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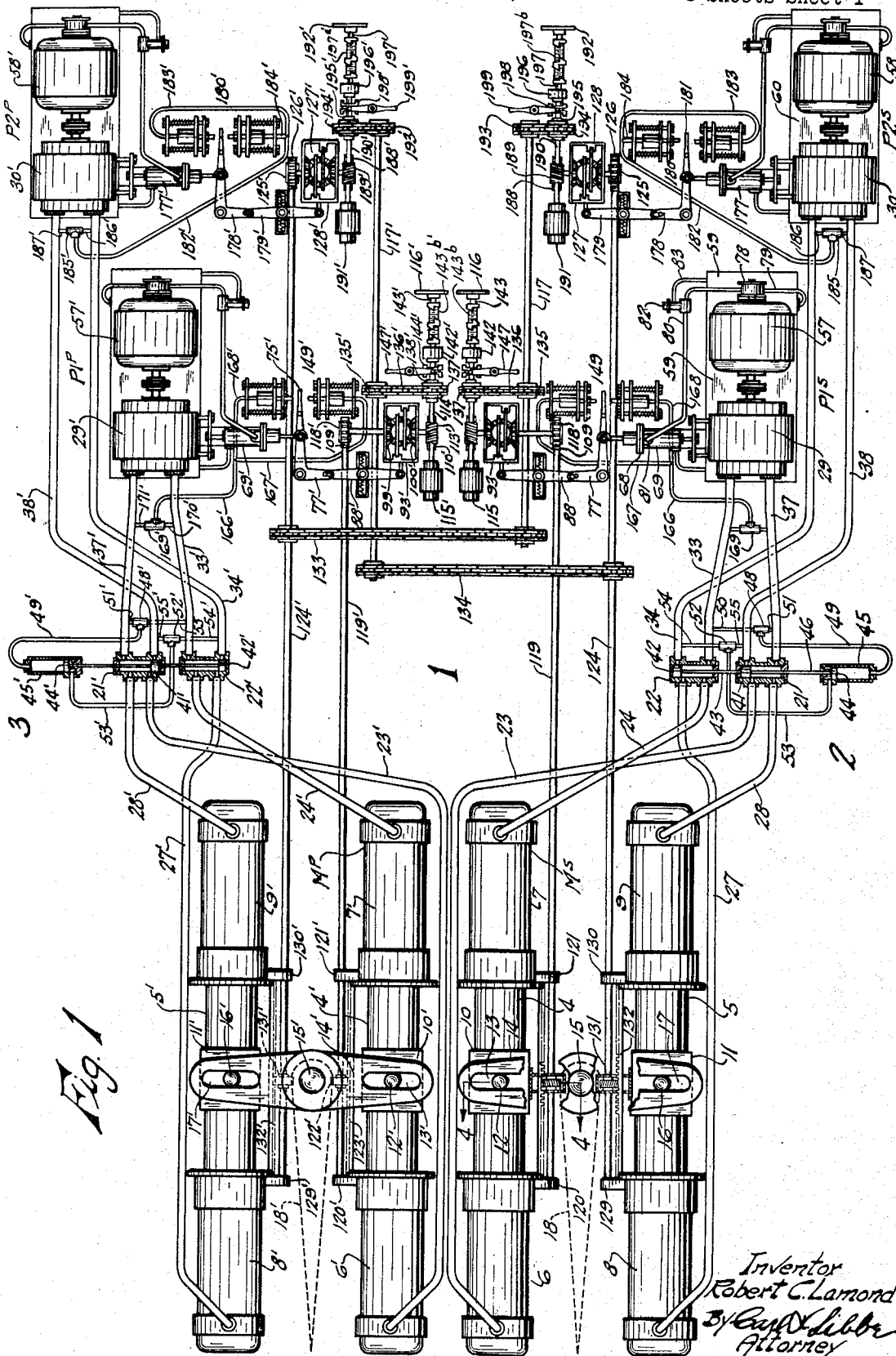
R. C. LAMOND

2,282,194

STEERING GEAR

Filed Nov. 1, 1938

3 Sheets-Sheet 1



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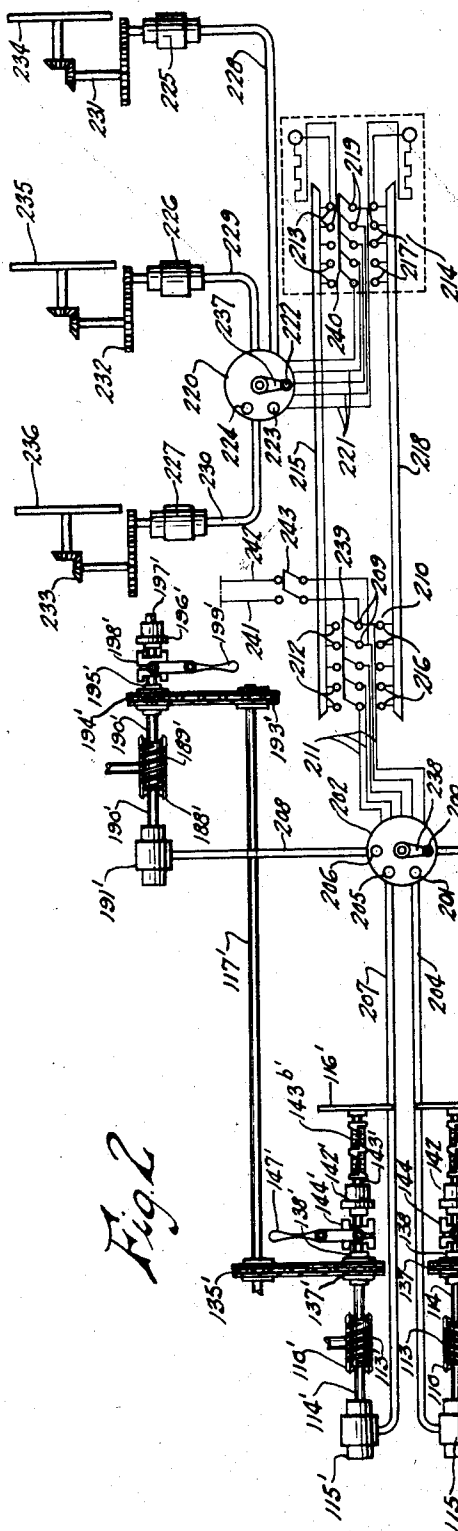
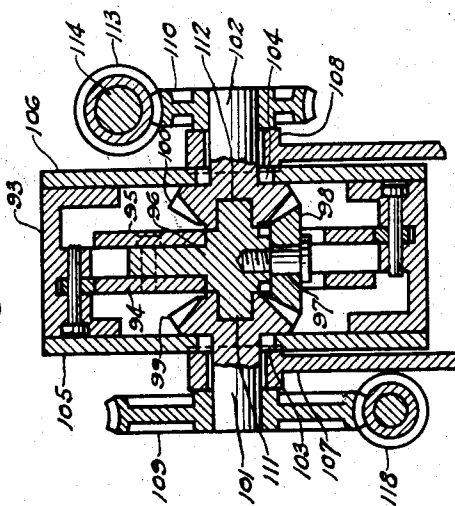
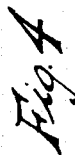
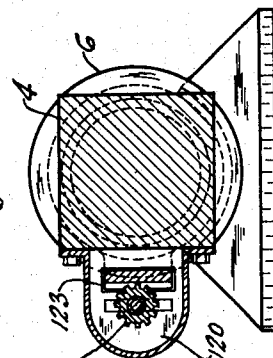
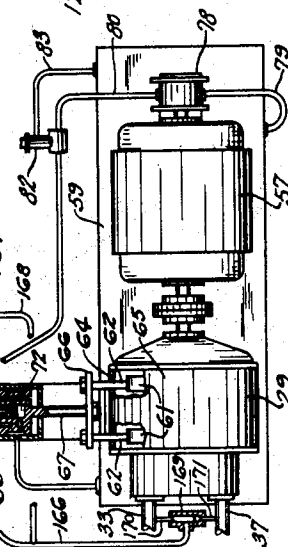
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2,282,194

