hydraulic line 309 from the base unit 221.

The leftward ends of the slip tubes 277A-280A and 277B-280B within the outer and intermediate boom sections 223 and 224 are each radially supported only by their telescoped relationship within a coaxial slip tube fixed to the next leftward boom section end wall 230A and 230B. However, the slip tubes 276C-280C in the inner or leftwardmost boom section 225 are also supported at their leftward ends by split collars 286D, similar to the collar 286 above described in detail, fixed to a transverse wall 312 (FIG. 5) removably secured as by nut and bolt connections 313 between the extended sidewalls 228B and 229B of the leftward, inner boom section 225. The transverse wall 312 is preferably located a short distance beyond the leftward end of the top and bottom walls of the inner boom section 225 to allow ready access to the collars 286D for repair or disassembly.

Suitable connections (not shown, but which may be similar to the connections generally indicated at 305 and 308 in FIG. 9) are provided at the ends of the smaller slip tubes 277C-279C for connection to the electrical cable 201 and hydraulic lines 202 and 203. The leftward waterway slip tube 276C connects as by welding 314 to the lower section 51 of the conduit system within the monitor 11. The leftward ends of the spare slip tube set 280 may be terminated in any convenient way depending on the particular use to which it is to be put.

It will be apparent that slip tubes used for fluid conveying, such as the waterway slip tube set 276 and the hydraulic supply and return slip tube sets 277 and 278, are capable of extension to various lengths between minimum and maximum extensions without regard to the particular fluid being conveyed thereby. However, the electrical slip tube set 279 contains a set of electrical conductors preferably in the form of a cable 316 electrically connectible between the aforementioned cable 201 and cable 306 disposed at the upper and lower ends of the boom, respectively, and requires some means for enabling extension and retraction of the cable 316. This problem has been solved by providing the cable 316 in the form of a spiral of coils 317 which when the slip tubes of the set 279 are retracted as shown in FIG. 11, are snugly compressed together. On the other hand, when the slip tubes of the set 279 are extended as indicated in FIG. 12, the effective length of the cable correspondingly increases by reason of separation of the coils 317 thus allowing the cable to, in effect, stretch upon extension of the electrical slip tube set without detrimental effect on electrical current or signal carrying capacity thereof. The periphery of the coiled cable 316 clears the inner surface of the smallest slip tube 279A to prevent binding and enable smooth and unhindered coiling and uncoiling of the cable 316 during retraction and extension of the boom 16.

Turning now to the base unit 21 which supports the boom and monitor unit, same comprises a framework 321 (FIGS. 2 and 13) to be fixedly mounted on any desired support, such as the pumper truck 22. The mounting of the framework 321 on the pumper truck 22 may be carried out in any convenient way (not shown), the framework 321 preferably being fixed to the frame of the truck. The framework 321 includes upstanding frame elements 322 (FIG. 13) atop which is fixedly

mounted a base plate 323 which overhangs the frame elements 322 and is braced at its outer edges by suitable bracing 325. A central opening 326 is provided in the base plate 323 for purposes appearing hereinafter. A turntable 327 is coaxial with and mounted atop the base plate 323 for rotation with respect thereto by a bearing unit generally indicated at 329. The turntable 327 is provided with a central opening 328 for purposes appearing hereinafter.

The bearing unit 329 is an antifriction bearing, for example, a ball bearing, having a lower race 330 centrally and fixedly mounted atop the base plate 323. The bearing unit 329 further includes an upper race 333 centrally fixed to the lower surface of the turntable 327 and cooperating with the lower race 330 to rotatably support the turntable 327 on the base plate 323, the bearing unit 329 absorbing radial as well as axial thrust loads. An annular keeper member 334 is fixed to the base plate 323 around the periphery thereof and extends upwardly past the turntable 327 and includes an annular, inwardly radially extending flange 334A which overhangs the turntable above the bearing unit 329. Low friction material such as nylon is provided between the flange 334A and the upper surface of the turntable 327 as indicated at 335. The low friction material 335 may be in the form of a ring continuously underlying the flange 334A. The keeper member 334 may be removably secured to the base plate by any convenient means (not shown). The keeper member 334 and low friction element 335 prevent the turntable from rocking upwardly due to the weight of the boom when the boom 16 is extended substantially horizontally. The low friction characteristics of the bearing 329 and element 335 allow rotation of the turntable while the boom is pivoted to any desired position. The keeper member 334, being located in close adjacency to the periphery of the circular turntable 327, acts as a secondary radial thrust element for preventing the turntable from shifting out of concentricity with the base plate 323.

Parallel, upstanding pairs of platelike supports 336 and 337 are fixedly mounted on the turntable 327 and diametrically opposed at equal distances from the central opening 328 for pivotally supporting the rightward or bottom portion of the boom 16 as discussed in detail hereinafter.

The rightward end of the outer boom section 223 has its top, bottom and sidewall extending rightwardly past the end wall 230 and somewhat past the central axis of the turntable 327. The base portion 221 includes a pair of substantially convex, downwardly opening shells (FIGS. 1 and 2), one of which is indicated at 340, such shells being disposed on opposite sides of the rightward end thereof and in the region of the upstanding supports 336 and 337. The rightward end of the shells 340 are joined by a convex end wall structure 341 which structure extends across the width of the boom 16 at the rearward, or as seen in FIGS. 1 and 13, the rightward end thereof. The shells 340 include side plates 342 which are outwardly spaced from and parallel to the sidewalls 228 and 229 of the outer boom section 223 for purposes appearing hereinafter. The end wall 341 and side plates 342 have lower edges located somewhat below the center of the sidewall 228 and 229 of the outer boom section 223 but located above the bottom wall thereof. The end wall 341 terminates at a point sufficiently high as not to interfere with a pivoting

movement of the boom 16. The shells 340 are fixed to the sidewalls of the boom section 223 by any convenient means including a cross beam 343 fixed to the top wall of the boom section 223.

In the particular embodiment shown, the sidewalls 228 and 229 of the boom section 223 are covered with additional plates 344 disposed between said sidewalls and the aforementioned shells 340 and fixed thereto, said plates extending a short distance above and below the top and bottom walls of the boom section 223 for providing additional strengthening thereto. A top plate 345 is fixed to the upper edges of the plates 344 as well as to the cross beam 343 and the rear wall 341. The top plate 345 and side plates 344 thus extend from the rearward or rightward end (FIG. 13) of the outer room section 223 forwardly to a point somewhat past the end wall 230 thereof. The rearward or rightward end of the pressure fluid cylinder 244 is disposed between the plates 344 and the top plate 345.

Further convex and rearwardly or rightwardly opening shells 346 are provided at the forward or leftward ends of the side plates 344 and have flange-like portions 347 spaced outwardly from and in parallelism with the side plates 344 for purposes appearing hereinafter.

A pivot assembly 355 (FIGS. 13-16) includes a centrally located waterway pivot unit 356 from both ends of which extend coaxial stub shafts 358 for supporting the waterway pivot unit 356 and the lower or rightward end of the boom 16 on the supports 336 and 337. Although the stub shafts 358 may coact with boom 16 and the supports 336 and 337 in any convenient way, one example of such connection is shown in FIG. 15. Here, the supports 336 and 337 are provided with coaxial openings 360 in which are disposed bushings 364 snugly receiving and supporting the stub shafts 358. The sidewalls 228 and 229 of the outer boom section 223 (the sidewall 229 being shown in FIG. 15), the overlaying plates 344 adjacent said sidewalls and the side plates 342 of the shells 340 on opposite sides of the boom 16 are provided with coaxial openings 362. A cylindrical member 363 extends between the boom sidewalls and the side plates 342 coaxially of the openings 362 and is secured thereto as by welding. The interior of the member 363 is lined with a snugly fitting, low friction bearing sleeve 364, preferably of nylon. The bearing sleeve 364 is snugly but rotatably received on the stub shaft 358. Thus, the stub shafts 358 serve to pivotally to support the boom 16 on the supports 336 and 337 upstanding from the turntable. A collar 366 is preferably disposed on each of the stub shafts 358 inboard of the inboard support 337 for maintaining the central portion of the waterway pivot unit 356, hereinafter described, centered between the upstanding supports 337 and with respect to the turntable 327.

