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A. L. ASH ET AL

1,935,005

BULKHEAD DOOR, SLUICE GATE, AND THE LIKE

Filed May 17, 1932

3 Sheets-Sheet 1

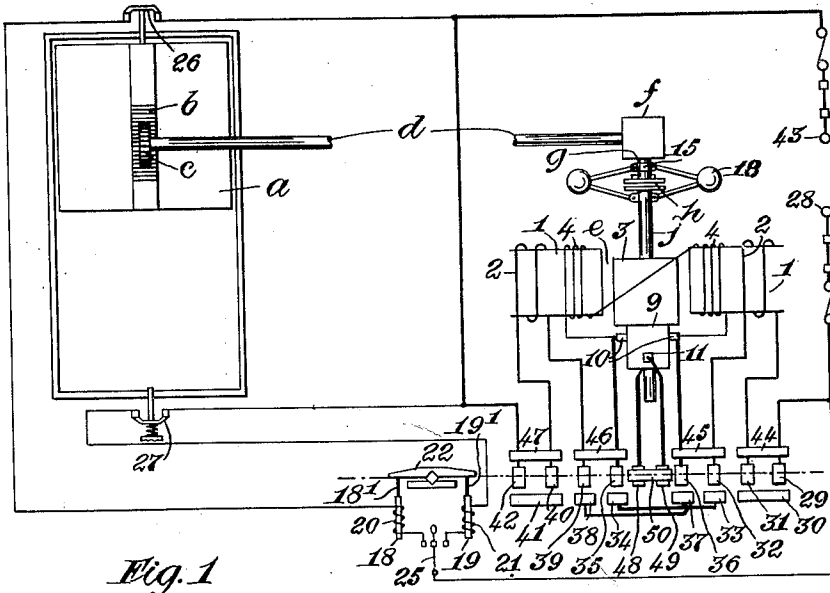


Fig. 1

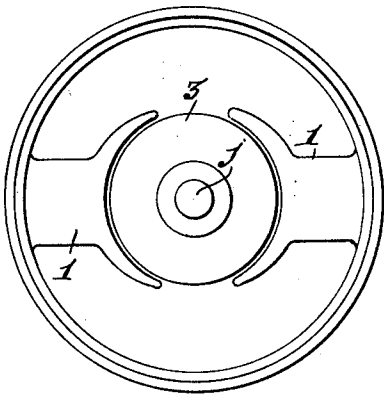


Fig. 3.

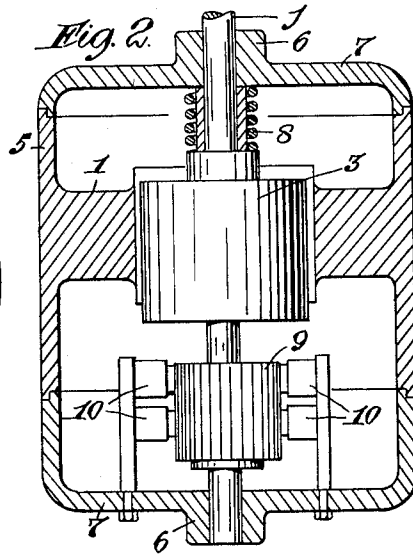


Fig. 2.