STEERING GEAR

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3 Sheets-Sheet 2



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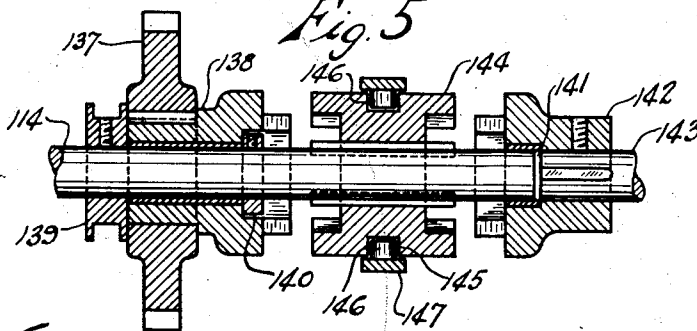
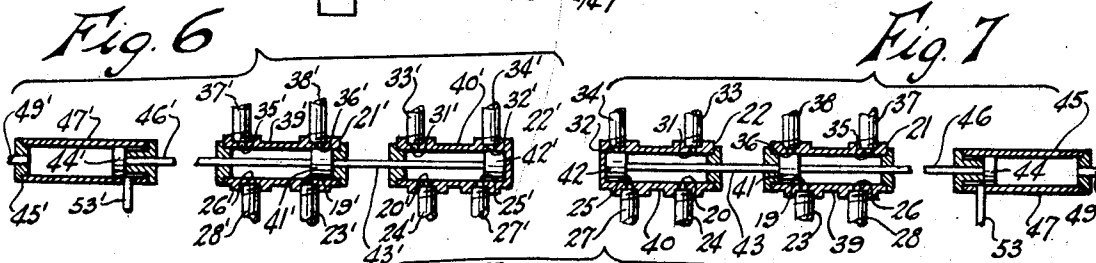
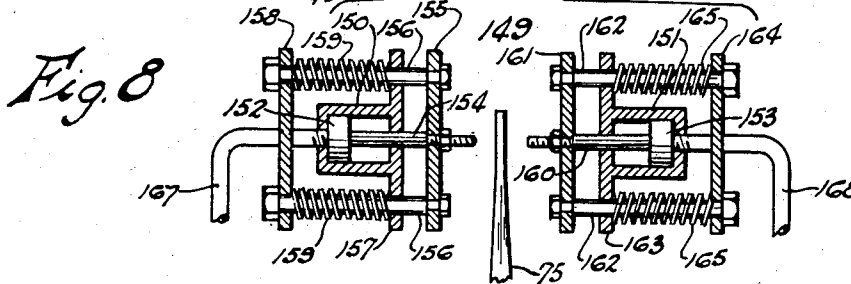
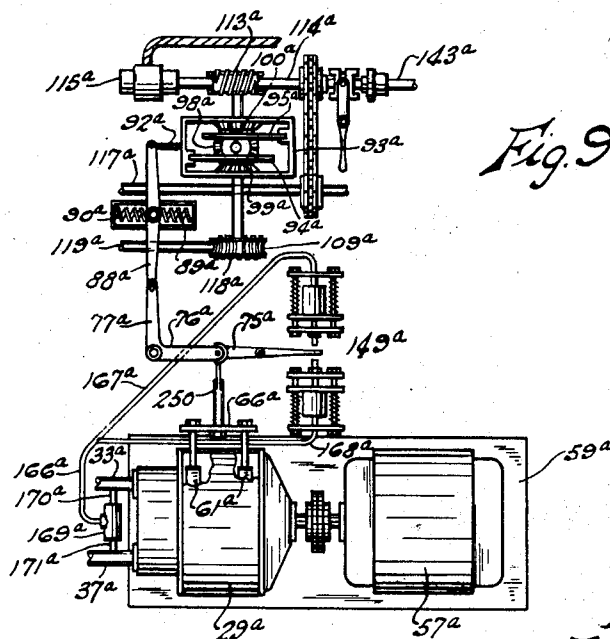
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2,282,194

STEERING GEAR

Filed Nov. 1, 1938

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,282,194

STEERING GEAR

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21 Claims. (Cl. 114—150)

This invention relates to steering mechanisms for ships, and more particularly to steering mechanisms of the electro-hydraulic type.

Steering of ships is usually effected by manual means located in the bridge or at some other point remote from the operating unit which effects adjustment of the rudder. Various types of mechanisms have been devised to transmit the motion of the manual means located in the bridge to the controls of the steering unit proper. For the purpose of illustration, electrical means are shown herein, although it is apparent that other well known forms of transmission mechanisms may be employed if desired without departing from the invention.

As the units increase in size the effort required to operate the manual means increases. The present invention contemplates a control mechanism which reduces this effort to a minimum by connecting one of the control units of a two-rudder system for operation by the manual means disposed in the bridge, and by operating the other of said units through a followup mechanism operatively connected to the first unit. Substantially synchronous operation of the two rudders is thus effected through a control system requiring a minimum of physical effort on the part of the operator.

One object of the present invention is to provide a simplified and generally improved steering mechanism which may be controlled from any one of a plurality of stations with a minimum of physical effort.

Another object is to provide a two-rudder steering device, each rudder being operated by motor means which in turn may be actuated by one or more pumping units, the controls for the pumping units and motor means being so constructed that the operation of either one of said motor means controls the operation of the other.

A further object is provided in a multi-rudder steering mechanism, a control system which insures synchronous operation of the various rudders thereof.

A more specific object is to provide in a steering mechanism of the two-rudder type, one or more pumping units for each of the rudder adjusting motors, and a plurality of followup devices actuated by said motors and operatively connected to the controls of the associated pumping units, whereby the operation of either of said motors causes simultaneous operation of the other.

Other and further objects will become appar-

ent as the description of the invention progresses.

Of the drawings:

Fig. 1 is a plan view of the steering mechanism comprising the present invention, certain of the elements being shown in section, and others broken away to more clearly illustrate certain of the operating parts thereof.

Fig. 2 is a partly diagrammatic plan view showing the electric control system for the steering mechanisms and one of the pumping units and the control mechanism therefor, certain of the elements of the control mechanism being shown in section, and others with parts broken away to show the structure thereof.

Fig. 3 is a sectional elevational view of the differential gearing associated with the control mechanism for one of the pumping units and the operating means therefor.

Fig. 4 is a sectional view taken substantially along line 4—4 of Fig. 1.

Fig. 5 is a sectional view of the clutch mechanism associated with one of the pumping units for controlling the operation thereof.

Fig. 6 is a sectional view of the changeover valve mechanism associated with the port unit.

Fig. 7 is a similar view of the changeover valve associated with the starboard unit.

Fig. 8 is a plan view partly in section of the fluid motor mechanism for actuating the controls of one of the pumping units to neutral position under predetermined conditions, and

Fig. 9 is a plan view of an alternative control mechanism for the pumping units, certain parts being broken away to show more clearly the structure of certain of the elements thereof.

Referring to the drawings, the numeral 1 designates generally the entire steering mechanism consisting of a starboard unit 2 and a port unit 3. Starboard unit 2 comprises a fluid motor M^s which is adapted to be operated by pumping unit $P1^s$ or $P2^s$. Port unit 3 is identical in construction with starboard unit 2, and also comprises a fluid motor M^p adapted to be actuated by pumping unit $P1^p$ or pumping unit $P2^p$. Motor M^s comprises a pair of rams 4 and 5, the former of which operates in spaced, axially aligned cylinders 6 and 7, while the latter operates in a pair of similarly spaced cylinders 8 and 9. Rams 4 and 5 are provided with flattened portions 10 and 11 respectively, intermediate the ends thereof. Extending upwardly from flattened surface 10 is a projection 12 which engages in an extended slot 13 provided near one end of a cross-head 14 to which a rudder post 15 is secured. Extending upwardly from flattened surface 11 is

a similar projection 16 which engages in an extended slot 17 provided near the other end of crosshead 14. Secured to the lower end of rudder post 15 is the usual rudder 18 shown in dotted lines in Fig. 1.

As shown more particularly in Figs. 1, 6 and 7, the outer ends of cylinders 6 and 7 are connected to ports 19 and 20 of changeover valves 21 and 22 respectively by pipes 23 and 24. The outer ends of cylinders 8 and 9 are respectively connected to the ports 25 and 26 of valves 22 and 21 by pipes 27 and 28. The pumps 29 and 30 of pumping units P1^s and P2^s respectively, are connected to the ports 31 and 32 of valve 22 by pipes 33 and 34. Pumps 29 and 30 are also connected to the ports 35 and 36 of valve 21 by pipes 37 and 38. Valves 21 and 22 comprise cylindrical casings 39 and 40 respectively, having valve elements 41 and 42 operating therein. These valves are connected for simultaneous movement by a rod 43 and are connected to the piston 44 of a fluid motor 45 by a second rod 46. Fluid motor 45 comprises a cylinder 47 in which the piston 44 operates. One end of cylinder 47 is connected to a shuttle valve 48 by means of a pipe 49, the shuttle valve 48 in turn being connected to pipes 33 and 37 by pipes 50 and 51 respectively. The other end of cylinder 47 is connected to a shuttle valve 52, by a pipe 53, shuttle valve 52 in turn being connected to pipes 34 and 38 by pipes 54 and 55 respectively. Thus, when fluid under pressure is discharging from pump 29 through pipe 33 or 37, fluid enters the cylinder 47 through pipe 49, thereby actuating the valve elements 41 and 42 to the position shown in Figs. 1 and 7. In the event fluid under pressure is discharged through pipe 33, pipe 37 is connected to suction, as is well known in pumps of the character herein shown. Under these conditions fluid from pipe 33 enters port 31 of valve 22, and then passes to the end of cylinder 7 through pipe 24 and to cylinder 8 through pipe 27, causing the crosshead 14 to move in a counterclockwise direction. The fluid in cylinders 6 and 9 now enters valve 21 through pipes 23 and 28 respectively, and returns to pump 29 through pipe 37. In the event that fluid is delivered to pipe 37 fluid enters the ends of cylinders 6 and 9 through pipes 23 and 28 respectively, while the fluid in cylinders 7 and 8 is returned to valve 22 through pipes 24 and 27, from which it flows to pump 29 through pipe 33.