Pressure fluid cylinders 376 and 377 (FIGS. 1, 2 and 13) are disposed on opposite sides of the boom and are each supported pivotally at the lower ends thereof between corresponding ones of the support plates 336 and 337 by suitable pivot pins 378. The piston rod 381 of each of the pressure fluid cylinders 376 and 377 has its upper end located between the corresponding sidewall of the outer boom section 223 and the flange-like portion 347 of the opposed shell 346, such upper piston rod end being pivotally supported therebetween on a pivot pin 382. Thus, extension of the pressure fluid cylinders 376 and 377 causes the boom 16 to pivot up-

wardly about the axis of the pivot assembly 355 and hence about the axes of the stub shafts 358.

The waterway pivot unit 356 (FIGS. 13-16) comprises a hollow cylindrical member 386 of circular cross-section, the ends of which are closed by end plates 387 and 388, as by welding. The ends of the cylinder 386 are coaxially secured by screws 390 to the stub shafts 358 by radial flanges 389 secured as by welding to the inner ends of the stub shafts 358. The cylindrical member 386 is provided adjacent its rightward end with an inlet opening 392 in the peripheral wall thereof. A fluid inlet conduit 393 is secured to the peripheral wall of the cylindrical member 386, preferably by welding, and communicates with the interior of the cylindrical member 386 through the inlet opening 392. The conduit 393 is sinuously curved, extending substantially radially from the cylindrical member 386, curving toward the central portion of the conduit 386 and then curving in the opposite direction so that the outer or, as shown in FIG. 15, the lower end thereof extends substantially radially from the cylindrical member 386. The axis of the lower end of the conduit 393 is preferably located in the central radial plane of the cylindrical member 386.

The cylindrical member 386 is provided with a reduced diameter portion 395 at its leftward end for snugly receiving thereon a sleeve 396. The sleeve 396 is snugly held axially of the cylindrical member 386 between a shoulder 397 defining the rightward end of the reduced diameter portion 395 and the leftward one of the radial flanges 389. The sleeve 396 has an opening 398 through the peripheral wall thereof, the opening 398 preferably being located at the same distance from the longitudinal center of the cylindrical member 386 as is the aforementioned opening 392. A fluid outlet conduit 399 is affixed, preferably by welding, to the exterior of the sleeve 396. The conduit 399 is preferably identical to the aforementioned conduit 393, being sinuous in shape and extending radially from the opening 398, curving rightwardly toward the longitudinal center of the cylindrical member 386, and then curving in the opposite direction so that the outer end thereof is aligned radially of the cylindrical member 386 and is coaxial with the lower or inlet end of the conduit 393. The cylindrical member 386 is provided with a circumferentially elongate opening 401 (FIGS. 15 and 16) which is centered on the opening 398 in the sleeve 396 and is of the same width, axially of the cylindrical member 386, as the opening 398. Thus, fire fighting fluid flows upwardly through the conduit 393 into the interior of the cylindrical member 386 and then leftwardly and upwardly through the openings 401 and 398 and into the conduit 399.

The circumferentially elongate opening 401 is designed to allow complete communication of the opening 398 in the sleeve 396 with the interior of the cylindrical member 386 through substantial pivotal movement of the sleeve 396 with respect to the cylindrical member 386, in the present embodiment through an arc of 93°. The circumferential ends of the opening 401 are preferably arranged tangentially of the inside diameter of the cylindrical member 386, rather than radially thereof, so that when the outlet conduit 399 is at either of its extreme pivotal positions, indicated at 399A and 399B in broken lines in FIG. 16, the wall of the opening 401 will form a smooth continuation of the interior surface, or at least a portion thereof, of the outlet conduit

399 for enhancing smooth fluid flow between the cylindrical member 386 and conduit 399.

Suitable and conventional sealing means 403 and 404 are provided between the opposed surfaces of the cylindrical member 386 and sleeve 398, on opposite sides of the opening 398, to prevent fluid leakage from the interior of the cylindrical member 386.

The outlet end of the conduit 399 is joined, preferably by welding as indicated at 406 (FIG. 13), to a generally funnel-shaped reducer section 407 which is in turn connected by a suitable coupling, preferably a split ring coupling 408 of any conventional type, to the rightward or inlet end of the inner waterway slip tube 276A above described for conveying fire fighting fluid from the waterway pivot unit 356 to the waterway slip tube set 276.

The lower or inlet end of the conduit 393 is connected by a coupling 410, preferably a split ring type coupling of any conventional type, to the upper end of an upstanding, rotatable waterway conduit 411. The conduit 411 extends downwardly from the conduit 393 through the central openings 328 and 326 of the turntable 327 and base plate 323, respectively. The lower end 412 of the rotatable waterway conduit 411 connects, within the framework 321, through a conventional swivel joint 413 of the type allowing continuous relative rotation of coupled conduits, to a fire fighting supply conduit 414 fixed with respect to the framework 321 by any convenient means (not shown). The conduit 414 in turn is connected to a suitable source of fire fighting fluid, such as water, under pressure generally indicated at 416. A valve 417 is preferably interposed between the source 416 and the fixed waterway conduit 414.

An electrical and hydraulic swivel assembly 419 (FIGS. 13 and 17) coaxially surrounds the conduit 411 above the lower end 412 thereof, the swivel assembly 419 being located within the framework 321 and comprising a hydraulic swivel unit 420 and an electrical swivel unit 421. The hydraulic swivel unit 420 comprises an inner shell 422 which surrounds and is rotatable with the conduit 411 and an outer shell 423 which snugly surrounds the inner shell 422 but allows rotation of the inner shell 422 with respect thereto. The inner shell 422 is fixed coaxially to the turntable 327 by a plate 422A which spans the central opening 328 in the turntable. Similarly, the outer shell 423 is fixed to the base plate 323 of the framework 321 by a plate 423A which spans the opening 326 in the base plate 323. The plates 422A and 423A are preferably removably affixed to the turntable 327 and base plate 323, respectively, by any convenient means such as screws 418. The plates 422A and 423A are affixed to the shells 422 and 423 respectively by any convenient means (not shown). Thus, the plates 422A and 423A hold the shells 422 and 423, respectively, in coaxially aligned relationship with each other, with the turntable 327 and with the waterway conduit 411. The outer shell 423 is provided with an inwardly directed radial flange 424 (FIG. 17) which at its inner end rests atop an upwardly facing shoulder 425 on the periphery of the inner shell 422 for further vertically locating the outer shell 423 with respect to the inner shell 422.

The outer shell 423 (FIG. 17) is provided with a plurality of axially spaced, hydraulic fluid inlet openings, one of which is indicated at 431, such openings preferably being tapped for receiving conventional hydraulic

fittings 432 connected to suitable controlled hydraulic lines. The openings 431 are preferably circumferentially staggered on the outer shell 423 to avoid crowding.

At the axial locations of the openings 431 on the outer shell 423 there are disposed in the periphery of the inner shell 422 annular grooves, one of which is indicated at 434. Such grooves extend completely around the circumference of the inner shell 422 and communicate with respective ones of the openings 431 in the outer shell. Seals, such as O-ring seals 435, are provided between the opposed surfaces of the inner and outer shells 422 and 423 on both sides of each of the grooves 434 for preventing leakage of hydraulic fluid from each such groove to the next or to the exterior of the hydraulic swivel unit 420. A plurality of axially extending passages 437 are provided in the inner shell 422 opening at the upper edge thereof as indicated at 438 for connection by a suitable conventional fitting to hydraulic lines rotatable with the turntable 327 as hereinafter discussed. Each of the axial passages 437 connects through a radial opening 439 through the inner wall of a corresponding one of the annular grooves 434 and hence with a corresponding one of the openings 431 and fittings 432.