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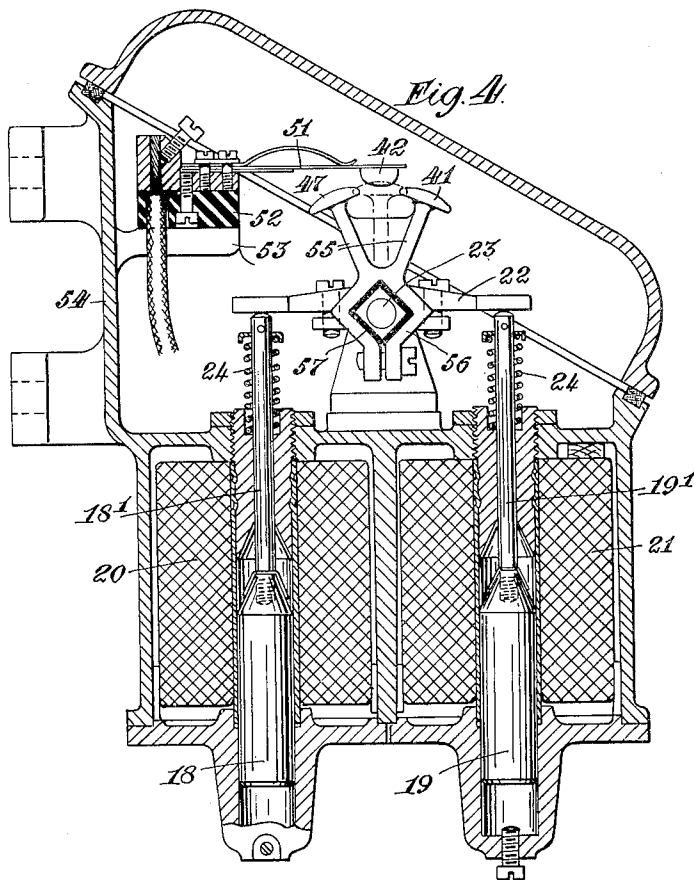
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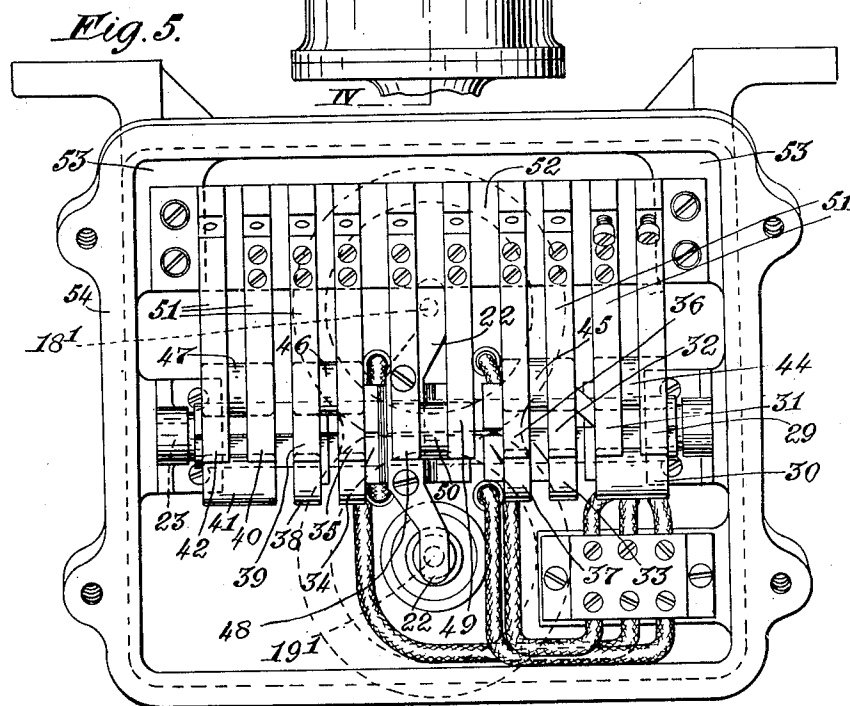
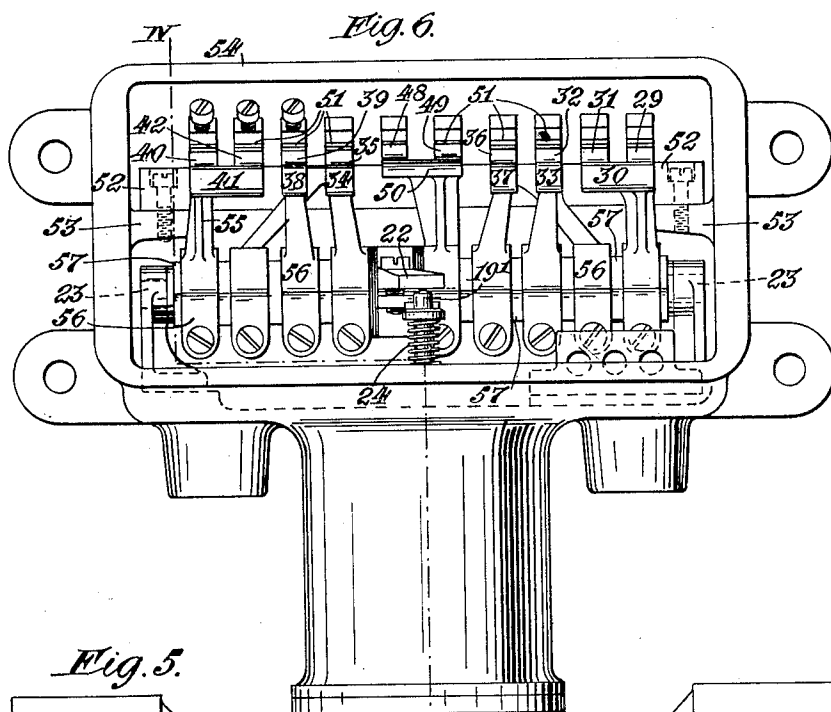
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BULKHEAD DOOR, SLUICE GATE, AND THE LIKE