When valves 21 and 22 are in the position shown in Figs. 1 and 7, it will be noted that valve elements 41 and 42 close ports 36 and 32 respectively, thereby preventing the flow of fluid to or from pump 30 during operation of pump 29. It will also be observed that when pump 30 is placed on stroke so as to deliver fluid pressure to pipes 34 or 38, this fluid pressure is communicated to shuttle valve 52 through pipe 54 or 55, as the case may be. From shuttle valve 52 fluid is delivered to the opposite end of motor 45, causing the piston 44 operating therein to actuate valve elements 41 and 42 to the opposite end of cylinders 39 and 40. When this occurs valve elements 41 and 42 close ports 35 and 31 respectively, thereby preventing fluid to flow to or from pump 29. However, ports 36 and 32 of valves 21 and 22 respectively, are uncovered, thereby connecting the cylinders of motor M^s to pump 30.

In the event that pump 30 is so adjusted as to deliver fluid pressure to pipe 34, pipe 38 is connected to suction. Under these conditions the fluid entering port 32 of valve 22 now flows

to the end of cylinder 7, through port 20 and pipe 24. Fluid also enters the end of cylinder 8 through port 25 and pipe 27. The fluid in cylinders 6 and 9 now flows to valve 21 through pipes 23 and 28 and is then returned to the pump 30 through pipe 38. When this occurs crosshead 14, and consequently rudder 18 is moved in a counter-clockwise direction. In the event that pump 30 is now so adjusted as to deliver fluid pressure to pipe 38 and suction to pipe 34, fluid from pipe 38 enters valve 21 through port 36. The fluid so entering valve 21 is then conducted to the end of cylinder 6 through port 19 and pipe 23. Fluid also enters the end of cylinder 9 through port 26 and pipe 28. The fluid in cylinders 7 and 8, however, is now returned to pump 30 through pipes 23 and 27, respectively, valve 22 and pipe 34. Crosshead 14, and consequently rudder 18, now swing in a clockwise direction.

Motor M^s is similar in construction to motor M^s, and also comprises a pair of substantially parallel rams 4' and 5'. Ram 4' operates in a pair of spaced, axially disposed cylinders 6' and 7', while ram 5' operates in a pair of similarly disposed cylinders 8' and 9'. Rams 4' and 5' have also disposed intermediate the ends thereof flat surfaces 10' and 11'. Extending upwardly from flat surface 10' is a projection 12' which operates in an extended slot 13' provided near one end of a crosshead 14', secured intermediate the ends thereof to the rudder post 15'. Flat surface 11' also has projecting upwardly therefrom a projection 16' which operates in the extended slot 17' provided near the other end of crosshead 14'. A rudder 18' is secured to post 15' in any suitable manner.

Port unit 3 is also provided with a pair of changeover valves 21' and 22' (Figs. 1 and 6) for distributing the fluid from pumping units P1^p or P2^p to the proper cylinders of motor M^p.

The outer ends of cylinders 6' and 7' are connected to ports 19' and 20' of changeover valves 21' and 22' respectively by pipes 23' and 24'. The outer ends of cylinders 8' and 9' are respectively connected to the ports 25' and 26' of valves 22', and 21', by pipes 27' and 28'.

The pumps 29' and 30' of pump units P1^p and P2^p are respectively connected to the ports 31' and 32' of valve 22' by pipes 33' and 34'. Pumps 29' and 30' are also connected to the ports 35' and 36' of valve 21' by pipes 37' and 38'.

Valves 21' and 22' also comprise cylindrical casings 39' and 40' having, respectively, operating therein valve elements 41' and 42' interconnected for simultaneous operation by a rod 43'. Valve elements 41' and 42' are also actuated to different positions of adjustment by a fluid motor 45' comprising a cylinder 47' in which operates a piston 44'. Piston 44' is connected to valve element 41' by a rod 46'. When valve elements 41' and 42' are in the position shown in Figs. 1 and 6, ports 36' and 32' are closed, thereby preventing fluid from flowing to or from motor 30'. Pump 29', however, is connected for operation. In the event that fluid from pump 29' is delivered to pipe 37', pipe 33' is connected to suction. Under these conditions fluid enters port 35' of valve 21', and is conducted to cylinders 6' and 9' by pipes 23' and 28' respectively. The fluid in cylinders 7' and 8', however, enters valve 22' through pipes 24' and 27' respectively, and is then returned to pump 29' through pipe 33'. When pipe 33' is connected to pressure and pipe 27' to suction, fluid enters valve 22' through pipe 33' and is then conducted to the ends of

cylinders 7' and 8' by pipes 24' and 27' respectively. The fluid in cylinders 6' and 9' is now conducted to valves 21' by pipes 23' and 28' from which it returns to pump 29' through pipe 37'. The outer end of motor 45' is connected to a shuttle valve 48' by a pipe 49'. Shuttle valve 48' in turn is connected to pipes 33' and 37' by pipes 50' and 51' respectively. The other end of fluid motor 45' is connected to a second shuttle valve 52' by a pipe 53'. Shuttle valve 52' in turn is connected to pipes 34' and 38' by pipes 54' and 55' respectively. Thus, when pump 29' is in operation and is adjusted to on-stroke position so as to deliver fluid pressure to either pipe 33' or 37', the piston 44' of motor 45' actuates the valve elements 41' and 42' to the position shown in Fig. 1, thereby permitting pump 29' to actuate motor M^P as just described, the valve heads 41' and 42' as pointed out before, being so disposed as to prevent fluid from flowing to or from pump 30'. However, when pump 30' is connected for operation so as to deliver fluid pressure to either of pipes 34' or 38' piston 44' actuates valve elements 41' and 42' to their opposite positions of adjustment, thereby closing ports 35' and 31', and thus preventing the flow of fluid to or from pump 29'. Under these conditions ports 36' and 32' of valves 21' and 22' respectively, are uncovered thereby permitting operation of motor M^P by pump 30'.

Pumps 29, 30, 29' and 30' are of the reversible discharge type and may be of the general character of those shown in Patent No. 1,077,989, or of any other suitable type. Pumps 29, 30, 29' and 30' may be driven by electric motors 57, 58, 57' and 58' respectively, or by any other suitable power means. The mechanisms for controlling the stroke and direction of discharge of pumps 29, 30, 29' and 30' are identical in structure and operation, therefore a description of one will suffice for all. For convenience a detailed description of the control mechanism for pump 29 will now be given.

Referring more particularly to Figs. 1 and 2, it will be observed that pump 29 and motor 57 are mounted upon a supply or makeup tank 59 from which fluid may be drawn into the system. Pump 30 and motor 58 are also mounted upon a similar supply or makeup tank 60. Pump 29 is provided with the usual sliding blocks shown at 61 in Fig. 2, for controlling the stroke and direction of discharge thereof. A pair of guide rods 62, 62 are secured at one end thereof to sliding blocks 61, and extend through and are guided in suitable apertures provided in the side wall 64 of the pump casing 65. The outer ends of guide rods 62, 62 are secured to a crosshead 66 which in turn is secured to the free end of the piston rod 67 of a fluid motor 68. Fluid motor 68 may be of the general type shown and described in my Patent No. 1,986,640, and since the specific structure thereof forms no part of the present invention, a detailed description thereof is deemed unnecessary herein.

The fluid motor 68 comprises generally a cylinder 69 having a piston 70 operating therein and to which the other end of rod 67 is secured. A valve 71 slidably mounted in the central bore 72 of piston 70 controls the operation of the latter. Valve 71 extends through a fluid sealed bearing 73 provided in the end wall 74 of cylinder 69, and its outer end has pivotally attached thereto the left hand end of a lever 75 and the right hand end of the arm 76 of a bell crank lever 77. Piston 70 is actuated to different positions of adjustment

by fluid pressure supplied by a small pump 78 mounted at one end of the casing of motor 57 and driven by the armature shaft of the latter, or by any other suitable means. Fluid from supply tank 59 is drawn into pump 78 through a pipe 79 and discharged therefrom through a second pipe 80. Pipe 80 is connected to a port 81 provided in the cylinder 69 of motor 68, and has provided therein a relief valve 82 which in turn is connected to supply tank 59 by a pipe 83. Piston 70 and valve 71 are provided with ports through which fluid is conducted to either end of the cylinder 70 depending upon the direction of movement of valve 71. When the valve 71 is in its central position of adjustment both ends of the cylinder are disconnected from pump 78. However, when valve 71 is moved in either direction from its central position by mechanism hereinafter described, certain ports are uncovered by said valve, thereby causing fluid to actuate the piston 70 correspondingly in the direction of movement of the valve until the ports are again covered thereby at which time piston 70 comes to rest. The sliding blocks 61 of pump 39 being operatively connected to piston 70 are correspondingly adjusted and retained in adjusted position, causing the pump to deliver fluid to pipe 33 or 37, as the case may be. Upon adjustment of piston 70 in this manner the pressure of the fluid delivered by pump 78 builds up, and when this pressure exceeds a predetermined value the fluid discharges to supply tank 59 through relief valve 82 and pipe 83.