In the present embodiment, a further radial opening 441 connects one of the hydraulic fluid axial passages 437 with the interface between the shoulder 425 and flange 424 for providing lubrication to the relatively rotating surfaces thereof, an O-ring seal 442 being located between the facing peripheral walls of the flange 424 and inner shell 422 to prevent fluid leakage from the interface of the flange 424 and shoulder 425.

The radially inner wall of the inner shell 422 is radially spaced from the periphery of the conduit 411 by an annular space 433. The inner shell 422 and conduit 411 are maintained in coaxial relationship by annular guides 444, preferably of nylon, disposed therebetween, such annular guides being disposed at least adjacent the top and bottom of the shell 422. The guides 444 are provided with a plurality of circumferentially spaced axial openings 445 therethrough for purposes appearing hereinafter.

If desired extra passages 437, grooves 434 and openings 431 may be provided for future use with additional accessories or the like.

The electrical swivel unit 421 comprises a vertical stack of insulative disks 446, disks of different diameters alternating vertically through the stack. The exterior surfaces of the lesser diameter disks 447 are provided with annular conductors 448 on the periphery thereof. Insulated wires 449 electrically connect to the annular conductors 448 and are led radially inwardly along the interfaces of opposed ones of the disks 446 and pass upwardly through an annular space 451 separating the radially inner surfaces of the disks 446 from the conduit 411.

The wires 449 are led upwardly through the openings 445 in the guides 444 and the annular space 443 between the shell 422 and conduit 411, emerging at the upper end of the shell 422, the wires 449 preferably being joined above the shell 422 in the aforementioned cable 306 (FIG. 13) which leads upwardly along the conduit 411 past pivot unit 355 to the plug and socket connection 305 on the rightward end wall 230 of the outer boom section 223.

The disks are held in coaxially fixed location below the shell 422 by elongate screws 453 passing upwardly therethrough into threaded relationship with the shell 422.

An annular, radially outwardly extending flange 456 is provided at the lower end of the outer shell 423. A plurality of circumferentially spaced, elongate rods 457 threadedly engage the flange 456 and depend therefrom in parallelism with the axis of the conduit 411, said rods extending below the stack of disks 446. The lower ends of the rods 457 are secured to a plate 458 by nuts 459, which plate snugly surrounds the conduit 411 adjacent the lower end 412 thereof for maintaining the rods 457 in parallelism with the conduit 411.

A plurality of insulative spacers 461 are disposed on the rods 457 for holding insulated finger sets 462 in proper axially spaced relationship and in opposition to respective ones of the conductor rings 448, there being one such finger set 462 for each conductive ring 448. In the particular embodiment shown, finger sets for adjacent ones of the rings 448 are disposed on different rods 457 to avoid crowding. Each of the finger sets 462 includes a pickup finger 464 having a conductive element 465 at one end thereof in slidable engagement with a respective one of the conductive rings 448, the other end of the pickup finger 464 receiving the corresponding rod 457 therethrough for pivotally supporting same. Each finger set 462 further includes a tension finger 466 disposed on the same rod 457 and in radial face-to-face, frictionally engaging contact with its associated pickup finger 464. The fingers 464 and 466 tangentially engage the stack of disks 446 at spaced circumferential locations thereon, the tension finger 466 engaging one of the large diameter ones of the disks 446 and tending through its engagement with the pickup finger 464 to urge the conductive element 465 thereof snugly against the corresponding conductive ring 448 to insure good electrical contact therebetween as the disks rotate with the conduit 411 and with respect to the finger sets 462. Elongate conductors 468 lead from the conductive elements 465 of each of the finger sets 462 and are preferably joined in a cable 469 leading to suitable switching, here the switching 217 above mentioned with respect to FIG. 18.

By reason then of the relative rotation connection of electrical and hydraulic lines afforded by the swivel unit 419, the turntable 327 and the boom 16 mounted thereon are allowed to rotate continuously through successive 360° circles without limitation due to electrical and hydraulic lines extending between fixed portions of the truck 22 and the turntable 327 which is rotatable with respect thereto.

Rotative drive is provided to the turntable through a motor, preferably a hydraulic motor 471 of the rotative type, and gear box 472. More particularly, the gear box 472 is mounted upon the turntable 327 and has an output shaft 473 which extends downwardly through an opening 474 in the turntable at a location spaced radially between the central opening 328 and bearing 329. A drive sprocket 475 is fixed to the output shaft 474 and located between the turntable and base plate 323 and drives a driven sprocket 476 fixed to the support plate 423A through a chain 477. The hydraulic motor 471 is fixedly supported with respect to the turntable 327, preferably by means of a bracket 478 fixed to the gear box 472. The motor 471 and gear box 472 are provided with driving and driven sprockets 479 and 480,

rotational driving engagement between such sprockets being effected by a chain 481.

FIG. 18 discloses schematically, as above discussed, the electrical and hydraulic connections to the monitor unit 11. The hydraulic lines 202 and 203 of the monitor unit 11 connect as above discussed through the supply and return slip tube sets 277 and 278 (FIG. 10), through flexible hydraulic lines one of which is indicated at 309 (FIG. 9 and 13), the hydraulic swivel unit 420 (FIG. 17) including the passages 437, grooves 434 and fittings 432, to hydraulic lines 482 and 483 (FIG. 18) connected to a suitable hydraulic fluid pump 484 and hydraulic reservoir 485. When the apparatus 10 is mounted on the pumper truck 22, the pump 484 and reservoir 485 may be a part of the hydraulic system supplied with the truck. In a conventional manner, a pressure relief valve 484A is preferably provided between the inlet and outlet sides of the pump 484 to allow continuous actuation of the pump without excessive pressure build-up when all valving associated with motive power units to be driven by the pump are in an off condition, precluding flow from the pump.

In addition, a manually actuable dump valve 482A is preferably provided intermediate the pump 484 and hydraulic supply line 482. The dump valve 482A is arranged so that in its normal or unactuated position, straight through connection between the output of the pump 484 and the line 482 is effected. On the other hand, when manually actuated, the dump valve 482A cuts off pressure fluid supplied from the pump to the line 482 and drains the line 482 and hence the hydraulic supply slip tube set 277 to the reservoir 485. Thus, the dump valve 482A facilitates free retraction of the boom by preventing pressure build-up in the hydraulic supply slip tube set 277 tending to retard such retraction, as when the valves 213 associated with the nozzle 12, rotate motor 69 and pivot motor 176 are in their intermediate or rest condition, the valves 213 in such condition precluding connection between the supply and return lines 202 and 203. On the other hand, it is contemplated that should the valves 213 be of the "center open" type and thereby provide a shunt between the supply and the return lines 202 and 203 when in their center position, such dump valve 482A would not be necessary. However, suitable flow restrictors would be required in circuit with the valves 213 so that the shunt between the lines 202 and 203 when the valves are in their center position would not tend to unduly reduce the system hydraulic pressure. No such problem of impeding retraction of the boom 16 exists with respect to the return line 203 which is always open to the reservoir 485.

Summarizing the electrical connections to the monitor unit 11, and more particularly to the transducers 196 through 198 thereof, same are effected through the pairs 216 of the cable 201, the cable 316 of the electrical slip tube set 279 (FIGS. 9-12), the connection 305 to the flexible cable 306 which passes the pivot unit 355 (FIG. 13) at the base of the boom 16 and passes downwardly along the waterway conduit 411 to the electrical and hydraulic swivel unit 419, including the wires 449, conductive rings 448, conductive elements 465, and cable 469 (FIG. 18) and thence to the switches 217.