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

1,935,005

BULKHEAD DOOR, SLUICE GATE, AND THE LIKE

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Application May 17, 1932, Serial No. 611,918, and in Great Britain June 8, 1931

4 Claims. (Cl. 172-239)

This invention relates to electrical operating and controlling apparatus for bulkhead doors, sluice gates and the like and is concerned with improvements in such apparatus wherein the door, gate or the like is operated from an electric motor through a clutch device which is engaged automatically upon the attainment of a predetermined motor speed.

According to the principal feature of the present invention, the electric motor is provided with an armature or rotor which is adapted for being moved axially with variation of its speed of rotation either by the magnetic action between it and its field-system or stator, or by the action of separate speed sensitive means such as a centrifugal governor gear, or by a combination of these two actions. The last named alternative is preferred. This axial movement is useful for two effects: It may be utilized firstly to initiate, effect or assist engagement of the clutch device for connecting the motor to the door, gate or the like, and secondly to produce a change in the strength of field in which the armature is rotating. Thus the field conditions at starting, with the armature out of register with the field system, may be such as to ensure rapid acceleration of the motor, whilst those at working speed, with the armature in its normal position, may be such as to provide the maximum power output. One embodiment of the invention as applied to a bulkhead door is illustrated by way of example in the accompanying drawings, in which:—

Figure 1 is a pictorial circuit diagram, Figures 2 and 3 are a vertical section and end view of an electric motor, and

Figures 4, 5 and 6 a vertical section (on the line IV—IV of Figure 6), a plan view and a part front elevation of an automatic switch.

Referring first of all to Figure 1, the installation illustrated comprises in essentials a bulkhead door *a* with an operating rack *b* meshing with a pinion *c* on a shaft *d*. Said shaft *d* is adapted for being driven, in a manner herein-after described, by a motor *e* through a gear-box *f*, a shaft *g*, clutch *h* and a motor shaft *j*. As illustrated, the electric motor *e* is a direct current machine with two poles 1. Said machine preferably possesses substantially series characteristics, the series windings 2 being designed to give an exceptional field strength so as to obtain the necessary lifting power at an upper speed limit. For the largest bulkhead doors it has been estimated that a motor developing, say, only 1-2 H. P. at 1,000-2,000 R. P. M. should provide ample

power. The motor may be of "crane" rating as its operation is extremely infrequent and of short duration. As will be appreciated, however, it is desirable that the starting torque should be the maximum possible. Subsidiary shunt field windings 4 are provided for influencing the running of the motor as will be explained later. The armature 3 of particularly robust construction is totally enclosed in a cast steel yoke and housing 5 (Figures 2 and 3) and is mounted in bearings 6 provided in the end covers 7. These bearings are advantageously splined sleeve and ball bearings and adapted to permit of axial movement of said armature. With a motor *e* of the rating mentioned above, an axial movement of about $\frac{1}{2}$ " out of the normal field position may be provided for. A loading spring 8 tending to hold the armature 3 in a lowermost position out of register with the poles is interposed between the armature 3 and the upper end cover 7. The commutator 9 is suitably extended to maintain contact, during axial movement of the armature 3, with normal brushes 10 and with subsidiary short-circuiting brushes 11 set at 90 electrical degrees to said normal brushes.

Any appropriate type of robust clutch *h*, such as a dog clutch, able to withstand a heavy impact may be employed, but it is desirable that the clutch should be capable of working in either a horizontal or vertical position. Preferably a centrifugal governor device 12 is provided, as illustrated, for engaging, or for assisting the axial movement of the armature 3 in engaging, the clutch device *h*. It is desirable that this governor 12 should have a substantial flywheel effect; for example with a motor rating such as has been indicated the governor may be designed to accumulate energy up to, say, 350 inch. lbs. at 2,000 R. P. M. The swinging balls or other elements of the governor are connected to and rotate with the armature shaft *j* on one side of the clutch *h* and are connected to a collar 15 free to rotate on, but axially immovable in relation to, the shaft *g* on the other side of said clutch.