Bell-crank lever 77 is pivoted at 84 and its arm 85 has provided near the free end thereof a slot 86 through which extends a pin 87 extending upwardly from one end of a lever 88. Lever 88 is pivoted intermediate the ends thereof upon a pair of springs 89 and 90 mounted in a box 91. Springs 89 and 90 provide a yieldable fulcrum for lever 88. The other end of lever 88 is pivotally attached to the outer end of a rod 92, the inner end of which being rigidly secured to one end of a cam follower 93. Cam follower 93 is actuated to different positions of adjustment by main and return cams 94 and 95 respectively, which in turn are secured in any suitable manner to a supporting member 96 (Fig. 3). The lower end of member 96 has secured thereto a stud 97 upon which is rotatably mounted a bevel gear 98, which, as shown more particularly in Fig. 3, meshes with a pair of spaced bevel gears 99 and 100. Bevel gears 99 and 100 have integral therewith hubs 101 and 102 respectively, which extend through enlarged openings 103 and 104 provided in the side walls 105 and 106 of cam follower 93.

Hubs 101 and 102 are supported intermediate the ends thereof in bearings 107 and 108 respectively. A worm wheel 109 is secured to the outer end of hub 101, while a second worm wheel 110 is secured to the outer end of hub 102. Member 96 is supported by a pair of studs 111 and 112 extending laterally therefrom and which are rotatably mounted in circular recesses provided in the inner surfaces of bevel gears 99 and 100 respectively.

From the foregoing description it will be observed that upon rotation of bevel gear 100, bevel gear 98 is correspondingly actuated and that if bevel gear 99 is held against rotation, gear 98 will simply roll thereon and thus impart a rotary movement to member 96 and consequently to cams 94 and 95. In the event that gear 100 is now held against movement, and bevel gear 99

is properly actuated, bevel gear 98 will be actuated in the reverse direction thereby rolling on gear 100, and thus actuating member 96 and the cams 94 and 95 secured thereto in the reverse direction. The control mechanism for pump 29 thus far described is generally similar to that shown and described in Patent No. 2,111,594, and to which reference may be had for a more complete description of the structure thereof.

Worm wheel 110 meshes with a worm gear 113 secured in any suitable manner to a shaft 114 which in turn may be actuated by a synchronous receiver 115, a hand wheel 116, or by a jack shaft 117 operatively connected to motor M^p, as will appear more fully hereinafter. Worm wheel 109 on the other hand, meshes with a worm gear 118 secured to one end of a followup shaft 119 operatively connected to motor M^s.

As shown more particularly in Figs. 1 and 4, one end of followup shaft 119 is mounted in suitable bearings 120 and 121 extending laterally from cylinders 6 and 7 respectively, of fluid motor M^s. Secured to shaft 119 and disposed intermediate the portion thereof extending between bearings 120 and 121 is a spiral gear 122, which meshes with a spiral rack 123 secured in any suitable manner to ram 4. Owing to the length of shaft 119, other bearings (not shown) may also be provided to prevent flexure thereof. It therefore is seen that upon movement of ram 4 a rotary movement will be imparted to shaft 119. Worm gear 118 now actuates worm wheel 109, and consequently bevel gear 99, which in turn causes a corresponding adjustment of cam follower 93.

Motor M^s has also operatively connected therewith a second followup shaft 124. One end of shaft 124 has secured thereto a worm gear 125 which meshes with a worm wheel 126 attached to one side of differential gearing 127 for actuating the cam follower 128 associated with the control mechanism for pump 30. The other end of shaft 124 is suitably journaled in bearings 129 and 130 extending laterally from cylinders 8 and 9 respectively, of fluid motor M^s. The portion of shaft 124 extending between bearings 129 and 130 has also secured thereto a spiral gear 131 which meshes with a spiral rack 132 secured in any suitable manner to ram 5.

Motor M^p has also operatively connected thereto a pair of similar followup shafts 119' and 124'. Followup shaft 119' has secured at one end thereof a worm gear 118' which meshes with the worm wheel 109', for actuating the bevel gear 99' of the differential gear associated with the control mechanism for pump 29'. The other end of shaft 119' has also secured thereto intermediate its bearings 120' and 121' a spiral gear 122', which meshes with a spiral rack 123' secured in any suitable manner to ram 4'. Followup shaft 124', on the other hand, has secured at one end thereof a worm gear 125' which meshes with the worm wheel 126' secured to one side of the differential gearing 127' associated with the control mechanism for pump 30'. The other end of shaft 124' has also secured thereto at a point intermediate its bearings 129' and 130', a spiral gear 131' which meshes with a rack 132' secured in any suitable manner to ram 5'.

Followup shaft 124' and jack shaft 117 are connected for simultaneous movement by a chain and sprocket mechanism indicated generally at 133. Shaft 124 is operatively connected to a second jack shaft 117' by a chain and sprocket mechanism indicated generally at 134. Thus

upon operation of motor M^p rotary movement is imparted to followup shaft 119' and 124', and jack shaft 117. It is also seen that upon operation of motor M^s rotary movement is imparted to followup shafts 119 and 124, and to jack shaft 117'.

Shaft 117 has secured intermediate the ends thereof a sprocket wheel 135, which is connected by means of a chain 136 to a sprocket wheel 137, keyed or otherwise secured to a clutch element 138 rotatably mounted on shaft 114 (Figs. 1 and 5). Clutch element 138 is held against axial movement by a pair of collars 139 and 140 secured in any suitable manner to shaft 114. Shaft 114 terminates at the right hand end thereof (Fig. 5) in a circular recess 141 provided in a second clutch element 142 secured in any suitable manner to a second shaft 143. Keyed to shaft 114 and disposed between clutch elements 138 and 142 is a third clutch element 144. Fig. 5 shows the elements in normal position in which position clutch element 144 is out of engagement with elements 138 and 142. Clutch element 144 is provided with a circular groove 145 disposed intermediate the ends thereof for receiving a pair of diametrically opposed studs 146, 146 extending inwardly from the bifurcated end of a shifting lever 147 pivoted intermediate its ends at 148. Thus, by swinging lever 147 in one direction the jaws of elements 138 and 144 engage, and accordingly upon rotation of sprocket wheel 137, shaft 114 is also caused to rotate. Upon swinging lever 147 in the opposite direction the jaws of elements 142 and 144 become engaged and consequently shaft 114 is connected to shaft 143, and upon actuation of hand wheel 116 or receiver 115 the said shafts are correspondingly operated. However, when lever 147 is swung into the intermediate position, as shown in Figs. 1, 2 and 5, shafts 114 and 143 are disconnected. Sprocket wheel 137 is also disconnected so as to actuate element 138 about its journal on shaft 114. Synchronous receiver 115, however, is at all times connected to the other end of shaft 114, and upon operation thereof the said shaft is caused to rotate.

Shaft 143 has also associated therewith a limit stop mechanism indicated at 143^a. Limit stop 143^b is of the general type of that shown in my Patent No. 2,013,690 to which reference may be had for a complete description thereof. Suffice it to say that limit stop 143^a is provided for the purpose of preventing overtravel of receiver 115, or hand wheel 116, when clutch elements 142 and 144 are engaged.

The control mechanism for pump 29 also includes means for preventing overloading of the electric motor 57 and associated parts due to excessive pressures in the system. This mechanism includes a fluid motor device 149 comprising a pair of cylinders 150 and 151 having pistons 152 and 153 operating respectively, therein. The piston rod 154 secured to piston 152 extends through a properly sealed opening in one end of cylinder 150. The other end of piston rod 154 is secured to a crosshead 155 to the opposite ends of which are secured a pair of guide rods 156, 156. Rods 156, 156 extend through apertures provided in the annular flange 157 of cylinder 150 and the opposite ends thereof are secured to a second crosshead 158. A pair of coil springs 159, 159 encircle rods 156, 156, and extend between flange 157 and the inner face of crosshead 158. The piston rod 160 for piston 153 is secured to a cross head 161 to the outer ends of which

are also secured a pair of guide rods 162, 162. These guide rods extend through apertures provided in the annular flange 163 of cylinder 151, and are secured at their outer ends to a second crosshead 164. A pair of coil springs 165, 165 extend between annular flange 163 and the inner surface of crosshead 164. The outer ends of cylinders 150 and 151 are connected to a pipe 166 by branch pipes 167 and 168. Pipe 166 is connected to a shuttle valve 169 which in turn is connected to pipes 33 and 37 by pipes 170 and 171, respectively. Lever 75 is pivoted at 172 and the right hand end thereof (Figs. 1 and 2) lies midway between the ends of piston rods 154 and 160. By this construction it is seen that in the event the fluid delivered to pipe 33 or 37, leading from pump 29, exceeds the tension of the springs associated with motor 149, pistons 151 and 153 will move toward each other, thereby engaging lever 75 and actuating the same to a central position. This actuation of lever 75 causes a corresponding adjustment of valve 71, which conditions motor 69 to actuate the stroke controls 61 of pump 29 toward neutral position, thereby reducing the output of the said pump 29.

