

Jan. 16, 1945.

C. M. HINES

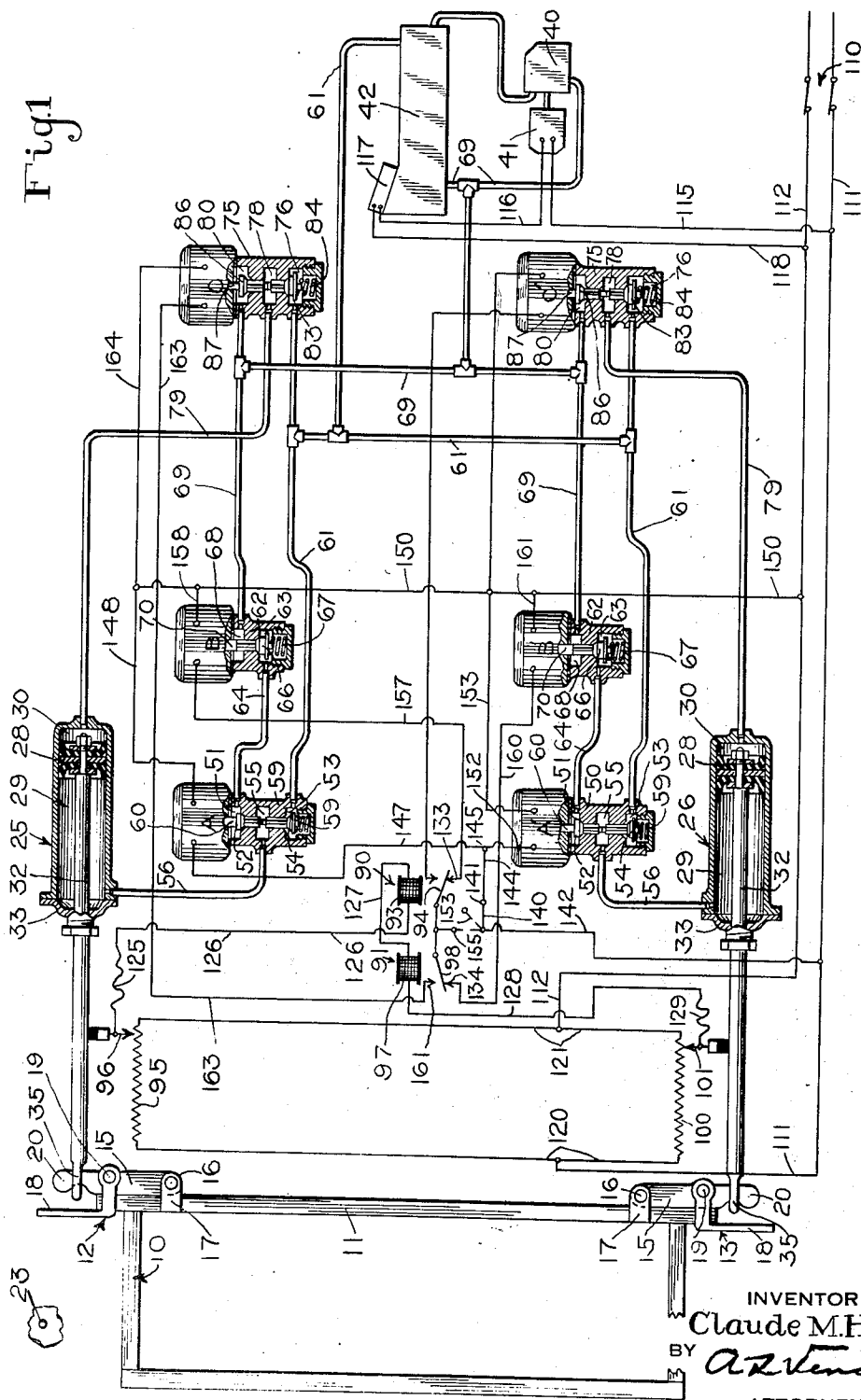
2,367,580

SHIP LAUNCHING MEANS

Filed Sept. 14, 1943

3 Sheets-Sheet 1

Fig. 1



INVENTOR
Claude M. Hines
BY *A. R. Venable*
ATTORNEY

Jan. 16, 1945.

C. M. HINES

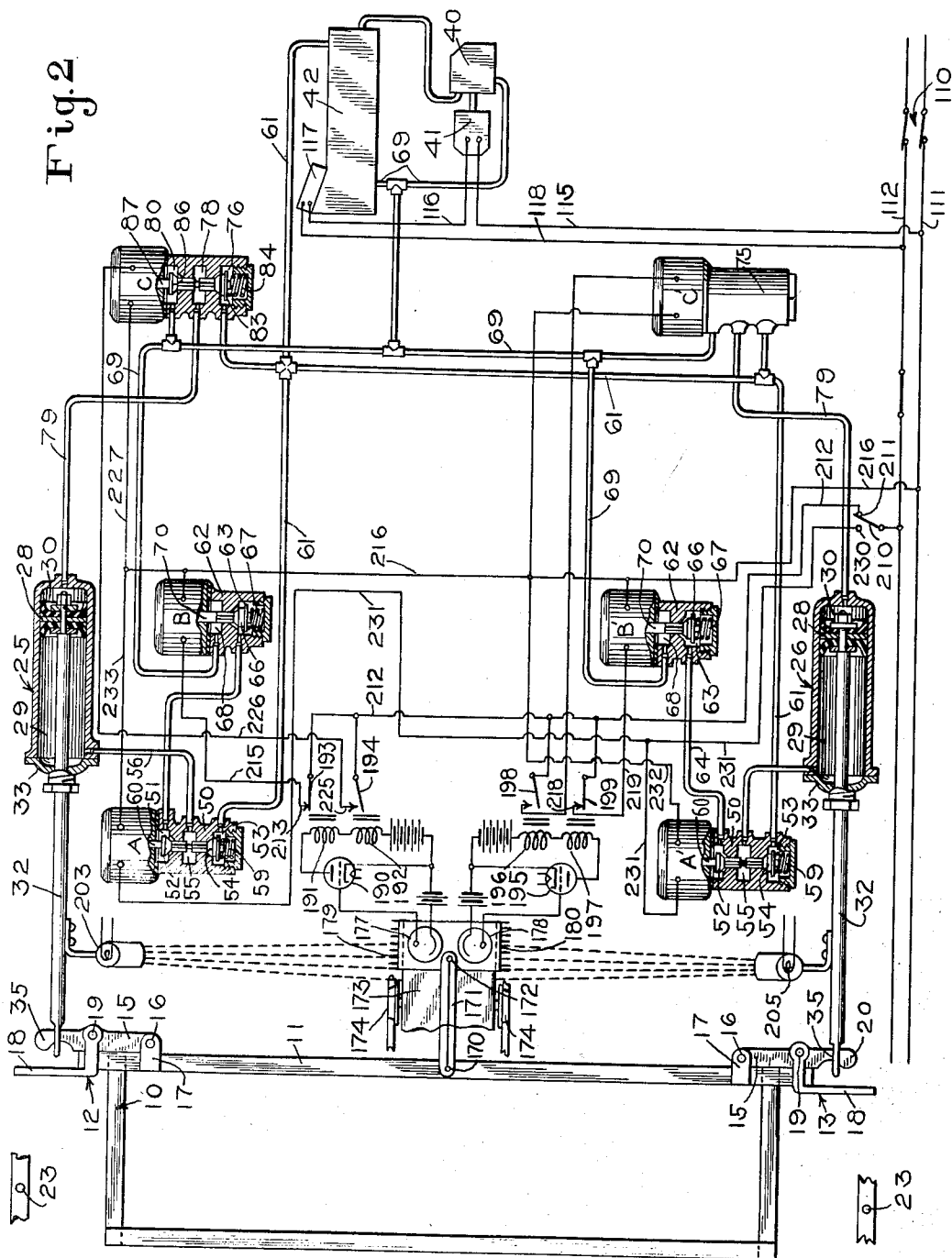
2,367,580

SHIP LAUNCHING MEANS

Filed Sept. 14, 1943

3 Sheets-Sheet 2

Fig. 2



INVENTOR
Claude M. Hines
BY *A. R. Fenwick*
ATTORNEY

Jan. 16, 1945.