In addition to the hydraulic and electric connections to the monitor unit and nozzle above discussed, FIG. 18 also discloses a preferred arrangement of hydraulic

connections to boom extension cylinder 244, boom pivot cylinders 376 and 377 and turntable rotation drive motor 471. Although such connections may be arranged in any convenient way, in the particular embodiment disclosed, three-position valves 486, here three in number, are respectively associated with each of the pressure fluid cylinder 244, the pair of pressure fluid cylinders 376 and 377 and the motor 471. The valves 486 may be substantially identical to the valves indicated at 213, the three-position valves 486 thus each having a center position whereat neither supply nor return flow is carried through the valve, a rightward position whereat supply and return flow is carried through the valve and a leftward position whereat supply and return flow through the valve is reversed. Thus, each valve 486 in its center position causes no change in the position of the movable element of the particular hydraulic motor associated therewith, in its rightward position causes motion of the movable member of the motor in one direction and in the leftward position causes motion in the opposite direction. The valves 486 are preferably spring biased to the center position and in the preferred embodiment shown are provided with manually actuable control buttons 487 which can be pushed or pulled by an operator to change the setting of the valve. In addition, if desired, the valves may be additionally or alternatively actuable by electric remote control means as discussed hereinabove with respect to the valves 213, namely by suitable solenoids (not shown) in turn actuated by reversible electrical switches (not shown) which may be similar to the switches 217.

A supply line 491 extends from the pump 484 to the input port 492 of each of the valves 486 and a return line 493 extends from the outlet port 494 of each valve back to the reservoir 485. The boom extension cylinder 244 connects to one of the valves 486 through lines 496 and 497. The boom pivot cylinders 376 and 377 have their hydraulic connections paralleled, corresponding ports of the two cylinders connecting through the hydraulic lines 498 and 499 to another one of the valves 486. The motor 471 connects to the remaining one of the valves 486 through lines 501 and 502. It will be understood that each of the lines 496 through 499 and 501 and 502 connects to its appropriate valve 486 through the hydraulic swivel unit 420, and more particularly through the passages 437, grooves 434 and fittings 432 thereof.

The switches 217 and push-pull buttons 487, or electric control switching (not shown) for controlling the valves 486, are preferably mounted on a control panel 426 on the back of the truck 22 as shown in FIG. 2. In addition to the control panel 426, if desired, electrical remote control of the apparatus 10 may be effected by means of a remote control box 427 bearing on at least one face thereof a plurality of manually actuable controls such as switches (not shown) and connected by an electrical cable 427A to the control panel 426 on the back of the truck 422. Connection of the control box 427 to the circuitry discussed above with respect to FIG. 18 and controlling the apparatus 10 allows the operator of the apparatus 10 to control same while located at a position remote from the truck, as for example, to enable him to obtain a better view of the location of the upper end of the boom with respect to the burning structure. Such arrangement allows the operator to visually position and orient the nozzle 12 or other

accessory devices associated with the monitor unit 11 in the most effective way to achieve the desired results. Moreover, if effective fighting of a fire requires the truck to be positioned in a hazardous location close to the burning structure, the provision of the remote control box 427, which may be carried by the operator to a substantial distance from the vehicle, provides an additional safety factor reducing the possibility of injury to the operator.

OPERATION

Although the operation of the apparatus 10 embodying the invention has been disclosed in substantial detail in the detailed description above, same will now be reviewed briefly to ensure a complete understanding of the invention.

Although the apparatus 10 embodying the invention can be mounted in any of a variety of ways including mounting at a stationary location or mounting on a variety of vehicles, the apparatus 10 is particularly adapted for use on a conventional fire pumper truck such as the truck 22, the relatively short retracted length of the boom enabling mounting of the apparatus 10 on such a relatively short truck and eliminating the need for use of an articulated support vehicle or one having steerable rear wheels such as a hook and ladder truck. Moreover, the mounting of the apparatus 10 on such a pumper truck in no way interferes with the normal use of the pumper truck. Moreover, the apparatus 10 may be arranged, if desired, for rapid dismounting should it be desired to utilize the apparatus 10 on different vehicles at different times.

When the apparatus 10 is not used, the boom sections 225 and 224 are normally retracted within the outer boom section 223 as shown in FIG. 1 and the boom is normally horizontally supported on the support 24 on the truck to enable rapid transport of the apparatus 10 to the location of a fire.

Upon arrival at a fire, the jack legs 26 are extended so as to contact the ground and transversely stabilize the truck, to prevent tipping of the truck or substantial rocking thereof when the boom is extended and angled transversely to the truck. The jack legs 26 may be operated in any conventional way and controls therefor may appear on the control panel 426 (FIG. 2) which carries manual actuable controls for the apparatus 10.

Preparatory to the use of the apparatus 10, the hydraulic pump 484 (FIG. 18) is actuated to apply hydraulic pressure to the monitor supply line 482 and to the line 491. The valves 486 and 213 are at this point normally in their center or rest position shown, as are the switches 217. Also, the electrical source 218 (FIGS. 17) is actuated, such source comprising, for example, the battery or generator of the supporting vehicle 22 or an external power pack. However, the electrical source 218 may be of any character desired, substantial simplicity being achieved in the preferred embodiment of the invention by use of a DC source, again such as a vehicle battery.

Although the various portions of the apparatus 10 may be operated in any desired sequence, as may be dictated by the particular circumstances of use in a given instance, the pressure fluid cylinders 376 and 377 (FIGS. 1 and 13) are normally first actuated at least to a minor extent so as to pivot the boom 16 upwardly (clockwise as seen in FIG. 1) so as to clear the support 24. Further, if it is desired that the nozzle 12 be ele-

vated to a position high above the vehicle 22, as is normally the case in fighting fires at or near the top of a tall structure, the boom may be pivoted upwardly by the cylinders 376 and 377 to its fully elevated position shown at dotted lines at 16A in FIG. 1. In the particular embodiment shown, the boom 16 is capable of pivotal movement through an angle of approximately 93°, from a position at approximately 13° below the horizontal to a position approximately 80° above the horizontal, the latter position being the one indicated at 16A.

The boom pivot cylinders 376 and 377 are energized from the pump output line 491 through the corresponding one of the valve 486, the latter being connected to said cylinders through the hydraulic swivel unit 420 (FIGS. 13 and 17) and lines 498 and 499. Manual push movement on the corresponding one of the buttons 487 appropriately positions the corresponding valve 487 to allow pressure fluid flow into the rearward or lower end of the cylinders 376 and 377 to lift the boom 16. Lowering of the boom 16 is accomplished by movement of the same valve 486 in the opposite direction away from its central position to supply pressure fluid flow to the upper end of the cylinders 376 and 377 for urging the piston rods thereof downwardly and allowing the boom to drop in a controlled manner. Although the pressure fluid cylinders 376 and 377 are here shown to be double acting cylinders so that the one of the valves 486 controlling same is shown to be a three-position reversible valve, it is contemplated that the aforementioned cylinders can be single acting and the corresponding supply and return valve 486 simplified correspondingly, the return hydraulic path from the bottom end of the pressure fluid cylinders to the reservoir preferably then having a controllable restriction (not shown) for preventing too rapid dropping of the boom 16.