The control mechanism for pump 30 also consists of a fluid motor 177 similar to motor 69, the valve of which being operatively connected to cam follower 128 by levers 178 and 179. A pair of fluid motors indicated at 180 and operable upon a lever 181 is provided to condition motor 177 to adjust the stroke controls of pump 30 to neutral position in the event excessive pressures are developed in the system. Motor 180 is connected to a pipe 182 by branch pipes 182 and 184, the pipe 182 being connected to a shuttle valve 185, which in turn is connected to pipes 34 and 38 respectively, by pipes 186 and 187.

The side of differential gearing 127 opposite worm wheel 126 is provided with a worm wheel 188 which meshes with a worm gear 189 secured to a shaft 190. Shaft 190, like shaft 114, associated with the control mechanism for pump 29, is adapted to be operated by a synchronous receiver 191, a hand wheel 192, or by jack shaft 117. Jack shaft 117 has secured to the outer end thereof a sprocket wheel 193, which is connected to a sprocket wheel 194, secured to clutch element 195, loosely mounted on shaft 190. A second clutch element 196 is secured to the shaft 197, to which hand wheel 192 is also secured. A slidable clutch element 198, similar to clutch element 144, is disposed between clutch elements 195 and 196, and is adapted to be shifted into engagement with either of said last mentioned elements by a hand lever 199.

The control mechanism associated with pump 29' also comprises a motor 69' for actuating the stroke controls thereof to different positions of adjustment. The valve of motor 69' is operatively connected to the cam follower 93' by levers 77' and 88'. The bevel gear 100' is actuated by worm wheel 110' which meshes with a worm gear 113' secured to a shaft 114'. Shaft 114', like shaft 114, may be actuated by a synchronous receiver 115', a hand wheel 116', or by jack shaft 117'. Jack shaft 117' has provided intermediate the ends thereof a sprocket wheel 135', which is connected to a sprocket wheel 137' by a chain 136'. Sprocket wheel 137' is keyed or otherwise secured to a clutch element 138', loosely mounted on shaft 114'. A clutch element 142' is secured to the shaft 143' to which hand wheel 116' is also secured. A

shiftable clutch element 144', similar to the clutch element 144, is keyed to shaft 114' and is adapted to be moved into engagement with clutch element 138' or 142', by means of a lever 147'.

The control mechanism for pump 23' has also associated therewith a motor unit 149' for actuating the control mechanism for fluid motor 69' to effect an adjustment of the pump controls toward neutral position when the pressure developed thereby exceeds a predetermined value. Motor 149' is connected to a pipe 166' by a pair of branch pipes 167' and 168'. Pipe 166' is connected to a shuttle valve 169' which in turn is connected to pipes 33' and 37' by pipes 170' and 171'.

The side of the differential gearing 127' associated with pump 30' disposed opposite worm wheel 126', is also actuated by a worm wheel 188', which in turn meshes with a worm gear 189', secured to a shaft 190'. Shaft 190', like shaft 190, is adapted to be operated by a synchronous receiver 191', a hand wheel 192', or by jack shaft 117'. Secured to the outer end of jack shaft 117' is a sprocket wheel 193', which is connected to the sprocket wheel 194' by a chain connection. Sprocket wheel 194' is secured to a clutch element 195' rotatably mounted on shaft 190'. A second clutch element 196' is secured to the opposite end of the shaft 197', to which the hand wheel 192' is secured. A shiftable clutch element 198' is keyed to shaft 190' and is adapted to be shifted into engagement with either of elements 195' or 196' by means of a hand lever 199'.

The control mechanism for pump 30' has also associated therewith a fluid motor unit 180' for actuating the controls for fluid motor 177' to effect an adjustment thereby of the stroke controls of pump 30' toward neutral position when the pressure developed thereby exceeds a predetermined value. Motor unit 180' is connected to a pipe 182' by branch pipes 183' and 184', the said pipe 182' being connected to a shuttle valve 185', which in turn is connected to pipes 34' and 38' by pipes 186' and 187' respectively.

Synchronous receivers 191 and 115 are connected to the poles 200 and 201 of a unit selector switch 202 by conductors 203 and 204 respectively. Synchronous receivers 115' and 191' are likewise connected to the poles 205 and 206 of switch 202 by conductors 207 and 208 respectively. Switch 202 is connected to the central contacts 209 of a switch 210 by a series of conductors 211. The port side contacts 212 of switch 210 are connected to the port side contacts 213 of a third switch 214 by conductors 215. The starboard contacts 216 of switch 210 are connected to the starboard contacts 217 of switch 214 by conductors 218. The central contacts 219 of switch 214 are connected to a station selector switch 220 by a series of conductors 221. The poles 222, 223 and 224 of station selector switch 220 are connected to synchronous transmitters 225, 226 and 227 respectively, by conductors 228, 229 and 230. Selsyn transmitters 225, 226 and 227 are connected by gearing 231, 232 and 233 to hand wheels 234, 235 and 236 respectively, which may be positioned at different points on the ship. A contact arm 237 is provided on selector switch 220 to enable selection of any one of the steering stations for operation. Switch 202 is also provided with a contact arm 238 for selecting any one of the synchronous receivers 191, 115, 115' or 191' for

operation. Switch 210 has connected to the central contacts 209 thereof a double-throw switch element 239 which is adapted to connect the said contacts 209 with contacts 212 or 216. The central contacts 219 of switch 214 have also connected thereto a double-throw switch element 240 adapted to connect the said contacts 219 with contacts 213 or 217.

Electric current is supplied to the system just described, by bus bars 241 and 242 leading from any suitable source of supply. These bus bars are connected to two of the contact elements 209 of switch 210, as shown in Fig. 2. A switch 243 is provided to connect or interrupt the circuit, as desired.

From the foregoing description it is thought that the structure and operation of my improved steering mechanism is apparent. However, in order to correlate the various elements thereof a brief résumé of the operation of the apparatus as a whole will now be given.

Let us assume that it is desired to effect steering by manipulation of hand wheel 234 and to connect the synchronous receiver 115 associated with a control mechanism for pump 29 for operation. Contact arm 237 of station selector switch 220 is first moved into contact with pole 222, as shown in Fig. 2. Switch element 240 of switch 214 is now moved into engagement with contact elements 217, while the switch element 239 of switch 210 is moved into engagement with contact elements 216. Contact arm 238 of unit selector switch 202 is now moved in engagement with pole 201 thereof. Switch 243 is also closed, thereby completing the circuit to the electric control system. It is understood that when unit P1^s is in operation pumping unit P2^s is idle, and vice versa when pumping unit P2^s is in operation pumping unit P1^s is idle. The same is true of pumping units P1^p and P2^p; when one of said units is in operation the other is idle.

Let us assume that it is desired to have pumping unit 29' operate motor M^s in unison with the operation of motor M^s by pump 29. Lever 147' is now swung in a clockwise direction (Figs. 1 and 2) whereby the jaws of clutch elements 138' and 144' are brought into engagement. Lever 147 is also swung in a clockwise direction to connect clutch elements 142 and 144, thereby connecting limit stop 143^a for operation. Now upon operation of hand wheel 234 current is generated in synchronous transmitter 225, which, through switch 220, conductors 221, switch 214, conductors 218, switch 210, selector switch 202, and conductors 204 is conducted to synchronous receiver 115, causing the latter to rotate shaft 114.

The worm gear 113 secured to shaft 114 now rotates worm wheel 110, and consequently bevel gear 100. Inasmuch as the rams 4 and 5 of motor M^s at this time are stationary, bevel gear 99 provided at the opposite side of the differential gear transmission is held stationary. Thus, upon actuation of bevel gear 100 as just described, a rotary movement is imparted to bevel gear 98, which simply rolls upon bevel gear 99, thereby swinging supporting member 96, and consequently cams 94 and 95, which in turn impart translational movement to the cam follower 93. This movement of cam follower 93 tilts levers 88 and 77, thereby causing an adjustment of the valve 71 of fluid motor 69. When this occurs fluid from pump 78 passes through ports provided in motor 69, and thereby effects an adjustment of the piston 70 thereof in the direction of move-

ment of valve 71, and consequently causing a corresponding adjustment of the sliding block 61 of pump 29. Movement of piston 70 continues until the ports uncovered by valve 71 are closed, at which time piston 70 comes to rest and the pump 29 remains on stroke.

Let us assume that the pump has been so adjusted as to deliver fluid pressure to pipe 33 and suction to pipe 37. Fluid pressure from pipe 33 now enters the outer end of fluid motor 45 through pipe 50, shuttle valve 48, and pipe 49, thereby causing the parts to assume the position shown in Fig. 1. Fluid from pipe 33 now enters valve 22 and flows to the outer end of cylinder 7 of motor M^s through pipe 24 and to the outer end of cylinder 8 through pipe 27. Crosshead 14 of motor M^s, as well as the rudder 18, is now moved in a counter-clockwise direction. Fluid from cylinders 6 and 9 is now returned to valve 21 through pipes 23 and 28 from which it flows back to pump 29 through pipe 37. Upon operation of fluid motor M^s as just described, a rotary movement is imparted to follow up shafts 119 and 124. The followup shaft 119, it will be remembered, has provided thereon worm gear 118 which meshes with worm wheel 109, and consequently the rotary movement imparted to this shaft causes actuation of bevel gear 99.