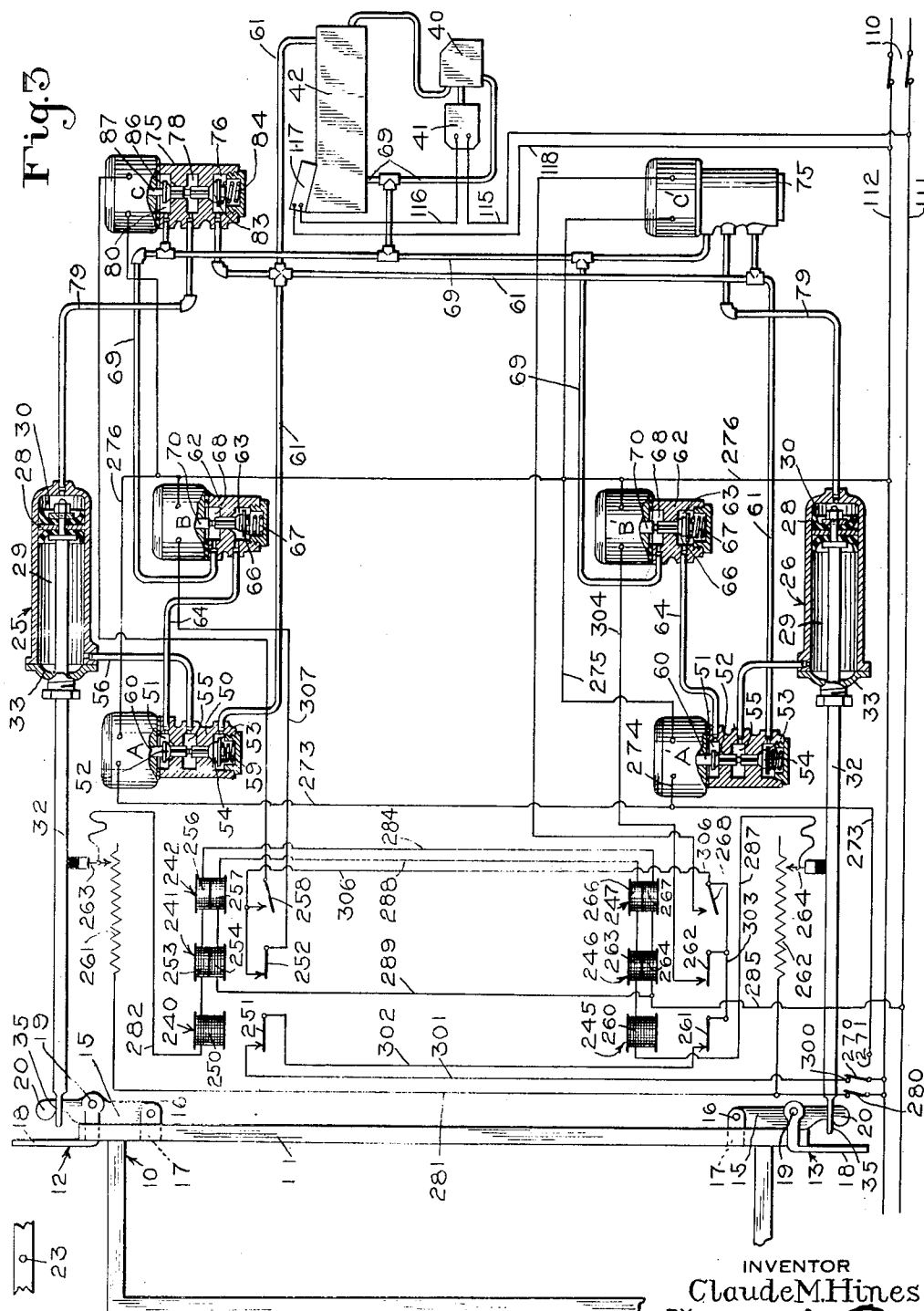
C. M. HINES

2,367,580

SHIP LAUNCHING MEANS

Filed Sept. 14, 1943.

3 Sheets-Sheet 3



INVENTOR
Claude M. Hines
BY *A. A. Venell*
ATTORNEY

UNITED STATES PATENT OFFICE

2,367,580

SHIP LAUNCHING MEANS

Claude M. Hines, Pittsburgh, Pa., assignor to The Westinghouse Air Brake Company, Wilmerding, Pa., a corporation of Pennsylvania

Application September 14, 1943, Serial No. 502,287

23 Claims. (Cl. 61—67)

This invention relates to electrical and fluid pressure control systems, and more particularly to electrohydraulic means for automatically controlling the launching of a boat or ship.

A shipbuilding dock located on a river or inlet that is too narrow to permit endwise launching of a boat is usually arranged to enable a completed hull to be launched broadside or sideways. In such a case the boat may be constructed parallel to the shore on suitable cradles resting on ways which are set at an incline from the building platform to the water. Where circumstances and engineering policy thus make expedient the broadside launching of a boat, careful control must be exercised to start both ends of the hull down the ways simultaneously. The initial stage of such a launching is most important, for any untimely checking of one end of the hull, as it travels down the ways, which allows the other end to overtravel to an appreciable extent, may result in failure of the hull to enter the water in a safe manner, or may even cause complete loss of control and possibly foundering of the vessel.

One object of my invention is to provide improved means for automatically controlling movement of a boat down ways in effecting a broadside launching.

Another object of the invention is to provide hydraulic means adapted to control at least the initial stages of the operation of launching a vessel, including means for scanning the launching motion and responsive to any tendency of the moving hull to assume a faulty or oblique position on the ways for restoring the correct alignment thereof, without unduly interfering with continued progress of the boat toward the water.

It is a further object of the invention to provide improved means for controlling the position of a hull while it is launched sideways, including fluid pressure means operative to control movement of the hull on the ways, detecting means sensitive to development of a slight displacement of one end of the moving hull relative to the other, and controlling valve means responsive to the detecting means for regulating the fluid pressure means.

Other objects and advantages of the invention will appear in the following more detailed description thereof, taken in connection with accompanying drawings, in which

Fig. 1 is a schematic view of a ship launching apparatus constructed and arranged in accordance with the invention, certain elements of the apparatus being shown in section;

Fig. 2 is a schematic, partly sectional, view of a

ship launching apparatus embodying a different form of the invention; and

Fig. 3 is a schematic view, partly in section, illustrating the invention in still another form.

Apparatus shown in Fig. 1

Referring to Fig. 1 of the drawings, the apparatus there illustrated includes a cradle 10 which may be of any suitable construction adapted to support a boat or ship during construction. The cradle 10 is adapted to rest on suitable ways, not shown, on which the cradle and a completed hull are adapted to slide to the left, as viewed in the drawings, when the launching operation is carried out. Forming part of the cradle 10 is a bar 11 which is adapted to be disposed in right angular relation with respect to the ways on which the cradle travels to the water, and which has at one end a trip mechanism 12 and at the opposite end a similar trip mechanism 13. Each of the trip mechanisms 12 and 13 comprises a lever 15 having one end journaled on a pin 16 which is secured to a lug 17 carried by the bar 11, and a latch member 18 which is pivotally connected to a pin 19 secured to the lever intermediate the end carried on pin 16 and an outer end 20. The latch member 18 has a suitably formed clevis portion adapted to fit over the adjacent end of the bar 11 for holding the lever 15 in parallel relation therewith, as shown in the drawings, so long as the cradle remains on the boat building platform prior to launching of the boat. An outer end of each latch member 18 is operatively aligned with a stationary stop element 23, which is arranged to be engaged by the latch member for tripping the mechanism, following a movement of the cradle a predetermined distance toward the water in launching the boat.