The turntable 327 (FIGS. 1 and 13) and boom 16 mounted thereon may be rotated about a vertical axis, defined by the axis of the waterway conduit section 411 to any rotational position with respect to the base plate 323 and supporting vehicle 22. Indeed, the turntable and boom may be continuously rotated in either rotational direction. Such rotation of the turntable is accomplished by actuation of the corresponding one of the valves 487 (FIG. 18) thereby connecting the output of pump 484 through the hydraulic swivel unit 420 (FIG. 13) to one or the other of the lines 501 and 502 to the rotation drive motor 471. The motor 471, through the chain drives 481 and 477, causes the turntable to move rotatively with respect to the framework 321. Rotation of the motor 471 and turntable 327 in one direction is accomplished by manual pushing of the button 487 associated therewith, causing rightward movement of the valve 487 associated with the motor 471, reverse rotation being accomplished by pulling of the button 487 to position the valve 486 in its leftward-most position. Return of the valve 486 to its central position causes rotation to stop. Since the turntable 327 can be continuously rotated through multiples of 360° and without interference by electrical and hydraulic lines, for example lines 306 and 309, the turntable 327 and boom 16 may be quickly changed from position to position as required by the efficient fighting of a particular fire or series of fires without interference by any rotation stop means or without the necessity of reversing rotation after rotation through an arc approaching 360°.

During such rotation of the turntable 327, electrical control signals from the switching 217 (FIG. 17) through the cable 469 are applied through the wires 468 and the conductor portions of the fingers 464 (FIG. 17) to the rotating conductive rings 448 and thence through wires 449 to the cable 306 which rotates with the turntable and boom. Similarly, pressure fluid from the pump 204 applied through valves 486 and the supply line 202 is applied through ones of the hydraulic inlet openings 431 (FIG. 17) and thence through corresponding ones of the grooves 434 to corresponding ones of the passages 437 and thence through corresponding hydraulic lines fixed for rotation with the turntable 327, one such line being indicated at 309, to corresponding ones of the extension cylinder 244, the pivot cylinders 376 and 377, the turntable rotation motor 471 and to one of the lines 309 connected to the hydraulic supply slip tube set 277 (FIG. 10). Thus, the rotation of the turntable 327 and boom 16 in no way interferes with delivery and return of pressure fluid from the various hydraulically operated devices in the apparatus 10, which rotate with the turntable 327.

The hydraulic connections to the motor 471 are not affected by pivotal motion of the boom about the axis of the stub shaft 358, as is the case with the pivot pressure fluid cylinder 376 and 377. However, the hydraulic lines (one of which is shown at 309) and the electrical cable 306 which are ultimately connected to devices mounted on the boom 16, such as the motors of the monitor unit 11 and the extension pressure fluid cylinder 244, must be arranged to flex upon pivoting of the boom on the substantially horizontal axis of the stub shaft 358. Thus, such conduits and such cable are of flexible material capable of bending as a result of pivoting of the boom.

The boom 16 may be extended, for example, after having aimed the upper end of the boom at the desired ultimate location for the upper boom end by rotation of the turntable 327 and pivoting of the boom 16 on the stub shafts 358 as above described. Extension of the boom is accomplished by actuation of the button 487 of the corresponding one of the valves 486 (FIG. 18) associated with the extension pressure fluid cylinder 244. Should the boom 16 be inadvertently extended to a greater distance than desired, same can be retracted to the desired extent by a reverse actuation of the aforementioned button 487. Extension of the pressure fluid cylinder 244 causes the piston rod 246 (FIG. 8) thereof to extend the intermediate boom section 224 with respect to the outer boom section 223. The corresponding extension of the inner or upper boom section 225 is simultaneously accomplished by the cable slave system 249 and more particularly by means of the extension cable set 251. In the particular embodiment shown, the boom segments 223-225 are dimensioned there so that the boom 16 when totally extended reaches a length of 65 feet. However, by changing the length of the boom sections or adding or subtracting further and similar boom sections, the extended length of the boom 16 may be modified to lengthen or shorten same as desired.

During the course of extension or retraction of the boom 16 and corresponding extension or retraction of the boom segments 223-225 with respect to each other, relative sliding motion and support of the boom sections is accomplished by the above described guide

blocks 236-239. Maximum extension of the boom may be determined by the stroke of the pressure fluid cylinder 244 and/or by interference of opposed ones of the guide blocks 236-239 as desired.

During the course of extension or retraction of the boom 16, relative sliding motion takes place between the individual slip tubes of each slip tube set 276-280, suitable sealing means, as above discussed, preventing leakage during such sliding movement of the telescoping slip tubes of each such set. Extension of the boom 16 is assisted to some extent by pressurization from the respective sources of the waterway slip tube set 276 and hydraulic supply slip tube set 277. However, normally the waterway slip tube set 276 will not be receiving fire fighting fluid, such as water, under pressure during extension to avoid unintended spraying of water from the nozzle 12 during such extension. On the other hand, closure of the waterway inlet valve 417 (FIG. 13) causes no pressure lock in the waterway slip tube set 276 since the waterway slip tubes are vented by the nozzle 12. Although pressurization of the hydraulic slip tube set 277 may assist somewhat the extension of the boom, the force generated thereby is not sufficient to inadvertently extend the boom. It will be apparent from inspection of FIG. 18 that the boom 16 may be extended whether or not the dump valve 482A is actuated. During such extension of the boom, the slip tubes of the electrical slip tube set 279 extend and the cable 316 extends therewith by reason of separation of the coils 317 thereof.

Upon extension of the boom 16 to the desired height, so that the nozzle 12 and monitor unit 11 are positioned in their desired locations, the monitor unit 11 may be actuated for rotatably and pivotally orienting the nozzle 12 to aim same in the desired direction, that is for placing the stream or spray of fire fighting liquid such as water at the location of a fire in or on an adjacent elevated structure and for regulating the character of the fluid output of the nozzle, to make same a straight stream or fog.

To achieve such a rotation, the solenoid 196 (FIG. 18) is actuated in a forward or reverse direction by proper actuation of associated switch 217 connected to the electrical source 218. Solenoid 214 of the unit 196 moves the corresponding one of the valves 213 rightwardly or leftwardly depending on the polarity of actuation of the corresponding switch 217 and thereby applies hydraulic fluid from the supply line 202 (supplied from the pump 484 through the hydraulic supply slip tube set 277 the connected one of the flexible hydraulic conduits 309, the hydraulic swivel unit 420 and the pump valve 482A) in a manner to cause rotation of the rotate motor 69 in the forward or reverse direction as desired. Such rotation of the rotate motor 69 drives through the chain drive 72 (FIG. 5) the center section 52 of the portion of the waterway 47 contained in the monitor unit 11, thus rotating the coupling 57, the upper section 53 and through flanges 111 and 121, the pivot unit 32 of the monitor unit 11 and the nozzle 12 supported thereby. Relative rotation of the above described portions of the waterway 47 with respect to the conduit subsections 64 and lower section 51 and with respect to the boom 16 is allowed by the relative rotation coupling 67. Similarly, rotation of the upper or pivotal section 32 of the monitor 11 carrying the plural hydraulic lines 124, ultimately connected to the transducers 196-198 fixed with respect to the boom 16, is al-

lowed by the hydraulic relative rotation unit 79. The latter carries, past the rotating interface defined by the inner and outer shells 81 and 82, hydraulic flow in lines 209 and 210 by means of the openings 103 in the outer shell 82 and the grooves 96 and axial passages 97 in the inner shell 81, the latter connecting by suitable fittings to the aforementioned lines 124.

Provision of the transducers 196-198 eliminates the necessity for multiple hydraulic supply and return slip tube sets within the boom 16, allowing several hydraulic motive power units to be energized from only a single hydraulic supply and return slip tube set pair, the slip tube sets 277 and 278, and a single electrical slip tube set 279. Such arrangement reduces the complexity, cost, weight and potential for unreliability of the boom 16.