Inasmuch as bevel gear 100 has now come to rest and is held in position through its connection, bevel gear 98 is caused to rotate in the reverse direction and rolls on bevel gear 100, thereby returning supporting member 96 and cams 94 and 95 to normal position. This movement of cams 94 and 95 is imparted to cam follower 93 which, through levers 88 and 77, adjust valve element 71 of motor 69 in the reverse direction from which it was operated by synchronous receiver 115. The ports of motor 69 are now uncovered and fluid from pump 78 actuates piston 70 in the reverse direction causing actuation of the sliding blocks 61 of pump 29 to neutral position. When piston 70 assumes this position the inlet ports are again covered, and consequently the said piston 70 comes to rest.

Upon actuation of fluid motor M^s as just described, the rotary motion imparted thereby to followup shaft 124 is transmitted by means of the chain and sprocket connection 134, to jack shaft 117'. The rotary motion thus imparted to jack shaft 117' is now imparted to shaft 114' of the control mechanism associated with pump 29' through the chain and sprocket connection between said shafts. Inasmuch as clutch elements 138' and 144' are engaged rotary movement is imparted to shaft 114'. This movement of shaft 114' causes actuation of the worm gear 113' secured thereto, which in turn actuates worm wheel 110' and consequently bevel gear 100' of the differential gearing which through the cams operated thereby effects a translational movement of cam follower 93'. This movement of cam follower 93' is imparted to the valve of fluid motor 69' through levers 88' and 77', causing adjustment of the stroke controls of pump 29'.

Pump 29' has now been adjusted so as to deliver fluid to pipe 37', and suction to pipe 33'. The fluid so delivered to pipe 37' enters valve 21' from which it discharges to the outer ends of cylinders 6' and 9', through pipes 23' and 28', causing crosshead 14' and consequently rudder 18' to move in a counter-clockwise direction. The fluid in cylinders 7' and 8' is now conducted to valve 22' through pipes 24' and 27' respectively, from which it flows back to pump 29' through

pipe 33'. Upon operation of fluid motor M^P rotary motion is imparted to followup shafts 119' and 124'. By this action of followup shaft 119' the worm gear 118' secured to the outer end thereof causes actuation of worm wheel 109', and consequently of bevel gear 99'. This action causes actuation of the cam follower 93' to normal position which in turn through levers 88' and 77' adjusts the valve of fluid motor 69' to normal position, which in turn conditions the latter to actuate the controls of pump 29 to neutral position. During operation of the apparatus, should an abnormal load be imposed upon the pumps 29 and 29', such as a heavy wave striking the rudders 18 and 18', the fluid motors 149 and 149' will effect an adjustment of the stroke controls of the pump toward neutral position. Under these conditions it will be seen that the pistons 152 and 153 of fluid motor 149 move toward each other, thereby centering lever 75, which in turn adjusts valve 71 toward normal position. Piston 70 now actuates the stroke control 61 of pump 29 toward neutral. When lever 75 is operated in this manner bell-crank lever 15 is also operated, and inasmuch as cam follower is held against movement by the gearing associated therewith, lever 88 will now pivot about its connection with rod 92. This action of lever 88 is permitted by virtue of the springs 89 and 90, which constitute the resilient fulcrum therefor. The stroke controls of pump 29' are also adjusted toward neutral position in a similar manner by the operation of fluid motor 149'.

In the event it is desired to have pump 30' operate motor M^P during operation of motor M^S by pump 29, clutch element 144' is moved out of engagement with element 138', while the clutch element 198' associated with the control mechanism for pump 30' is actuated to the left so that the jaws thereof engage with the jaws of clutch element 195', thereby operatively connecting shaft 190' with jack shaft 117'. Now upon operation of motor M^S rotary motion will be imparted to shaft 190', and consequently to the worm gear 189' secured thereto through followup shaft 124, chain and sprocket connections 134, jack shaft 117', and chain and sprocket mechanism 193' and 194'. When clutch elements 195' and 198' are so engaged the operation of the parts is identical to those previously described in connection with the control mechanism for pump 29'.

If it is desired to operate pump 30 from any of the steering stations 234, 235 or 236, contact arm 238 of switch 202 is moved into engagement with pole 200, thereby connecting the synchronous receiver 191 associated with the control mechanism for pump 30 for operation. Now upon adjustment of the controls of pump 30 to on-stroke position, as described in connection with the discussion of pump 29, fluid pressure may be delivered to pipe 34 or 38, as the case may be. When this occurs valve elements 41 and 42 of valves 21 and 22 respectively, are moved to the opposite position of adjustment by the operation of motor 45 which, it will be remembered, is now connected to pipes 34 and 38 through pipe 53, shuttle valve 52, and pipes 54 and 55. If it is desired that pump 29' shall operate motor M^P, while pump 30 operates motor M^S, clutch elements 138' and 144' are engaged, and the operation previously described is repeated.

If, on the other hand, it is desired to employ pump 30' for actuating motor M^P, clutch elements 138' and 144' are disengaged, and clutch

elements 195' and 198', associated with the control mechanism for pump 30' are engaged.

If it is desired to connect, for example, synchronous receiver 115' for operation with any of the steering stations, the contact arm 238 of switch 202 is moved into engagement with pole 205, and switch elements 239 and 240 of switches 210 and 214, respectively, are moved into engagement with contact elements 212 and 213. Now, upon operation of hand wheel 234, for example, rotary motion is imparted to synchronous receiver 115' which, through the connection previously described, causes adjustment of the valve associated with motor 69', which in turn causes proper adjustment of the stroke controls of pump 29'.

If it is desired to have pump 29 operate in unison therewith the clutch elements 138 and 144 associated with the control mechanism therefor are engaged. Now upon operation of motor M^P by pump 29', a rotary motion is imparted to followup shaft 119' and 124'. By virtue of the connection of followup shaft 119' with the gearing for adjusting cam follower 93' associated with the control mechanism for pump 29', the pump controls are returned to neutral position. On the other hand, the rotary motion imparted to followup shaft 124' is transmitted to jack shaft 117 by the chain and sprocket connection 133. Inasmuch as clutch elements 138 and 144 are now engaged, the rotary movement so imparted to pack shaft 117 is imparted to shaft 114, thereby causing actuation of worm gear 113, which in turn actuates worm wheel 110, and bevel gear 100. By this action, as previously described, the valve 71 of fluid motor 69 is properly adjusted, which in turn conditions the piston 70 for operation, which in turn adjusts the stroke control 61 of pump 29 to on-stroke position. Pump 29 now delivers fluid pressure to motor M^S.

Upon operation of motor M^S rotary motion is imparted to followup shaft 119, which is transmitted to bevel gear 99 through worm gear 118 and worm wheel 109, thereby causing cam follower 93 to actuate the valve 71 of motor 69 to neutral position, and thereby effect adjusting of the stroke controls 61 of pump 29 to neutral position, as previously described.

In the event that it is desired to condition pump 30 for operation during operation of pump 29', clutch elements 195 and 198 of the control mechanism for pump 30 are moved into engagement. The followup shaft 124' will now transmit motion to shaft 190 which in turn adjusts the valve associated with fluid motor 177 whereby the latter in turn adjusts the stroke controls of pump 30 to on-stroke position. Pump 30 now effects a corresponding movement of motor M^S as previously described.

Upon operation of motor M^S the operation of the followup shaft 124 associated therewith by virtue of the worm gear 125 secured thereto causes actuation of the differential gearing 127 in the reverse direction, to return cam follower 128 to its previous position of adjustment. This movement of cam follower 128 is transmitted to the valve of fluid motor 177, which again conditions the latter for operation so as to return the stroke controls of pump 30 to neutral position.

If it is desired to operate the controls of pump 30' from any one of the steering stations previously described, contact arm 238 of switch 202 is moved into engagement with pole 206. Now upon operation of hand wheel 234, for example, adjustment of the stroke controls of pump 30' is

effected, as previously described in connection with the description of pump 29'.

The control mechanisms for pump 29 or 30 may be connected so as to condition either of said pumps for operation during operation of pump 30' by simply manipulating the clutches previously described. If it is desired to operate pump 29 in conjunction with pump 30', clutch elements 138 and 144 are engaged by the operation of lever 147. If, on the other hand, it is desired to have pump 30 operate in conjunction with pump 30', clutch elements 195 and 198 are engaged by manipulation of lever 199. It therefore is seen that a highly flexible control system has been provided, whereby either one of the starboard units P1^s or P2^s may operate in conjunction with either of the port units P1^p or P2^p.

In the event it is desired to effect steering without the use of the electrical system just described, switch 239 is opened. If it is desired, for example, to effect steering by manipulation of hand wheel 116 associated with the control unit for pump 29, clutch elements 142 and 144 are engaged, thereby connecting shafts 143 and 114 for operation. Now upon movement of hand wheel 116 in either direction, worm gear 113 is rotated, which causes operation of bevel gear 100, as previously described; which through the differential gear, cam follower 93, and levers 88 and 77, causes adjustment of valve 71 of motor 69, whereupon the sliding blocks 61 of pump 29 are actuated to on-stroke position. The same procedure is followed if it is desired to effect manual steering by manipulation of hand wheel 116' associated with the control mechanism for pump 29'. To connect hand wheel 116' for operation, lever 197' is so operated as to move clutch element 144' into engagement with clutch element 142'. Manual steering may also be effected by manipulation of hand wheel 192 associated with the pump controls for pump 30 by simply engaging clutch elements 198 and 196. Manual steering may also be effected from hand wheel 192' by simply engaging clutch elements 196' and 198'.