For controlling and maintaining correct alignment of the cradle 10 during the initial two or three feet of movement down the ways during a launching, there are provided a pair of hydraulic cylinders 25 and 26, which are disposed parallel to each other and to the direction in which the boat is to be launched, the cylinder 25 being operatively aligned with the trip mechanism 12 and the cylinder 26 similarly arranged with respect to the trip mechanism 13. The hydraulic cylinders 25 and 26 are similar in construction, comprising casing structures that are securely anchored to a stationary part of the building platform, and strong enough to withstand the pull of gravity on the cradle 10 and vessel carried thereby. Each of the hydraulic cylinders contains a piston carrying suitable packing means and forming at one

side thereof a stop pressure chamber 29 and at the opposite side a thrust pressure chamber 30. Secured to each piston 28 and extending through the stop pressure chamber 29 is a piston rod 32, which extends outwardly of the cylinder casing structure through an opening in a cylinder head 33. Each piston is provided with suitable packing means serving to prevent leakage of hydraulic fluid between the stop and thrust chambers 29 and 30. The outer end of each of the piston rods 32 carries a ring or hook portion 35, with which the end 20 of the adjacent trip mechanism lever 15 is adapted to engage, as shown in the drawings.

The apparatus illustrated in Fig. 1 further includes a source of hydraulic pressure comprising a pump 40 operative by an electric motor 41, and an accumulator device 42, which may be of any suitable design and is operative to receive and store up under pressure hydraulic fluid delivered by the pump 40. The accumulator is adapted to deliver fluid at maximum pressure to a high pressure pipe 61.

Associated with each of the hydraulic cylinders 25 and 26 is a group of three magnet valve devices, which are constructed and arranged to control the communication of hydraulic pressure from the accumulator 42 to the respective pressure chambers in the hydraulic cylinders for regulating a launching operation, as hereinafter explained. In Fig. 1 the three magnet valve devices associated with the hydraulic cylinder 25 have been designated by the characters A, B, and C, and exactly similar magnet valve devices controlling hydraulic pressure in the cylinder 26 have been marked A', B', and C'. A description of the magnet valve devices A, B, and C associated with the upper hydraulic cylinder 25 will thus convey a clear understanding of the corresponding magnet valve devices A', B' and C', like reference characters being used to designate the same elements in each case.

The magnet valve device A comprises a casing 50 having formed therein a valve chamber 51 containing a valve element 52, a valve chamber 53 containing a valve element 54, and an intermediate chamber 55, which is always in communication with the stop chamber 29 of cylinder 25 by way of a pipe 56. The valve chamber 53 is connected to the high pressure pipe 61. Both the valve elements 52 and 54 have fluted stems extending through bores in the casing connecting the respective valve chambers to the intermediate chamber 55, in which the fluted stems engage to render the valve elements operative together. A coil spring 59 is interposed between the valve element 54 and an inner wall of chamber 53 for urging that valve element toward its seated position and the other valve element 52 toward a normal unseated position. A plunger 60 is mounted in engagement with the upper valve element 52 for moving both valve elements downwardly upon energization of a suitable coil contained in the magnet valve device A.

The magnet valve device B comprises a casing 62 having formed therein a valve chamber 63 communicating through a pipe 64 with valve chamber 51 of the magnet valve device A. Mounted in the valve chamber 63 is a valve element 66 which is normally urged upwardly by a spring 67 toward engagement with a suitable seat for controlling communication between the valve chamber 63 and a chamber 68, which is connected to a low pressure pipe 69 leading to the sump or low pressure intake portion of the pump and accumulator assembly 40-42. The valve element

66 is adapted to be moved downwardly to an unseated position under the force applied to a plunger 70 mounted in casing 62, upon energization of a magnet coil forming part of the magnet valve device B.

The magnet valve device C comprises a casing 75 in which is formed a valve chamber 76 communicating with the high pressure pipe 61, a central chamber 78 communicating with a pipe 79 leading to the thrust chamber 30 in the hydraulic cylinder 25, and an upper valve chamber 80, which is connected to the low pressure pipe 69 already described. Mounted in valve chamber 76 is a valve element 83, which is normally urged toward its seated position, as shown in Fig. 1, by the force of a spring 84, and which is operative to control communication from the chamber 76 through a suitable bore to the central chamber 78. For controlling communication from the chamber 78 to valve chamber 80 there is provided a valve element 86, which is disposed within the valve chamber 80 and has a fluted stem extending into the chamber 78 where it engages a similar fluted stem of the valve element 83. The valve element 86 is thus subject to the force of the spring 84 and is held in its unseated position while the valve element 83 is in seated position. An electromagnet is provided in the magnet valve device C for moving a plunger 81 that engages the upper valve element 86, in opposition to the force exerted by spring 84.

According to the invention in the form disclosed in Fig. 1, control of both groups of magnet valve devices A, B, and C, and A', B', and C', is maintained through the medium of a pair of directional relay devices 90 and 91, which are adapted to be energized in accordance with any variation in the relative movements of the respective piston rods 32 of hydraulic cylinders 25 and 26, during a boat launching operation as hereinafter explained.

The directional relay 90, comprising a magnet 93 and a movable switch contact member 94 operative thereby, is adapted to be energized by current directed from a variable resistor 95, which is associated with a sliding contact element 96 carried in suitably insulated relation on the piston rod 32 of hydraulic cylinder 25. The other directional relay 91 comprises a magnet 97 and a switch contact member 98, and is arranged for operation in response to the supply of current by way of a variable resistor 100 that is disposed adjacent the piston rod 32 of the hydraulic cylinder 26. A sliding contact element 101, carried on and insulated from the piston rod 32 of hydraulic cylinder 26, is disposed in engagement with the resistor 100 for controlling the flow of current therethrough, as hereinafter explained.

Assuming that a vessel rests on the cradle 10 and is ready to be launched, the launching control equipment shown in Fig. 1 may be conditioned for operation by closing a master control switch 110, which is adapted to establish connection from a source of electric power to a pair of line conductors 111 and 112. Electrical energy is thereby supplied to the motor 41 associated with the compressor 40, by way of the conductor 111, a conductor 115, connected to the motor, a conductor 116 connecting the motor to a compressor governor 117 of suitable design, and a return conductor 118 leading to the conductor 112. It will be understood that the compressor 40 is then rendered operative by the motor 41 to maintain a supply of hydraulic fluid under a predetermined pressure within the ac-

accumulator device 42. The accumulator device 42 thus becomes operative to maintain a predetermined hydraulic pressure throughout the high pressure pipe 61, and in the valve chambers connected thereto, including valve chambers 76 in the respective magnet valve devices C and C', and valve chambers 53 in the magnet valve devices A and A'. As hereinbefore explained, the inlet or sump connections of the compressor 40 and accumulator device 42 communicate with the low pressure pipe 69 leading to the valve chambers 80 of the two magnet valve devices C and C', and to the chambers 68 in magnet valve devices B and B'.