Pivoting of the nozzle 12 occurs on actuation of pivot motor 176 of the pivotal section 32 of the monitor unit 11. Such actuation is carried out by the electrohydraulic transducer 197 upon appropriate actuation of the associated one of the switches 217 (FIG. 18) energizing the appropriate one of the conductors 468 (FIG. 17) with a signal transferred through the electrical swivel unit 421 to the cable 306 and thence through the cable 316 in the electrical slip tube set 279 to cable 201 and thence to the transducer. Resulting actuation of the solenoids 214 of the transducer 197 causes the incorporated one of the valves 213 to be moved to the right or to the left as determined by a setting of the switch 217 and thereby applying from the hydraulic supply line 202 forward or reverse hydraulic flow to the pivot motor 176 (FIG. 4). The resulting rotation of the pivot motor 176 causes, through the chain drive 183, pivoting of the outer shell 146 which carries the nozzle 12. Again, pivotal movement of the nozzle 12 in no way affects the placement of the hydraulic lines 124 to the pivot motor 176 or nozzle 12.

During the course of such rotational or pivotal adjustment of the nozzle 12, and in any desired rotated or pivoted location thereof, fire fighting liquid, such as water, is continuously deliverable to the nozzle 12. Such fire fighting liquid is normally delivered from the pressurized source 416 (FIG. 13) by any convenient means to the fixed waterway conduit 414 and thence through the swivel 413 to the rotatable waterway conduit 411, the latter being rotatable with the turntable 327. Water then travels through the pivot assembly 355 to the innermost waterway slip tube 276A and thence through the remainder of the slip tubes of the waterway set 276 to the monitor unit 11. The swivel 413 allows continuous relative rotation between the fixed conduit 414 and rotatable conduit 411 and the waterway pivot unit 356 allows pivotal motion, resulting from pivoting of the boom 16, between the conduit 411 and the waterway slip tube set 276. Water flow from the pressurized source 416 to the waterway 47 may be controlled conventionally by means of a suitable valve 417, which if desired may be mounted on the control panel 426 (FIG. 2). Water then flows through the conduit sections 51-53, the divergent conduits 129 and 130, the blocks 131 and 132 and openings 150, grooves 147 and 148 and nozzle mounting tube 156 to the nozzle 12.

Control of the setting of the nozzle 12, as for straight stream or fog, is accomplished by a nozzle hydraulic motor incorporated within the nozzle 12 which is of any commercial type (not shown). Actuation of this nozzle motor is carried out by the transducer 198 upon

appropriate actuation of the one of the switches 217 (FIG. 18) associated therewith for applying a control signal through cable 469, the electrical swivel unit 421, wires 449, cable 306, cable 316 of the electrical slip tube set 279 and cable 201 to the aforementioned transducer 198. As a result, the solenoid 214 associated with the transducer 198 is actuated in one direction or another as desired to shift the associated valve 213 rightwardly or leftwardly as desired and thus supply hydraulic fluid from the supply line 202 to the nozzle 12 to cause adjustment thereof toward straight stream or toward fog as desired.

After use, the apparatus 10 may be returned to its rest condition of FIG. 1 by shutting the valve 417 to terminate fire fighting fluid flow to the nozzle 12, and suitable actuation of the valves 486 respectively associated with the boom extension cylinder 244, boom pivot cylinders 376 and 377 and boom rotation motor 471. The dump valve 482A may be actuated to avoid a hydraulic lock upon retraction of the boom 16 due to entrapment of hydraulic fluid in the supply slip tube set 277.

Should it be desired to change the orientation of the nozzle when the apparatus 10 is returned to its rest condition, the rotate and pivot motors 69 and 176 may be appropriately actuated through their respective transducers 197 and 196.

In addition to or instead of the nozzle 12, a variety of accessory devices may be mounted on the monitor unit 11. For example, instead of the nozzle, a conventional fire hose connection (not shown) may be affixed to the output end of the waterway 47 at the point of which the nozzle 12 is normally connected, to allow connection of a fire hose thereto. Thus, the boom may be extended and positioned adjacent the upper portion of the burning structure and firemen located thereat may secure a hose to the apparatus 10 using same as an aerial water supply, leading such hose away from the apparatus 10 for use in fighting the fire remote therefrom and on such structure. Further, as schematically indicated in broken lines at 501 in FIG. 3, accessory devices such as television cameras, sound equipment, lights or the like may be affixed to the monitor unit and more particularly with respect to the nozzle 12 for rotation and pivotable movement therewith, which accessory devices may thus be trained with the nozzle on the fire, for example, for providing additional information to fire fighters. Still further, it is contemplated that, as schematically indicated in broken lines at 502, accessory devices may be mounted on the monitor unit framework 33 or upper boom end by conventional pivoting and/or swiveling means which may be independently actuated to vary the direction of aim of such accessory devices, receiving electrical or hydraulic power or control signals, for example, from the cable 201 and/or hydraulic lines 202 and 203.

If desired an extension ladder can be affixed to the boom, preferably to the top face thereof, for extension and retraction therewith to enable persons to climb up and down the boom.

Although a particular preferred embodiment of the invention has been disclosed above for illustrative purposes, it will be understood that variations or modifications thereof which lie within the scope of the appended claims are fully contemplated.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Apparatus for fire fighting, comprising in combination:

- a support;
- an extensible boom having a plurality of hollow, telescoping sections;
- means adjacent one end of the boom for mounting said boom on said support for movement in a plurality of directions;
- means for extending and retracting said boom;
- a fluid output device and means for mounting same on the other end of said boom for movement with respect thereto in a plurality of directions;
- means supported by said other end of said boom and actuable for moving said fluid output device;
- first extensible means supported within said boom for telescoping therewith and connected to a source of fluid for conveying fluid from said source through said boom to said fluid output device;
- further extensible means supported adjacent said first extensible means within said boom for telescoping with said first extensible means and connected to an energy source for conveying energy through said boom to said means actuable for moving said fluid output device with respect to said boom;
- means for pivotally mounting said boom for movement in a substantially vertical plane with respect to said support and further means rotatably mounting said boom with respect to said support for rotation on substantially a horizontal plane, wherein said means for pivotally mounting said boom comprises a chamber defining member and a pair of aligned shaft elements removably affixed thereto and axially extending therefrom, means associated with said support for carrying said shaft elements, means associated with said boom and engageable with said shaft elements for pivotal connection with respect to said support and relatively pivotable fluid inlet and outlet conduits in communication with the chamber of said chamber defining member in offset relation axially of said chamber defining member.

2. The apparatus defined in claim 1 wherein said first and second extensible means comprise first and second sets of coaxially telescoping slip tubes located adjacent each other in said boom, ones of the slip tubes of each set being associated with corresponding ones of the sections of said boom for telescoping extension and retraction therewith.

3. The apparatus defined in claim 2 in which said sections of said boom differ in cross sectional area in series, the smallest of said boom sections being located adjacent said output device and the largest of said boom sections being located adjacent said support, slip tubes of each of said slip tube sets diminishing in cross section in series, the smallest of said slip tubes of each set being associated with the largest cross section boom section, each of said slip tubes being supported on its associated boom section at the ends thereof closest to said support, the remaining ends of at least some of said slip tubes of each slip set being supported only by the next adjacent slip tube in which they are received.

4. The apparatus defined in claim 2, in which said first slip tube set conveys fire fighting fluid to said output device, at least one of said second slip tube sets conveys pressure fluid to said means for moving said output device for energizing same and wherein a third slip tube set conveys electrical control signals to said

means for moving said output device for controlling application of pressure fluid thereto, and including transverse baffles at least at the ends of said boom and means releasably securing the ends of each said slip tube set to said baffles, said second and third slip tube sets lying radially between said first slip tube set and the walls of said boom.

5. The apparatus defined in claim 4, in which two second slip tube sets are provided, one thereof providing a supply path and the other a return path for pressure fluid wherein said pressure fluid is hydraulic fluid, and wherein said means for moving said output device consists of a plurality of independently controllable pressure fluid motor means and including transducers associated with each of said motor means for connecting same to said supply slip tube set and said return slip tube set, said transducers being independently actuable by control signals applied thereto from said third slip tube set.