To condition pump 29' for operation with pump 29 under these conditions clutch element 144' is moved into engagement with clutch element 138' as previously described. If it is desired to operate pump 30' in conjunction with pump 29, clutch elements 195' and 198' are engaged. Pump 29 or pump 30 may also be conditioned to operate in conjunction with pump 29' or pump 30' by adjustment of the clutch elements as previously described. It therefore is seen that a highly flexible control system has been provided which enables steering from a multiplicity of sources. By interconnecting the controls of one unit with those of another unit, the effort required to adjust the controls is reduced to a minimum. It is also seen that in the event of injury to the electrical control system steering may be effected manually.

Fig. 9 shows an alternative construction which may be employed in certain installations. In this construction the fluid motors for adjusting the stroke control elements of the pumps are eliminated. In this construction it will be observed that a pump 29^a is driven by an electric motor 57^a, both of which being mounted upon a supply or makeup tank 59^a. The sliding blocks 61^a are connected to a crosshead 66^a which in turn is connected to one end of a rod 250. The other end of rod 250 is pivotally attached to the left hand end of a lever 75^a and to the outer

end of the arm 76^a of a bell-crank lever 77^a. The other arm of bell-crank lever 77^a is pivotally connected to one end of a lever 88^a pivoted intermediate its ends upon a pair of coil springs 89^a and 90^a. The other end of lever 88^a is pivotally attached to the outer end of a rod 92^a secured to and extending outwardly from a cam follower 93^a. Cam follower 93^a is actuated by main and return cams 94^a and 95^a, which may be operated by gears 99^a, 98^a and 100^a, similar to those shown in Fig. 3. Bevel gear 99^a is actuated by a worm wheel 109^a which meshes with a worm gear 118^a secured to one end of a followup shaft 119^a. Bevel gear 100^a may be actuated by a worm wheel 110^a which meshes with a worm gear 113^a secured to a shaft 114^a. Shaft 114^a may be actuated by a synchronous receiver 115^a, and also by a hand wheel (not shown) secured to shaft 143^a, or by a jack shaft 117^a, as is the case of the control elements associated with pump 29 shown in Figs. 1 and 2.

Lever 75^a may also be actuated by a safety mechanism comprising the fluid motor 149^a, the opposite ends of which being connected to a pipe 166^a by branch pipes 167^a and 168^a. Pipe 166^a in turn is connected to a shuttle valve 169^a which in turn may be connected to the pipes 33^a and 37^a leading from pump 29^a by pipes 170^a and 171^a. Thus upon operation of cam follower 93^a in either direction, the sliding blocks 61^a of pump 29^a are directly actuated through levers 88^a and 77^a. As pointed out before, the mechanism shown in Fig. 9 is generally similar to that associated with the pumps previously described, except that the power means for actuating the sliding blocks to on-stroke position are eliminated. This mechanism is of a simplified construction and may be used to advantage in installations where the force required to place the pump on stroke is relatively small.

While the embodiments of the invention herein described are admirably adapted to fulfill the objects primarily stated, it is to be understood that it is not intended to limit the invention thereto, since it may be embodied in other forms, all coming within the scope of the claims which follow.

What is claimed is:

1. In a device of the class described, the combination of a fluid motor, power means for actuating said motor, a second fluid motor, a second power means for actuating said second fluid motor, means operated by said second fluid motor for controlling the operation of said first mentioned power means, and means operated by said first mentioned fluid motor for controlling the operation of said second mentioned power means.

2. In a device of the class described, the combination of a fluid motor, a pump for actuating said fluid motor, control means for said pump for controlling the operation thereof, a second fluid motor, a second pump for actuating said second motor, control means for said second pump, means actuated by said first mentioned motor for adjusting the controls of said second mentioned pump, and means actuated by the operation of said second mentioned fluid motor for adjusting the controls of said first mentioned pump.

3. In a device of the class described, the combination of a fluid motor, a pump for actuating said fluid motor, followup mechanism actuated by said motor, a second fluid motor, a pump for actuating said second fluid motor, a followup mech-

anism operated by said second motor, means operated by said first mentioned followup mechanism for controlling the operation of said second pump, and means operated by said second followup mechanism for controlling the operation of said first mentioned pump.

4. In a device of the class described, the combination of a fluid motor, a plurality of independently operable pumping units adapted to operate said fluid motor, followup mechanism operated by said fluid motor, a second fluid motor, a plurality of independently operable pumping units adapted to operate said second fluid motor, a second followup mechanism actuated by said second fluid motor, means actuated by said first mentioned followup mechanism for controlling the operation in any of said second mentioned pumping units, and means actuated by said second mentioned followup mechanism for controlling the operation of any of said first mentioned pumping units.

5. In a device of the class described, the combination of a fluid motor, a pair of pumping units adapted to actuate said fluid motor, independent control means for each of said pumping units, a second fluid motor, a second pair of pumping units adapted to actuate said second fluid motor, independent control means for each of said second pumping units, means operated by said second fluid motor for controlling the operation of either of said first mentioned pumping units, and means operated by said first mentioned fluid motor for controlling the operation of either of said second mentioned pumping units.

6. In a device of the class described, the combination of a fluid motor, a pump for actuating said motor, control mechanism for said pump for controlling the stroke and direction of discharge thereof, followup means between said motor and said control mechanism for actuating said pump to neutral position, a second fluid motor, a pump for controlling the operation of said second motor, control mechanism for said pump for controlling the stroke and direction of discharge thereof, followup means between said second motor and said second control mechanism for returning the controls of said second pump to neutral position, and means for operatively connecting said first mentioned followup means to said second mentioned control mechanism whereby upon operation of said first mentioned motor said second mentioned pump is actuated to on-stroke position, thereby effecting operation of said second mentioned motor.

7. In a device of the class described, the combination of a fluid motor, a pump for actuating said motor, control mechanism for said pump for controlling the stroke and direction of discharge thereof, followup means between said motor and said control mechanism for actuating said pump to neutral position, a second fluid motor, a pump for controlling the operation of said second motor, control mechanism for said pump for controlling the stroke and direction of discharge thereof, followup means between said second motor and said second control mechanism for returning the controls of said second pump to neutral position, means for operatively connecting said first mentioned followup means to said second mentioned control mechanism whereby upon operation of said first mentioned motor said second mentioned pump is actuated to on-stroke position, thereby effecting operation of said second mentioned motor, and means including a clutch mechanism

for conditioning said second mentioned control mechanism for operation by said first mentioned followup means.

8. In a device of the class described, the combination of a fluid motor, a pump for actuating said motor, control mechanism for said pump for controlling the stroke and direction of discharge thereof, followup means between said motor and said control mechanism for actuating said pump to neutral position, a second fluid motor, a pump for controlling the operation of said second motor, control mechanism for said pump for controlling the stroke and direction of discharge thereof, followup means between said second motor and said second control mechanism for returning the controls of said pump to neutral position, and means for operatively connecting said first and second mentioned followup means to said second and first mentioned control mechanisms, whereby the operation of either of said motors effects a corresponding operation of the other.

9. In a device of the class described, the combination of a fluid motor, a pump for actuating said motor, control mechanism for said pump for controlling the stroke and direction of discharge thereof, followup means between said motor and said control mechanism for actuating said pump to neutral position, a second fluid motor, a pump for controlling the operation of said second motor, control mechanism for said pump for controlling the stroke and direction of discharge thereof, followup means between said second motor and said second control mechanism for returning the controls of said second pump to neutral position, means for operatively connecting said first and second mentioned followup means to said second and first mentioned control mechanisms, whereby the operation of either of said motors effects a corresponding operation of the other, and clutch means for conditioning either of said control mechanisms for operation by said followup means.

10. In a device of the class described, the combination of a fluid motor, a pump for actuating said motor, stroke adjusting means for said pump, control mechanism operatively connected to said stroke adjusting means for controlling the stroke and direction of discharge of said pump, said control mechanism including a differential mechanism, followup means connecting said fluid motor to one side of said differential mechanism, a second fluid motor, a second pump for actuating said second fluid motor, control means for said second pump, followup means connecting said second fluid motor to said control means of said second pump, manual means adapted for connection with the opposite side of said differential mechanism, connecting means also connecting said second followup means to said opposite side of said differential mechanism, and clutch means adapted to connect or disconnect either said manual means or said connecting means from the said opposite side of said differential mechanism.