Closure of the master switch 110 also establishes a control circuit which includes the conductor 111, a branching conductor 120, the resistances 95 and 100 connected in parallel thereto, another branching conductor 121, and the return conductor 112. With both pistons 28 of the hydraulic cylinders 25 and 26 disposed in the normal or fully retracted position, as shown in Fig. 1, the slidable contact elements 96 and 101 carried by the respective piston rods are held in similar positions adjacent the ends of the associated resistors 95 and 100. The slidable contact element 96 and the opposite contact element 101 are electrically connected with the two directional relays 90 and 91 by way of a circuit which includes an extensible conductor 125 connected to contact element 96, a conductor 126, the coil 93, a conductor 127, the coil 97, a conductor 128 and another extensible conductor 129 leading to the slidable contact element 101. Since the two slidable contact elements 96 and 101 initially occupy the same starting position with respect to the parallel-connected resistors 95 and 100, substantially no current can normally flow through either of the directionally opposed coils 93 and 97. Consequently the switch contact members of the directional relay devices 90 and 91 are normally disposed in dropped out position, the switch contact member 94 thus normally resting in engagement with a back contact element 133 while the switch contact member 98 similarly engages a back contact member 134.

To establish the supply of hydraulic fluid to the hydraulic cylinders 25 and 26, the movable contact member 140 of a suitable selector switch is moved into engagement with a contact element 141, thereby establishing a circuit which includes the line conductor 111, a conductor 142, contact members 140 and 141, and a conductor 144 leading to a junction point 145, where the circuit divides and continues in one direction through a conductor 147, the coil of the magnet valve device A, a conductor 148, and a conductor 150 connected to the line wire 112. The other branch of this circuit leads from junction point 145 through a conductor 152, the winding of the magnet valve device A', and a conductor 153 connected to conductor 150. With the respective magnets of the valve devices A and A' thus energized, the valve elements 52 and 54 in each device are moved to their respective seated and unseated positions, as shown in Fig. 1, so that hydraulic fluid under pressure is supplied from the accumulator device 42 to the stop chambers 29 of both hydraulic cylinders 25 and 26, by flow through the high pressure pipe 61, valve chamber 53 and chamber 55 in each valve device, and each of the pipes 56. It will be understood that the pressure of hydraulic fluid thus maintained in the stop chambers 29 of both

hydraulic cylinders 25 and 26 exerts a sufficient force through the medium of the corresponding pistons 28 and piston rods 32 to restrain any tendency of the cradle 10 to move down the ways, even after the usual blocks or shoring means have been removed.

With the hydraulic pressure once established in the hydraulic cylinders 25 and 26, the switch contact member 140 may be moved to an intermediate position, indicated by the reference character 153. The resultant deenergization of the magnets of the two magnet valve devices A and A' renders the springs 59 thereof effective to return the associated valve elements to their normal positions. Each valve element 54 is thus seated while the cooperating valve element 52 is unseated. It will be understood that since the magnet valve devices B and B' are at this time deenergized, so that the respective valve elements 66 are maintained in seated position, the unseating of the valve elements 52 of the magnet valve devices A and A' will not cause any reduction in the pressure of fluid in either of the hydraulic cylinders 25 and 26.

When it is desired to effect operation of the apparatus shown in Fig. 1 to permit launching of a boat which has been erected on the cradle 10, the control switch member 140 is moved out of the intermediate position indicated at 153 and into engagement with a contact element 155. With the control switch thus positioned, the magnet windings in both of the magnet valve devices B and B' are simultaneously energized through parallel circuits under the control of the normally deenergized directional relay devices 90 and 91. The energizing circuit for the magnet valve device B includes the line conductor 111, conductor 142, contact members 140 and 155, switch contact member 94, back contact member 133, a conductor 117, the magnet coil B, a conductor 158 and the conductors 150 and 112. The circuit for the other magnet valve device B' comprises, beginning with the common contact element 155 of the control switch, the switch contact member 98 of directional relay 91, the back contact element 134, a conductor 160, the magnet B', and a conductor 161 connected to the conductor 150. Upon energization of the magnet coils of the devices B and B' as just explained, the respective valve elements 66 therein are forced downwardly to their unseated positions.

With both of the magnet valve devices B and B' thus energized to establish communication from the respective stop chambers 29 of the hydraulic cylinders 25 and 26 to the low pressure pipe 69, in each case by way of pipe 56, chamber 55 of valve device A or A', past the unseated valve element 52, through pipe 64 and past the unseated valve element 66, hydraulic fluid is then free to flow from the stop chambers to permit displacement of the pistons 28 to the left, under the force of gravity pulling the cradle 10 down the ways toward the water. Hydraulic fluid is at the same time drawn into the thrust chambers 30 of both hydraulic cylinders, by way of the respective pipes 79 which communicate at this time with the low pressure pipe 69 through the valve chambers 80 and chambers 78 of the deenergized magnet valve devices B and B'. If the launching operation thus proceeds according to plan, with both ends of the cradle moving down the ways at the same rate so that the sliding contact element 96 and 101 remain in balanced relation with respect to resistances 95 and 100 to prevent energization of either of the di-

rectional relays 90 and 91, the cradle 10 will travel toward the water unchecked until the two trip elements 18 engage the corresponding stop members 23 at substantially the same time. The trip members 18 are then actuated to cause the latch levers 15 to become released from the respective piston rods 32.

Let it be assumed, however, that the end of the cradle 10 adjacent the hydraulic cylinder device 25 fails for some reason to travel as fast at the other end of the cradle, so that the boat being launched tends to become canted with respect to the ways. With the sliding contact element 96 carried by the piston rod 32 associated with the hydraulic cylinder 25 thus checked, the continued movement of the other slidable contact element 101 along the resistor 100 at once throws out of balance the circuit which includes the resistors 95 and 100, and the directional relay devices 90 and 91 hereinbefore described. When the slidable contact element 101 is thus caused to overtravel the other slidable contact element 96, the relative reduction in resistance offered by the portion of the resistor 100 in the circuit permits a current to flow through the slidable contact element 101, conductors 129 and 128, coil 97, conductor 127, coil 93, conductors 126 and 125, the other slidable contact element 96, resistor 95 and conductor 121 to the return conductor 112. Current thus passing through the directional coils 97 and 93 effects energization only of the coil 97, so that the movable switch contact element 98 is lifted out of engagement with the back contact member 134 and brought into contact with a front contact element 161, while the other directional relay device 90 remains inoperative.

Disengagement of the switch contact member 98 from the back contact element 134 breaks the circuit for the magnet valve device B' and thus causes movement of the valve element 66 thereof to its seated position. The hydraulic fluid remaining in the stop chamber 29 of the hydraulic cylinder 25 is thereby bottled up, preventing further movement of the associated piston 28 to the left.

At the same time, the switch contact member 98 in engaging the front contact element 161 establishes a circuit for energizing the magnet valve device C, which circuit includes a conductor 163 connected to the front contact element 161, the coil of the magnet valve device C, a conductor 164, and the return conductor 150 leading to the line conductor 112. Upon energization of the magnet valve device C, the associated valve elements 86 and 83 are moved downwardly to their respective seated and unseated positions, with the result that hydraulic fluid at the predetermined pressure maintained in the accumulator 42 is supplied to the thrust chamber 30 of the hydraulic cylinder 25, the fluid under pressure flowing from the high pressure pipe 61 by way of valve chamber 76 of the magnet valve device C past the unseated valve element 83, and thence through chamber 78 and pipe 79 to the chamber 30. The hydraulic pressure thus applied to the piston 28 in hydraulic cylinder 25 is transmitted through the piston rod 32 and the connected latch mechanism 12 to the end of the cradle structure 10 that has just been retarded in its movement down the ways.