6. The apparatus defined in claim 5, in which said output device comprises a nozzle hydraulically actuable for varying the output stream pattern thereof and including a further independently controllable transducer associated therewith for connecting same to said supply slip tube set and to said return said slip tube set, said further transducer being independently actuable by control signals applied thereto from said third slip tube set.

7. The apparatus defined in claim 1, in which said means for supporting said output device includes a framework fixed to the end of the boom adjacent said output device, a first conduit fixed to said framework for receiving fluid from said boom, a second conduit coaxially aligned with said first conduit and in fluid communication therewith, said second conduit being supported for rotation by means on said framework and a third conduit assembly in fluid communication with said second conduit, said third conduit assembly including means pivotably mounted with respect to said second conduit and in fluid communication therewith and with said output device, said fluid output device being mounted on said pivotably mounted means.

8. The apparatus defined in claim 7, including a rotation motor carried by said framework adjacent said second conduit for rotating said second conduit with respect to said framework and a pivot motor disposed outboard of said framework between said second conduit and said pivotably mounted means for causing pivotal movement of said pivotably mounted means with respect to said second conduit.

9. The apparatus defined in claim 8, wherein said pivot and rotate motors are pressure fluid motors and including a plurality of transducers carried by said framework and means supplying pressure fluid to said transducers from said boom, fluid lines connecting said transducers independently to corresponding ones of said motors and control lines from said boom for independently actuating said transducers to apply pressure fluid to selected ones of said motors for energizing same, whereby each of said motors is independently actuable by pressure fluid by a common set of pressure fluid lines fixed with respect to said framework.

10. The apparatus defined in claim 1, in which said inlet and outlet conduits are sinuously curved and have axes lying in a plane transverse to the axis of said shaft elements, wherein one of said conduits is mounted on a shell rotatably surrounding said chamber defining

member and including an opening through said shell communicating with said one conduit, and a circumferentially elongated opening in the peripheral wall of said chamber defining member radially aligned with said one conduit and communicating therewith, the circumferential extent of said elongated opening substantially exceeding the corresponding extent of said opening of said shell so that said opening in said shell is fully exposed to said chamber through a wide range of pivotal positions of said shell upon said chamber defining means.

11. Apparatus adapted for fire fighting, comprising in combination:

a support;

an extensible boom having a plurality of hollow, telescoping sections;

means adjacent one end of the boom for mounting said boom on said support for movement in a plurality of directions, including means for pivotally mounting said boom for movement in a substantially vertical plane with respect to said support and further means rotatably mounting said boom with respect to said support for rotation in substantially a horizontal plane;

means for extending and retracting said boom;

a fluid output device and means for mounting same on the other end of said boom for movement with respect thereto in a plurality of directions;

means supported by said other end of said boom and actuable for moving said fluid output device;

first extensible means supported within said boom for telescoping therewith and connected to a source of fluid for conveying fluid from said source through said boom to said fluid output device;

further extensible means supported within said boom for telescoping therewith and connected to an energy source for conveying energy through said boom to said means actuable for moving said fluid output device with respect to said boom;

a turntable and means supporting same for rotation on said support, a fixed fluid conduit coaxially aligned with said turntable and disposed therebelow, a rotatable fluid conduit coaxially aligned with said fixed conduit and joined thereto by a swivel located below said turntable and extend upwardly through said turntable, a first shell depending from said turntable and fixed with respect thereto, said first shell coaxially surrounding said rotatable conduit for rotation therewith, a second shell snugly surrounding said first shell and disposed below said turntable, said second shell being fixed with respect to said support, and means on said first and second shells for conveying hydraulic fluid and electrical signals from sources fixed with respect to said support to lines rotatable with said rotatable conduit.

12. The apparatus defined in claim 11, including a pivot device having a cylindrical chamber, stub shafts extending coaxially therefrom, means supporting said stub shafts on said turntable, means supporting said one end of said boom on said stub shafts and conduits communicating with said chamber at axially spaced points thereon, said conduits remotely from said chamber having coplanar axis and being smoothly and sinuously curved between said points and said chamber, the outlet of one of said conduits being in fluid communication with said first-mentioned extensible means and said

boom and the inlet of the other of said conduits being connected to said rotatable conduit.

13. The apparatus defined in claim 11, in which said first shell is spaced radially from said rotatable conduit and including a plurality of wires disposed in said space and spaced axially therealong, a set of electrical contacts arranged for relative rotation, one ends of said wires being connected to said electrical contactors and the other ends of said wires being lead to said further extensible means in said boom.

14. Apparatus adapted for fire fighting, comprising in combination:

an extensible boom having a plurality of hollow, telescoping sections;

means for extending and retracting said boom;

a support;

means adjacent one end of said boom for mounting said boom on said support;

a device mounted on the other end of said boom;

a plurality of slip tube sets disposed within said boom, each said set of slip tubes comprising a plurality of coaxial telescoping slip tubes, ones of said slip tubes of each of said sets being associated with a corresponding one of the boom sections for telescoping extension and retraction therewith;

an energy source connected to one end of one of said slip tube sets, the other end of said one slip tube set being connected to said device on said other end of said boom, said device on said other end of said boom comprising a fire fighting fluid output device, said energy source comprising a source of fire fighting fluid under pressure and said one slip tube set providing fire fighting fluid from said source to said device despite extension and retraction of the boom;

a pressure fluid source and means movably mounting said device on said boom and energizable for moving said device, said energizable means being energizable by pressure fluid and means connecting said energizable means to the adjacent end of another slip tube set for receiving pressure fluid therethrough from said pressure fluid source;

said one set of slip tubes being disposed coaxially of said boom and further slip tube sets of smaller diameter surrounding same within said boom, said further slip tube sets including said another slip tube set, said one slip tube set being adapted to convey said fire fighting fluid from one end of said boom to the other and said further slip tube sets being adapted to convey pressure fluid and electrical control signals, respectively, between the ends of the boom, said device mounted on said other end of said boom comprising a fluid nozzle and including means mounting same for movement with respect to said boom and motor means for causing such movement;

first transducer means responsive to said electrical control signals and pressure fluid from said further slip tube sets for moving said nozzle in response thereto, said electrical signals originating at the opposite end of the boom, said nozzle connecting to the adjacent end of said one slip tube set through said means for movably mounting same with respect to the boom for receiving fire fighting fluid therefrom.

15. The apparatus defined in claim 14, wherein said means for movably mounting said nozzle comprises

first means for mounting same for continuous rotation through multiple 360° arcs about the axis of said boom and further means for pivotally moving same through an arc exceeding one half a circle in a plane containing or parallel to said boom axis, said nozzle being of the adjustable type and having therein hydraulically actuable means for controlling the spray pattern thereof and further transducer means for applying pressure fluid to said nozzle spray pattern control means, said first and further transducer means being responsive to electrical signals applied thereto through a slip tube set of said boom from a remote location, said transducer means being fixed with respect to and adjacent said other end of said boom and including conduits connecting said transducer means to said motor means and to said nozzle spray control means, two slip tube sets being sufficient to supply and return pressure fluid for all of said motor means and nozzle spray control means.

16. The apparatus defined in claim 15, wherein said pressure fluid is hydraulic fluid and said means for controlling rotation, pivoting, operation of and spray pattern of said nozzle comprise hydraulic motors, said further slip tube sets including a supply hydraulic slip tube set, a return hydraulic slip tube set and a third set of slip tubes carrying electrical cable.