11. In a device of the class described, the combination of a fluid motor, a pump for actuating said motor, stroke adjusting means for said pump, control mechanism operatively connected to said stroke adjusting means for controlling the stroke and direction of discharge of said pump, said control mechanism including a differential mechanism, a shaft, gearing connecting said shaft to one side of said differential mechanism, power means operatively connected to said shaft, a second fluid motor, a second pump for actuating said last mentioned fluid motor,

control means for said second pump, followup means connecting said second fluid motor to said control means, normally inoperative means connecting said followup means to said shaft, normally inoperative manual means for actuating said shaft, clutch means adapted to connect or disconnect either said normally inoperative means or said manual means from said shaft, and followup means connecting said first mentioned fluid motor to the opposite side of said differential mechanism whereby upon operation of said differential mechanism by said power means, said manual means or said first mentioned followup means, said mechanism is returned to normal position by said second mentioned followup means.

12. In a device of the class described, the combination of a fluid motor, a pump for actuating said motor, stroke adjusting means for said pump, a servo motor operatively connected to said stroke adjusting means for controlling the stroke and direction of discharge of said pump, a valve for controlling the operation of said servo motor, a differential mechanism, means operatively connecting said valve to said differential mechanism, a shaft, gearing connecting said shaft to one side of said differential mechanism, normally inoperative power means operatively connected to said shaft, a second fluid motor, a second pump for actuating said last mentioned fluid motor, control means for said pump, followup means connecting said second fluid motor to said last mentioned control means, normally inoperative means connecting said followup means to said shaft, normally inoperative manual means for actuating said shaft, clutch means adapted to connect or disconnect either said normally inoperative means or said manual means from said shaft, and followup means connecting said first mentioned fluid motor to the opposite side of said differential mechanism, whereby upon operation of said differential mechanism by said power means, said manual means, or said first mentioned followup means, said differential mechanism is returned to normal position by said second mentioned followup means.

13. In a device of the class described, the combination of a fluid motor, a pump for actuating said motor, stroke adjusting means for said pump, a servo motor operatively connected to said stroke adjusting means for controlling the stroke and direction of discharge of said pump, a valve for controlling the operation of said servo motor, a differential mechanism, means operatively connecting said valve to said differential mechanism, a shaft, gearing connecting said shaft to one side of said differential mechanism, normally inoperative power means operatively connected to said shaft, a second fluid motor, a second pump for actuating said last mentioned fluid motor, control means for said pump, followup means connecting said second fluid motor to said last mentioned control means, normally inoperative means connecting said followup means to said shaft, normally inoperative manual means for actuating said shaft, clutch means adapted to connect or disconnect either said normally inoperative means or said manual means from said shaft, followup means connecting said first mentioned fluid motor to the opposite side of said differential mechanism, whereby upon operation of said differential mechanism by said power means, said manual means, or said first mentioned followup means, said differential mechanism is returned to normal position by said

second mentioned followup means, and additional means operable upon said valve for actuating the same toward neutral position should the pressure developed by said pump exceed a predetermined value.

14. In a device of the class described, the combination of a fluid motor, a plurality of pumping units adapted to actuate said fluid motor, valve means disposed between said pumping units and fluid motor for selecting one of said pumping units for operation, independent control means for each of said pumping units, each of said control means including power means for actuating the same, followup means between said motor and each of said pumping units whereby upon operation of said pump by said power means said pump is returned to neutral by operation of said followup means, a second fluid motor, a plurality of pumping units adapted to actuate said second fluid motor, independent control means for each of said second pumping units for controlling the stroke and direction of discharge thereof, each of said control means comprising power means for initially adjusting the stroke of its respective pumping unit, followup means disposed between said second motor and each of said second pumping units for effecting movement of the control means therefor to neutral position after adjustment thereof by said power means, selector means for selecting any one of said power means for operation, means operated by the followup means associated with said first mentioned motor for actuating the control means associated with any one of said second mentioned pumping units, and means actuated by the followup means associated with said second mentioned motor for operating the control means associated with any one of said first mentioned pumping units, and clutch means for rendering effective or ineffective the operation of the control means associated with any of said pumping units by said followup means.

15. A steering mechanism for ships comprising, a pair of rudder operating motors, one or more pumps for operating one of said motors, one or more pumps for operating the other of said motors, independent control means for each of said pumps for controlling the stroke and direction of discharge thereof, a synchronous receiver operatively connected to each of said control means for actuating the same to different positions of adjustment, a selector switch for selecting any one of said synchronous receivers for operation, a plurality of synchronous transmitters for operating said synchronous receivers, and a selector switch for selecting any one of said synchronous transmitters for operation.

16. A steering mechanism for ships comprising a port unit and a starboard unit, each of said units comprising a rudder actuating fluid motor, and a pump for actuating said motor, independent control means for each of said pumps for controlling the stroke and direction of discharge thereof, independent operating means connected to each of said control means for adjusting the latter to different positions of adjustment, followup means connecting said fluid motors with the controls for the associated pumps for returning the same to normal position upon operation of said fluid motors, and means connecting the followup means of the port unit with the pump controls of the starboard unit whereby upon operation of the fluid motor of the port unit the pump of the starboard unit is correspondingly

adjusted causing actuation of the fluid motor of the starboard unit.

17. A steering mechanism for ships comprising a port unit and a starboard unit, each of said units comprising a rudder-actuating fluid motor, and a pump for actuating said motor, independent control means for each of said pumps for controlling the stroke and direction of discharge thereof, independent operating means connected to each of said control means for adjusting the latter to different positions of adjustment, follow-up means connecting said fluid motors with the controls for the associated pumps for returning the same to normal position upon operation of said fluid motors, means connecting the follow-up means of the port unit with the pump controls of the starboard unit whereby upon operation of the fluid motor of the port unit the pump of the starboard unit is correspondingly adjusted, causing actuation of the fluid motor of the starboard unit, and clutch means for connecting or disconnecting the control means for the pump of said starboard unit from the followup means of said port unit.

18. A steering mechanism for ships comprising a port unit, and a starboard unit, each of said units comprising a rudder-actuating fluid motor, and a pump for actuating said motor, independent control means for each of said pumps for controlling the stroke and direction of discharge thereof, independent operating means connected to each of said control means for adjusting the latter to different positions of adjustment, follow-up means connecting said fluid motors with the control means for the associated pumps for returning the same to normal position upon operation of said fluid motors, means connecting the followup means of the port unit with the pump controls of the starboard unit, means connecting the followup means of the starboard unit with the pump controls of the port unit, whereby upon operation of the control means of the pumps for either the port or starboard units by said independent operating means, the control means of the pump associated with the other unit is adjusted by said followup means, thereby causing actuation of the associated fluid motor.

19. A steering mechanism for ships comprising a port unit, and a starboard unit, each of said units comprising a rudder-actuating fluid motor, and a pump for actuating said motor, independent control means for each of said pumps for controlling the stroke and direction of discharge thereof, independent operating means connected to each of said control means for adjusting the latter to different positions of adjustment, follow-up means connecting said fluid motors with the control means for the associated pumps for returning the same to normal position upon operation of said fluid motors, means connecting the followup means of the port unit with the pump controls of the starboard unit, means connecting the followup means of the starboard unit with the pump controls of the port unit, whereby upon operation of the control means of the pumps for either the port or starboard units by said independent operating means, the control means of the pump associated with the other unit is adjusted by said followup means, thereby causing

actuation of the associated fluid motor, and clutch means for connecting or disconnecting the control means for the pumps associated with said port and starboard units from the followup means of said starboard and port units.

20. A steering mechanism for ships comprising a pair of rudders, a pair of fluid motors, one for operating each of said rudders, one or more pumps for operating one of said fluid motors, one or more pumps for operating the other of said motors, independent control means for said pumps for controlling the stroke and direction of discharge thereof, power means for actuating said control means to different positions of adjustment, followup means connecting each of said control means with its associated fluid motor whereby upon operation of said control means by said power means to effect operation of its associated fluid motor said followup means returns said control means to normal position, means connecting the followup means associated with one of said fluid motors with the control means for the pumps for the other fluid motor, means for selecting any one of said power means for operation, and means for operating the power means so selected.

21. A steering mechanism for ships comprising a port unit and a starboard unit, each of said units comprising a rudder, a fluid motor for actuating said rudder, and one or more pumps adapted to operate said motor, independent control means for each of said pumps for controlling the stroke and direction of discharge thereof, a synchronous receiver operatively connected to each of said control means for actuating the same to different positions of adjustment, follow-up means connecting each of said control means with its associated fluid motor for returning said control means to normal position after adjustment thereof by said synchronous receiver, means connecting the followup means of the port unit with the control means of the pumps for the starboard unit, means connecting the followup means of the starboard unit with the controls of the pumps for the port unit, a selector switch for selecting any one of said synchronous receivers for operation, a plurality of steering stations, each of said stations comprising a hand wheel, a synchronous transmitter, and means connecting said hand wheel to said synchronous transmitter, a selector switch for selecting any one of said steering stations for operation, means connecting said station selector switch with the selector switch for said synchronous receivers, and clutches for connecting or disconnecting the said port and starboard followup means from the control means of the pumps for said starboard and port units, whereby upon operation of one of the synchronous receivers associated with the port unit the controls for a pump associated with the starboard units will be actuated by said followup means, and upon operation of one of the synchronous receivers associated with the starboard unit the controls for one of the pumps associated with the port unit will be actuated by said followup means.

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