It will be apparent that the apparatus shown in Fig. 1 is thus operative to restore the correct alignment of the cradle carrying the vessel toward the water, by simultaneously checking mo-

tion of the advanced end of the cradle, and applying an accelerating or thrust force to the other end thereof to overcome the retarding frictional force that caused the difficulty. As the boat hull and cradle 10 are thereby brought out of an oblique position on the ways and into the correct alignment, the oppositely disposed slidable contact elements 96 and 101 are once again positioned at corresponding points on the respective resistors 95 and 100. The normal balanced condition of the circuit connected to the directional relay devices 91 and 90 is thus restored, and the coil 97 is consequently deenergized.

It will be understood that the foregoing operation may normally be expected to occur quickly, or within a few seconds. Upon deenergization of the magnet coil 97 of the directional relay device 91, the movable switch contact 98 thereof drops away from the front contact element 160, thus breaking the circuit through which the magnet valve device C has been energized, and restoring the circuit for energizing the magnet valve device B'. Upon deenergization of the magnet valve device C, the spring 84 shifts the valve element 83 into seated position while unseating the other valve element 86, so that further supply of hydraulic fluid under maximum pressure to the thrust chamber 30 of the hydraulic cylinder 25 is cut off, while that piston chamber is once again connected with the low pressure or sump pipe 69. The energization of the magnet valve device B' at the same time results in operation of the valve element 66 to reestablish communication between the stop pressure chamber 29 of the hydraulic cylinder 26 to the low pressure pipe 69, to permit the resumption of movement of the associated piston 28.

The cradle 10 is thus conditioned to continue sliding down the ways toward the water in the correct position, the tendency of one end thereof to advance farther than the other having been overcome by the operation of the control apparatus described.

The response of the control apparatus to faulty positioning of the cradle structure 10 on the ways when the end controlled by the hydraulic cylinder 26 overtravels that associated with hydraulic cylinder 25 has just been explained. It will be understood that the equipment is adapted to operate in the same manner in case the cradle should become displaced the opposite direction, with the end controlled by hydraulic piston 25 in advance of the end associated with hydraulic cylinder 26. In such a case the directional relay device 90 would be energized, with the result that hydraulic fluid under pressure would be applied to the piston in the hydraulic cylinder 26, while the further movement of piston in hydraulic cylinder 25 would be stopped temporarily, to effect restoration of the proper alignment of the cradle of the ways.

Apparatus shown in Fig. 2

A ship launching control equipment embodying the invention in a different form is illustrated in Fig. 2 of the drawings. In this case the hydraulic pressure apparatus is substantially similar to that shown in Fig. 1, and the various elements thereof have been represented by the same reference characters applied to the corresponding devices of the apparatus already described. Thus, although certain valve elements, pipes and the like appearing in Fig. 2 are some-

what displaced from the positions occupied by the same elements as shown in Fig. 1, in order to accommodate a different arrangement of the electroresponsive equipment, it will be understood that the hydraulic operation of the system shown in Fig. 2 is essentially the same as that in Fig. 1.

In addition to the hydraulic control elements already described, the equipment shown in Fig. 2 comprises an electronic detector apparatus which is operative to measure and initiate correction of angular displacement of the cradle 10 supporting the boat to be launched. As is shown in Fig. 2, a pin 170 mounted at the center point of the bar 11 of the cradle 10 is pivotally connected through a rod 171 to a pin 172 carried by a light carrier structure 173. Suitable rollers 174 are provided on the carrier structure 173 for permitting it to follow freely the lateral movement of the cradle 10 during initial stages of launching a boat. The rollers 174 are preferably guided by suitable track means (not shown) so that the carrier structure 173 will travel in a fixed path, regardless of any faulty angular movement of the cradle.

Supported on the carrier structure 173 are two oppositely facing photoelectric cells 177 and 178, which are constructed and arranged to respond to the incidence of light rays on lateral windows 178 and 180, respectively, housed on the carrier structure. The photoelectric cells 177 and 178 constitute elements of separate photoelectric relay assemblies, the other elements of which may either be carried on the carrier structure 173 or may be conveniently located elsewhere and connected to the respective photoelectric cells by suitable conductors. As shown in Fig. 2, the photoelectric relay assembly connected to the cell 177 may comprise an amplifier element 190 which is constructed and arranged to respond to current flowing through the photoelectric cell 177 for supplying a corresponding current of increased magnitude through a pair of series-connected electromagnets 191 and 192, which are in turn adapted to control the positioning of a pair of movable switch contact elements 193 and 194, respectively. The same construction is provided in the photoelectric relay assembly associated with the photoelectric cell 178, and may include an amplifier element 195 which is constructed and arranged to deliver current to magnet coils 196 and 197 in accordance with the incidence of light on the photoelectric cell 178. The magnet coil 196 is adapted to control movement of a switch contact member 198, while the other magnet coil 197 is arranged to actuate a switch contact member 199. It should be understood that each photoelectric relay assembly illustrated in Fig. 2 is shown in simplified form, and that in actual practice other types of electronic means might be employed to accomplish the same purpose.

According to the invention as illustrated in Fig. 2, the photoelectric cells 177 and 178 are normally disposed within the paths of light beams projected from corresponding points on the respective piston rods 32 of the hydraulic cylinders 25 and 26. Mounted on the piston rod 32 of the hydraulic cylinder 25 is an electric light element 203, which is adapted to be energized from a suitable source of power, not shown, for focusing a beam of light on the window 179 associated with the photoelectric cell 177. Similarly, an electric light element 205 is secured to the piston rod 32 of hydraulic cylinder 26, and is operative to di-

rect a beam of light through the window 180 to the photoelectric cell 178.

As indicated on the drawings, the windows 179 and 180 are preferably provided with suitable grills which are adapted to admit light rays focused directly on the windows while acting as shields for limiting the effect of light rays entering at oblique angles. It should be understood that the electric light elements 203 and 205 are mounted at the same positions on the respective piston rods 32 and are normally disposed slightly in advance of the center points of the windows 179 and 180 of the carrier structure 173. It will thus be seen that, with the various moving elements of the launching equipment disposed in normal positions, as shown in the Fig. 2, the beam of light directed by each of the light elements 203 and 205 will fall directly on only a portion of the area of the corresponding window and adjacent photoelectric cell. Under this condition each of the photoelectric cells 177 and 178 is adapted to effect energization of the associated photoelectric relay assembly to a normal degree. As hereinafter explained, an increase in the incidence of light on either of the photoelectric cells will result in energization of the associated photoelectric relay assembly to a degree in excess of the normal value. On the other hand, any change in the relative position of either electric light element with respect to the corresponding photoelectric cell causing the light beam to shift away from the photoelectric cell will result in de-energization of the photoelectric relay assembly controlled by that cell.

It should further be understood that the photoelectric relay assembly responsive to incidence of light on the photoelectric cell 177 is so constructed and arranged that, under the normal condition producing normal energization of the magnet coils 191 and 192 in the manner just explained, the switch contact element 193 is picked up while the switch contact element 194 is dropped out, as shown in Fig. 2. Likewise, the other photoelectric relay assembly controlled in accordance with the incidence of light on the photoelectric cell 178 is rendered operative, under the normal conditions specified, to maintain the switch contact element 199 picked up while the switch contact element 198 remains dropped out. A slight increase in the current generated in or controlled by either photoelectric relay assembly will cause both of the switch contact members associated therewith to assume picked up position. On the other hand, a slight decrease in the degree of energization of either photoelectric relay assembly from the normal degree will result in the dropping out of both of the associated switch contact elements.