17. Apparatus adapted for fire fighting, comprising in combination:

a source of fluid under pressure;

a fluid supply conduit extending from said source;

a further fluid conduit in fluid conveying communication with said first mentioned conduit at one end thereof and rotatable with respect thereto;

a pair of third conduits extending divergently from the other end of said further conduit, said third conduits being configured so that the ends thereof remote from said third conduit extend toward each other and are coaxially aligned;

means mounting a fluid output device between said coaxially aligned ends of said conduits in fluid carrying communication with said further conduits through said third conduits and for pivoting movement about said coaxial ends of said third conduits;

means actuable for causing pivotal movement of said device with respect to said third conduits;

whereby fluid is conveyed by said conduits from said source to said device while allowing rotation of said device about the axis of said first mentioned and further conduits and pivoting movement of said device about the coaxial portions of said third conduits;

a framework fixed with respect to said source of fluid and disposed around portions of said first mentioned and further conduits and means fixedly supporting said first conduit on said framework, said means for rotating said further conduit being supported by said framework.

18. The apparatus defined in claim 17, including an annular flange on said further conduit adjacent said framework and a plurality of rollers spaced around said flange and in rotative engagement with said flange, said rollers being supported by said framework for rotationally supporting said further conduit on said framework.

19. The apparatus defined in claim 18, in which said further conduit extends loosely through a hole in said framework, said flange being disposed outside said framework adjacent said hole, a plurality of hydraulic

lines rotatable with said further conduit and extending therealong in close adjacency thereto through said opening and into the region of said third conduits.

20. Apparatus adapted for fire fighting, comprising in combination:

- a source of fluid under pressure;
- a fluid supply conduit extending from said source;
- a further fluid conduit in fluid conveying communication with said first mentioned conduit at one end thereof and rotatable with respect thereto;
- a pair of third conduits extending divergently from the other end of said further conduit, said third conduits being configured so that the ends thereof remote from said third conduit extend toward each other and are coaxially aligned;
- means mounting a fluid output device between said coaxially aligned ends of said conduits in fluid carrying communication with said further conduits through said third conduits and for pivoting movement about said coaxial ends of said third conduits;
- means actuable for causing pivotal movement of said device with respect to said third conduits;
- whereby fluid is conveyed by said conduits from said source to said device while allowing rotation of said device about the axis of said first mentioned and further conduits and pivoting movement of said device about the coaxial portions of said third conduits;
- a first set of energizable lines fixed with respect to said first mentioned conduit, a second set of lines energizable from corresponding lines of said first set and fixed with respect to said further conduit, means supported on said further conduit for joining said first and second sets of said lines for relative rotation, said first set of lines being energizable by an operator of the apparatus and said second set of lines providing for actuation of at least said means for pivoting said device in response to actuation of said first set of lines.

21. Apparatus adapted for fire fighting, comprising in combination:

- an extensible boom having a plurality of hollow, telescoping sections;
- means for extending and retracting said boom;
- a support;
- means adjacent one end of said boom for mounting said boom on said support;
- a device mounted on the other end of said boom;
- a plurality of slip tube sets disposed within said boom, each said set of slip tubes comprising a plurality of coaxial telescoping slip tubes, ones of said slip tubes of each of said sets being associated with a corresponding one of the boom sections for telescoping extension and retraction therewith;
- an energy source connected to one end of one of said slip tube sets, the other end of said one slip tube set being connected to said device on said other end of said boom;
- walls extending transversely of and affixed to and within said boom sections adjacent at least one end of a slip tube of each of said slip tube sets, said slip tubes each being annularly grooved near the adjacent one of said walls, connectors for connecting said slip tubes to said walls, each of said connectors comprising a radially opposed pair of hemispherical elements having inwardly directed radial flanges adjacent one end thereof for reception into said

grooves in said slip tubes and radially outwardly directed flanges adjacent the other end for connection to said adjacent walls.

22. Apparatus adapted for fire fighting, comprising in combination:

- an extensible boom having a plurality of hollow, telescoping sections;
- means for extending and retracting said boom;
- a support;
- means adjacent one end of said boom for mounting said boom on said support;
- a device mounted on the other end of said boom;
- a plurality of slip tube sets disposed within said boom, each said set of slip tubes comprising a plurality of coaxial telescoping slip tubes, ones of said slip tubes of each of said sets being associated with a corresponding one of the boom sections for telescoping extension and retraction therewith;
- an energy source connected to one end of one of said slip tube sets, the other end of said one slip tube set being connected to said device on said other end of said boom;
- said boom comprising first, second and third telescoping sections, a pressure fluid cylinder connected between said first and second sections for extending said second section with respect to said first section, extension pulleys adjacent the free end of the second section and fixed with respect thereto and first cables extending from the free end of said first section around said first pulleys to the end of the third section received in said second section for extending said third section with respect to said second section when said second section extends with respect to said first section, retraction pulleys mounted adjacent and fixed with respect to the end of said second section and received within said first section and cables extending from the free end of said first section around said retraction pulleys and to the end of said third section received in said second section for retracting said third section with respect to said second section when said second section is retracted with respect to said first section.

23. Apparatus adapted for fire fighting, comprising in combination:

- an extensible boom having a plurality of hollow, telescoping sections;
- means for extending and retracting said boom;
- a support;
- means adjacent one end of said boom for mounting said boom on said support;
- a device mounted on the other end of said boom;
- a plurality of slip tube sets disposed within said boom, each said set of slip tubes comprising a plurality of coaxial telescoping slip tubes, ones of said slip tubes of each of said sets being associated with a corresponding one of the boom sections for telescoping extension and retraction therewith;
- an energy source connected to one end of one of said slip tube sets, the other end of said one slip tube set being connected to said device on said other end of said boom, said device on said other end of said boom comprising a fire fighting fluid output device, said energy source comprising a source of fire fighting fluid under pressure and said one slip tube set providing fire fighting fluid from said source to

said device despite extension and retraction of the boom;

- a pressure fluid source and means movably mounting said device on said boom and energizable for moving said device, said energizable means being energizable by pressure fluid and means connecting said energizable means to the adjacent end of another slip tube set for receiving pressure fluid therethrough from said pressure fluid source;
- a source of electrical control signals and means associated with said energizable means responsive to electrical control signals for controlling the flow of pressure fluid thereto and thereby controlling movement of said device, said electrical control signal responsive means connecting through a cable disposed in a further one of said boom contained slip tube sets with said source of electrical control signals, said cable being coiled within said further slip tube set for extension and contraction therewith, one end of said cable being connected to said source of electrical control signals and the other end of said cable being connected to said electrical control signal responsive means.

24. Apparatus adapted for fire fighting, comprising in combination:

- an extensible boom having a plurality of hollow, telescoping sections;
- means for extending and retracting said boom;
- a support;
- means adjacent one end of said boom for mounting said boom on said support;
- a device mounted on the other end of said boom;
- a plurality of slip tube sets disposed within said boom,

each said set of slip tubes comprising a plurality of coaxial telescoping slip tubes, ones of said slip tubes of each of said sets being associated with a corresponding one of the boom sections for telescoping extension and retraction therewith;

an energy source connected to one end of one of said slip tube sets, the other end of said one slip tube set being connected to said device on said other end of said boom;

the sections of said boom are serially graduated in cross sectional size, the largest cross section one thereof being located adjacent said support, each said slip tube set being serially graduated in cross sectional size, the smallest cross section boom section carrying the largest cross section slip tube of each of the slip tube sets.

25. The apparatus defined in claim 24, in which wall means are provided adjacent the end of each of said boom sections closest to said support and means are provided on said wall means for supporting fixedly with respect to each boom section the corresponding slip tubes disposed therewithin of each slip tube set, the opposite ends of said slip tubes being supported by reception into slip tubes of the same slip tube set located in the next smaller boom section, the end of the smallest boom section remote from said support having a further transverse wall and means thereon for supporting the free ends of the slip tubes of each slip tube set furthest from said support, whereby each of said slip tubes is supported at both ends thereof rigidly with respect to the boom.

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