The launching equipment shown in Fig. 2 can be prepared to control the launching of a completed vessel supported on the cradle 10 in the same manner as has already been described in connection with Fig. 1. A control switch element 210 is first moved into contact with a contact element 211 for establishing circuits for energizing the magnet valve devices B and B'. The circuit through which the magnet valve device B is energized includes the line conductor 112, the switch contact elements 210 and 211, a conductor 212, the relay switch contact element 193, a contact member 213 normally engaged thereby, a conductor 215, the magnet winding of the valve device B, and a return conductor 216 leading to line conductor 111. The second circuit through which current is supplied to energize the

magnet valve device B' comprises the conductor 212, the relay switch contact member 199 and a contact member 218 normally engaged thereby, a conductor 219, the coil of the valve device B' and return conductor 216.

With the cradle 10 disposed in the correct position at right angles with respect to the direction of movement down the ways, so that the electric light elements 203 and 205 are both conditioned to focus beams of light on the forward portions of windows 179 and 180, thereby effecting energization of the two photoelectric relay assemblies at the predetermined normal degree, the switch contact elements 194 and 198 are consequently disposed in their dropped out position, as shown. As hereinafter explained, the switch contact element 194 controls the circuit for energizing the magnet valve C, and the switch contact element 198 forms part of the circuit for energizing the magnet valve device C'. Both of these magnet valve devices are thus initially in their normal or deenergized positions, for connecting the thrust chambers 30 of both hydraulic cylinders to the low pressure pipe 69.

Upon energization of the magnet valve device B and B', as hereinbefore explained, hydraulic fluid is permitted to flow from the stop chambers 29 of the respective hydraulic cylinders 25 and 26 to the low pressure or sump pipe 69, by way of communications in the magnet valve devices A and A' and past the unseated valve elements 66 in the valve devices B and B'. So long as the cradle 10 remains in proper alignment with respect to the ways down which it is sliding towards the water, the electric light elements 203 and 205 carried by the piston rods 32 are maintained in the same normal positions relative to the carrier structure 173 following the cradle. Upon the substantially simultaneous engagement of the trip elements 18 of the latch mechanisms 12 and 13 with the respective stop elements 23, the cradle 10 is finally disconnected from the hydraulic cylinders and travels on into the water in the usual manner.

In the event of excessive motion of one end of the cradle and boat hull with respect to the opposite end, during the first stages of a launching operation, the photo-electric relay assemblies are immediately rendered operative to cause automatic correction of this undesirable condition. Assuming that the end of the cradle carrying the latch mechanism 12 is checked and is overrun by the other end of the cradle associated with the latch mechanism 13, it will be apparent that the resultant excessive movement of the piston rod 32 carrying the electric light element 204 will project the light beam forwardly of and away from the window 180, while on the other hand the electric light element 203 carried on the retarded piston rod 32 of hydraulic cylinder 25 will be projected directly on substantially the entire area of the window 179.

With the incidence of light on window 180 and the associated photoelectric cell 178 thus reduced to a minimum, the reduction in degree of energization of the associated photoelectric relay assembly, and in particular the reduction in current flowing through the coil 197, will cause the switch contact 199 to drop out of contact with the element 218. The magnet valve device B' is thereby deenergized to effect closure of the valve element 66 and consequent bottling up of hydraulic fluid within the stop chamber 29 of hydraulic cylinder 25.

At the same time, the increased current sup-

plied through the coils 191 and 192, due to the full incidence of light on the photoelectric cell 177 just explained, is effective to move the switch contact element 194 into engagement with a contact member 225, while the contact member 193 is maintained in contact with its contact member 213. Closure of the relay switch contact member 194 causes energization of the magnet valve device C through a circuit including the conductor 212, the switch contact members 194 and 225, a conductor 226, the coil of the magnet valve device C, and a conductor 227 connected to the conductor 216. The magnet valve device C is thus rendered operative to effect supply of hydraulic fluid under pressure to the thrust chamber 30 of the hydraulic cylinder 26, so that the end of the cradle 10 which has become stuck is subjected to a force tending to produce forward motion at the same time that the opposite end of the cradle is temporarily prevented from moving.

Upon restoration of the proper alignment of the cradle 10 on the launching ways, the various elements of the control apparatus, including the electric light elements 203 and 205 and the carriage structure carrying the photoelectric cells 177 and 178, are again brought into the same relative positions normally occupied as shown in Fig. 2. Both hydraulic cylinders 25 and 26 are then again conditioned to permit steady progress of the cradle and vessel toward the water without further interference.

When the control switch member 210 is moved out of engagement with the contact member 211 and into engagement with a contact member 230, following completion of the launching of the vessel, the circuits for energization of the magnet valve devices A and A' are established to render those devices operative to supply hydraulic fluid under pressure to the respective stop chambers 29 of hydraulic cylinders 25 and 26, as hereinbefore explained. In Fig. 2, the circuit for the magnet valve A' includes, beginning with the contact 230, a conductor 231, the winding of the magnet A' and a conductor 232 leading by way of return conductor 216 to the line conductor 111. The circuit for the other magnet valve device A includes the conductor 231, the winding of the magnet A, and a conductor 233 leading to the return conductor 216.

Apparatus shown in Fig. 3.

Elements of the hydraulic control apparatus, including the several magnet valve devices, hydraulic cylinders, and source of fluid pressure, are again shown in Fig. 3 of the drawings in association with a still different form of electroresponsive detector apparatus for measuring faulty alignment of the cradle 10 during a launching operation.

The electroresponsive detector apparatus shown in Fig. 3, in association with the hydraulic and mechanical elements of the invention already described, comprises three relays 240, 241 and 242 for controlling operation of the magnet valve devices A, B and C, and three corresponding relays 245, 246 and 247 which are operative to control the other set of magnet valve devices A', B' and C'.

The relay 240 comprises a single coil 250 and a switch contact member 251 adapted to be actuated thereby. The relay 241 is of the polarized type and has a switch contact 252, which is controlled by a pair of magnetically opposed or bucking coils 253 and 254 that are normally co-

operative when energized by like currents to pick up the contact member, as shown in the drawings. The coils 253 and 254 are constructed and arranged to drop out the contact member 252 in response to any increase in the current supplied through the upper coil 253, for a purpose hereinafter explained. The relay 242 also comprises a pair of bucking coils 256 and 257, which are so balanced as to react to equal energizing currents to allow an associated switch contact member 258 to remain in dropped-out position as shown. The relay 242 is of a polarized type and is designed to pick up the switch contact member 258 in response to an increase in the degree of energization of the coil 257, while remaining unresponsive to any increase in the energization of the other coil 256.

The relay 245 is similar to the relay 240 and includes a coil 260 operative when energized to pick up a switch contact member 261. The relay 246, like the relay 241, has a polarized characteristic and includes bucking coils 263 and 264, which when energized by balanced currents, cooperate to hold a switch contact member 262 in picked-up position. The switch contact member 262 is adapted to drop out in response to an increase in the current supplied to the coil 263. The polarized relay 247 comprises balanced opposing coils 266 and 267, which cooperate in response to an increase in current supplied to the coil 267 to pick up an associated switch contact member 268.

According to the invention, the relays 240, 241 and 242 and the associated relays 245, 246 and 247 are jointly controlled through the medium of normally balanced electrical circuit, which are in turn adapted to be energized in accordance with the conditioning of a pair of variable resistors 261 and 262 by the respective piston rods of hydraulic cylinders 25 and 26. The variable resistor 261 has associated therewith a slidable contact element 263 which is secured to the piston rod 32 of the hydraulic cylinder 25. The similar variable resistor 262 is provided with a slidable contact element 264 carried by piston rod 32 of hydraulic cylinder 26. It will be understood that the slidable contact elements 263 and 264 occupy similar relative positions on the respective piston rods, and are thus adapted to establish similar circuit conditions when the hydraulic cylinder devices are operated synchronously during a ship launching operation.

As in the equipments already described, the magnet valve devices A and A' are adapted to be energized to effect supply of hydraulic fluid under pressure from the high pressure pipe 61 to the stop chambers 29 of hydraulic cylinders 25 and 26, in order to condition the ship launching apparatus for operation to control movement of a vessel down the ways. In this case, a control switch member 270 is moved into contact with a contact member 271 to close a circuit which includes the conductor 112, the switch contact members just mentioned, a conductor 273, and a conductor 274 leading by way of the magnet winding A' and a conductor 275 to a return conductor 276 connected to the line conductor 112. The same circuit also includes a parallel branch which consists of the magnet winding of the valve device A, connected to conductor 273, and the return conductor 276. Operation of the magnet valve devices A and A' to supply hydraulic fluid to the hydraulic cylinders 25 and 26 will be understood from the descriptions already presented in

connection with the other embodiments of the invention.

Normal operation of the apparatus shown in Fig. 3 in the launching of a vessel is much the same as that of the previously described equipments. The electrical detector system is conditioned for operation upon closure of a switch 280, for establishing a circuit which includes the line conductor 112, the switch 280, a conductor 281, the resistor 261, the slidable contact element 263, a conductor 282, the series connected coil windings 250, 253 and 256, a conductor 284, the series-connected coil winding 267 and 264 and a conductor 285, leading to the line conductor 111. A parallel circuit normally balanced with that just traced is also established at this time, and includes the emergency switch 280, conductor 281, the resistor 262, the slidable contact element 264, a conductor 287, the series-connected coil windings 260, 263 and 266, a conductor 288, the series-connected coil windings 257 and 254, and a conductor 289 connected to the conductor 285. It will be apparent that since, under normal circumstances the variable resistors 261 and 262 are conditioned to maintain equal amounts of resistance in each of the circuits just traced, substantially similar currents will be supplied to the associated magnet windings of the relays. As already pointed out, such a balanced condition is accompanied by disposition of the movable contact member 251, 252, 261 and 262 in their picked-up or circuit closing positions, while the movable contact members 258 and 268 are normally maintained in their dropped-out or circuit opening positions, as shown in Fig. 3.

With the two sets of relays conditions for normal operation as just explained, the magnet valve devices B and B' are both energized to permit discharge flow of hydraulic fluid from the respective stop chambers 29 of the hydraulic cylinders 25 and 26, in the manner hereinbefore described in connection with the similar devices shown in Figs. 1 and 2. The magnet valve device B' is energized through a circuit which comprises the starting switch element 270, a contact member 300, a conductor 301, the closed switch member 251, a conductor 302, the closed switch contact member 261, a conductor 303, the closed switch contact member 262, and a conductor 304 connected one lead of the magnet B', the other lead of which is connected to the return conductor 276. The magnet valve device B is energized through a parallel branch of the foregoing circuit, which includes, beginning with the conductor 303, a conductor 306, the closed switch contact member 252, a conductor 307, the winding of the magnet B, and the return conductor 276.

The magnet valve devices C and C' are controlled by the relays 242 and 247, respectively, and since the movable contact members associated with these relays are at this time in dropped-out position, these magnet valve devices are thus conditioned to maintain communication between the thrust chambers 30 of the hydraulic cylinders 25 and 26 and the low pressure pipe 69.

To explain the operation of the relays forming the means for detecting movement of the cradle bearing the hull out of proper alignment, it will now be assumed that as the cradle 10 slides down the ways the slidable contact element 263 is caused to move farther to the left than the slidable contact element 264 carried on the opposite hydraulic cylinder piston rod, as viewed in Fig. 3. It will be apparent that in such a case the current passing through the resistor 261, and

through the series-connected magnet coil windings 240, 253, 256, 267 and 264, will be increased with respect to the current flowing in the opposite direction through the associated circuit, already traced. As previously explained, the bucking coils of the relay 241 are so constructed and arranged as to respond to an increase in the current supplied through the coil 253 by dropping out the movable contact member 252. Due to the directional characteristic of the polarized relay 242, the increase in current passing through the coil 256 is not effective to move the switch contact member 258, which remains in its dropped-out position. The polarized relay 247, however, becomes effective to the response to the increase in current supplied to the coil 267 to pick up the switch contact member 268. At the same time the relay 246 remains operative to hold the associated switch contact member 262 in its closed position.

With the polarized relay 241 thus rendered operative to drop out the switch contact member 252, the magnet valve device B is deenergized and the valve element 66 thereof is seated to cut off further discharge of hydraulic fluid from the stop chamber 29 of the hydraulic cylinder 25. Operation of the relay 247 to pick up the switch contact member 268 is at the same time effective to cause operation of the magnet valve device C', in the manner hereinbefore explained, to cause the supply of hydraulic fluid under pressure from the high pressure pipe 61 to the pipe 79 leading to the thrust chamber 30 of the hydraulic cylinder 26. The apparatus is thus automatically operative to halt the overtraveling end of the cradle 10 while exerting a starting force against the end which has become stalled or retarded. Upon restoration of the normal balanced condition of the circuits of the associated relays, as a result of return of the cradle to the proper alignment, the usual launching operation can be continued.

It will be apparent from the foregoing description of several species of the invention that my improved ship launching apparatus will be automatically operative to control the important initial stages of a launching operation in such a manner as to insure maintenance of the correct alignment of the vessel as it proceeds down the ways.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In an apparatus adapted to govern the launching of a vessel, in combination, fluid pressure means for controlling movement of one end of the vessel, fluid pressure means for controlling movement of the other end thereof, and automatic valve means constructed and arranged to control the fluid pressure in both of said fluid pressure means in accordance with the relative motion between the ends of said vessel while it is being launched.

2. In an apparatus adapted to govern the launching of a vessel, in combination, fluid pressure means for controlling movement of one end of the vessel, fluid pressure means for controlling movement of the other end thereof, automatic valve means constructed and arranged to control the fluid pressure in both of said fluid pressure means, and mechanism operative to actuate said valve means in accordance with relative motion between the ends of said vessel while it is being launched.

3. In an apparatus adapted to govern the

launching of a vessel, in combination, fluid pressure means for controlling movement of one end of the vessel, fluid pressure means for controlling movement of the other end thereof, automatic valve means constructed and arranged to control the pressure of fluid in both of said fluid pressure means, and means jointly cooperative with said fluid pressure means for effecting operation of said valve means.

4. In an apparatus adapted to govern the launching of a vessel, in combination, fluid pressure means for controlling movement of one end of the vessel, fluid pressure means for controlling movement of the other end thereof, automatic valve means constructed and arranged to control the pressure of fluid in both of said fluid pressure means, and means jointly cooperative with said fluid pressure means for effecting operation of said valve means, said last named means being constructed and arranged to detect improper alignment of said vessel during the launching operation.

5. In an apparatus adapted to govern the launching of a vessel, in combination, fluid pressure means for controlling movement of one end of the vessel, fluid pressure means for controlling movement of the other end thereof, a source of fluid under pressure, and automatic valve means constructed and arranged to supply fluid under pressure from said source to either or both of said fluid pressure means, in accordance with the relative motion between the ends of said vessel while it is being launched.

6. A ship launching control system comprising a plurality of spaced fluid pressure devices constructed and arranged to govern the launching of a hull sideways, valve means selectively operative to supply and release fluid under pressure to and from said fluid pressure devices, detector means for measuring undue changes in the relative positions of opposite ends of the hull when in motion, and means responsive to said detector means for effecting automatic operation of said valve means.

7. A ship launching control system comprising a plurality of spaced fluid pressure devices constructed and arranged to govern the launching of a hull sideways, and fluid pressure controlled valve means automatically operative, in response to any undue change in the relative positions of opposite ends of said hull when in motion, to effect selective operation of said fluid pressure devices for correcting the position of the moving hull.

8. A ship launching control system comprising a plurality of spaced fluid pressure devices constructed and arranged to govern the launching of a hull sideways, valve means selectively operative to supply and release fluid under pressure to and from said fluid pressure devices, detector means for measuring undue changes in the relative positions of opposite ends of the hull when in motion, and means cooperative with said detector means and with said valve means to establish fluid pressure conditions in each of said fluid pressure devices tending to synchronize the launching movements of both ends of the hull.

9. A ship launching control system comprising a plurality of spaced fluid pressure devices constructed and arranged to govern the launching of a hull sideways, electroresponsive valve means selectively operative to supply and release fluid under pressure to and from said fluid pressure devices, electrical detector means for measuring

undue changes in the relative positions of the opposite ends of the hull when in motion, and means cooperative therewith for controlling circuits for energizing said electroresponsive valve means.

10. A ship launching control system comprising cradle means for supporting a hull, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel of said cradle means in launching the hull sideways, latch means detachably connecting said fluid pressure devices to said cradle means and operative to release said cradle means upon predetermined travel thereof, and automatic valve means constructed and arranged to control the pressure of fluid in each of said fluid pressure devices in accordance with the relative motion between the ends of said cradle means in launching the hull.

11. In a launching control apparatus, in combination, cradle means adapted to support the vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel of said cradle means in launching the vessel sideways, each of said devices including a piston and a cylinder adapted to be charged with fluid under pressure, and valve means automatically operative to control the discharge of said fluid from each of said cylinders in accordance with the relative motion between the ends of said cradle means in launching a hull.

12. In a launching control apparatus, in combination, cradle means adapted to support the vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel of said cradle means in launching the vessel sideways, each of said devices including a piston operative in a cylinder adapted to be charged with fluid under pressure, valve means automatically operative to control the discharge of said fluid from each of said cylinders, and means for scanning the motion of said cradle means in launching the vessel and operative to control said valve means.

13. In a launching control apparatus, in combination, cradle means adapted to support the vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel of said cradle means in launching the vessel sideways, each of said devices including a piston mounted in a cylinder adapted to be charged with pressure, valve means operable to control the pressure of fluid in each of said cylinders, detector means associated with said cradle means and said fluid pressure devices for measuring any change in the alignment of said cradle means in motion, and means responsive to said detector means for controlling said valve means.

14. In a launching control apparatus, in combination, cradle means adapted to support the vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel of said cradle means in launching the vessel sideways, each of said fluid pressure devices comprising a cylinder containing a piston interposed between stop and thrust pressure chambers, valve means operable to control release of fluid selectively from the stop chambers of said fluid pressure devices, other valve means operable to control supply of fluid under pressure selectively to the thrust chambers of said fluid pressure devices, and control means operative to coordinate operation of said valve means

in accordance with relative motion between the ends of said cradle means in launching the vessel.

15. In a launching control apparatus, in combination, cradle means adapted to support the vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel of said cradle means in launching the vessel sideways, each of said fluid pressure devices comprising a cylinder containing a piston interposed between stop and thrust pressure chambers, valve means operable to control release of fluid selectively from the stop chambers of said fluid pressure devices, other valve means operable to control supply of fluid under pressure selectively to the thrust chambers of said fluid pressure devices, and detector means for scanning the motion of said cradle means in launching the vessel, said detector means being cooperative with said valve means, upon overtravel of one end of said cradle means beyond the other, to cause said fluid pressure devices to check the advanced end of said cradle means while applying a thrust force to the trailing end.

16. In a launching control apparatus, in combination, cradle means adapted to support the vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel of said cradle means in launching the vessel sideways, each of said fluid pressure devices comprising a cylinder containing a piston interposed between stop and thrust pressure chambers, valve means operable to control release of fluid selectively from the stop chambers of said fluid pressure devices, other valve means operable to control supply of fluid under pressure selectively to the thrust chambers of said fluid pressure devices, and detector means for scanning the motion of said cradle means in launching the vessel, said detector means being cooperative with said valve means, upon overtravel of one end of the cradle means beyond the other, to check the flow of fluid from the stop chamber of the fluid pressure device controlling the advanced end of said cradle means, while supplying fluid under pressure to the thrust chamber of the fluid pressure device controlling the trailing end.

17. In a launching control apparatus, in combination, cradle means adapted to support the vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel of said cradle means in launching the vessel sideways, each of said fluid pressure devices comprising a cylinder containing a piston interposed between stop and thrust pressure chambers, magnet valve devices operative to release fluid from the respective stop chambers of said fluid pressure devices, other magnet valve devices operative to supply fluid under pressure to the respective thrust chambers of said fluid pressure devices, energizing circuits for said magnet valve devices, and relay means adapted to be energized in accordance with the relative motion between the ends of said cradle means for controlling said circuits.

18. In a launching control apparatus, in combination, cradle means adapted to support the vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel of said cradle means in launching the vessel sideways, a plurality of magnet valve means selectively operable to supply and release fluid under pressure to and from said fluid

pressure devices, relay means controlling circuits through which the magnet valve devices are energized, and means conditioned by the joint action of said fluid pressure devices for controlling energization of said relay means.

19. In a launching control apparatus, in combination, cradle means adapted to support a vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel and alignment of said cradle means in launching the vessel sideways, a plurality of magnet valve devices controlling supply and release of fluid under pressure to and from each of said fluid pressure devices, means constituting opposed electrical circuits that are balanced while said cradle means is maintained in normal alignment, and relay means controlled by said circuits and responsive to an unbalanced condition thereof, resulting from faulty alignment of the cradle means, for selectively energizing said magnet valve devices in order to reestablish proper launching conditions.

20. In a launching control apparatus, in combination, cradle means adapted to support a vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel and alignment of said cradle means in launching the vessel sideways, a plurality of magnet valve devices controlling supply and release of fluid under pressure to and from each of said fluid pressure devices, means constituting opposed electrical circuits each including variable resistor elements controlled by the respective fluid pressure devices, and directional relay means responsive to current set up in one or the other of said circuits upon faulty movement of said cradle means, said directional relay means being constructed and arranged to effect selective energization of said magnet valve devices for maintaining said cradle means in proper alignment.

21. In a launching control apparatus, in combination,

cradle means adapted to support a vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel and alignment of said cradle means in launching the vessel sideways, a plurality of magnet valve devices controlling supply and release of fluid under pressure to and from each of said fluid pressure devices, electronic means constructed and arranged to scan the motion of said cradle means in launching the vessel and operative to effect selective energization of said magnet valve devices for maintaining said cradle means in proper alignment.

22. In a launching control apparatus, in combination, cradle means adapted to support a vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel and alignment of said cradle means in launching the vessel sideways, a plurality of magnet valve devices controlling supply and release of fluid under pressure to and from each of said fluid pressure devices, electronic means constructed and arranged to scan movement of said cradle means in launching the vessel, and relay means controlled by said electronic means for effecting selective energization of said magnet valve devices.

23. In a launching control apparatus, in combination, cradle means adapted to support a vessel to be launched, a plurality of spaced fluid pressure devices constructed and arranged to control lateral travel and alignment of said cradle means in launching the vessel sideways, a plurality of magnet valve devices controlling supply and release of fluid under pressure to and from each of said fluid pressure devices, and photoelectric relay means constructed and arranged to control energization of said magnet valve devices in accordance with the relative motion between the ends of said cradle means during a launching operation.

CLAUDE M. HINES.