The motor controller shown in Figures 4-6 has a rockable contact body with three positions, a "closing" position, an intermediate "off" position and an "opening" position. The controller is operated by the cores 18, 19 of a pair of independent solenoids 20, 21 each effective for moving the rockable contact body to the position required by the energization of that solenoid. The gravity-returned cores engage the rockable contact body by way of rod extensions 18', 19' and a see-saw bar 22 fast on the spindle 23 of said

body, the arrangement being such that when one core is raised by the energization of its solenoid, the other is depressed against a loading spring 24 by the bar 22. When neither solenoid is energized, the loading springs 24 ensure the contact body being definitely held in the off position. The solenoids 20, 21 are selectively energized by a manual remote control switch 25 (Figure 1) or by any one of a number of such switches, having three main positions, in an effective "off" position, and "closing" and "opening" positions in which the corresponding solenoids are energized. The remote control switches may be of the lever pattern, giving a clear indication by their position what operation, if any, is in progress. These control switches 25, which, if preferred, may operate in relay circuits, are arranged to control one door *a*, or a group of such doors. In any case they must be designed for dealing with comparatively highly inductive circuits. The solenoid circuits, or relay circuits, also contain so-called limit switches 26, 27 associated with the door *a* and adapted for automatically breaking the circuit of the energized solenoid 20, 21 and allowing return of the rockable controller contacts to the "off" position at or towards the end of an operation. In the case of the vertically movable door *a*, limit switches of simple construction may be fitted to the door frame and each arranged to make definite contact when not held open by the door. Contact should be broken before the door in closing makes material contact with the bottom sill.

A suitable contact arrangement for the controller is illustrated in Figures 1 and 5. With the rockable contact body in the "closing" position, i. e. with the solenoid 21 energized and said body rocked anti-clockwise (Figures 1 and 4), a circuit is completed from one main terminal 28 through fixed contact 29, rockable contact 30, fixed contact 31, part of the series field windings 2, fixed contact 32, rockable contacts 33 and 34, fixed contact 35, armature 3, fixed contact 36, rockable contacts 37 and 38, fixed contact 39, part of the series field windings 2, fixed contact 40, rockable contact 41 and fixed contact 42, to the other main terminal 43. The shunt field windings 4 across the main brushes 10 assist the series field thus produced. With the contact body rocked in the clockwise direction to the "opening" position a circuit is completed between the main terminals 28, 43 as follows: fixed contact 29, rockable contact 44, fixed contact 31, part of the series field windings 2, fixed contact 32, rockable contact 45, fixed contact 36, armature 3, fixed contact 35, rockable contact 46, fixed contact 39, part of the series field windings 2, fixed contact 40, rockable contact 47 and fixed contact 42. The direction of the current through the series field windings 2 is the same as it was in the previous instance, but that through the armature 3 is reversed, so that the direction of rotation of the motor is reversed. With the rockable contact body in the "off" position, the subsidiary brushes 11 are short circuited by way of fixed contacts 48, 49 and rockable contact 50. The fixed contacts are carried by springs 51 which are supported by an insulating bar 52 from brackets 53 in the controller casing 54. The rockable contacts are carried by arms 55 extending from prismatic bodies 56 which are clamped, over insulation 57, along the spindle 23 (Figures 4 and 6).

The mode of operation of the embodiment described is as follows:—

Let it be assumed that the door *a* is open and

that a control switch 25 at a remote point, for example the bridge of the vessel, is moved over to the closing position. The limit switch 27 at or near the bottom sill of the door being closed, the circuit of the closing solenoid 21 is completed and the rockable contact body of the controller is moved to the "closing" position and acts as a starting switch for the motor *e* by establishing the connections described above. Since the motor-armature 3 is out of register with the field poles 1, it commences to rotate, in the direction for closing the door *a*, in a considerably weakened field with the result that acceleration is rapid. When the speed has reached, say, approximately 2,000 R. P. M., the armature 3 will have moved, assisted by the governor 12, into the normal position relatively to the field poles 1 and the clutch *h* will engage. By this moment considerable power will have been stored in the governor 12 and associated rotating parts, so that on the engagement of the clutch *h*, an impact of substantial force is transmitted to the pinion and rack mechanism *b, c* of the door *a*. Should the first impact be insufficient to start the door moving or should an obstacle be encountered, the motor speed will fall off until the clutch *h* disengages (at a lower speed than it engaged) and allows the motor to re-accelerate for delivering a further impact, the operation being repeated until the succession of impacts dislodges the door. The door *a* will then close under the action of the governor 12, assisted by the motor *e* and gravity, the motor being prevented from running away by its subsidiary shunt field. When the door, approaching the bottom sill, opens the lower limit switch 27, the circuit of the closing solenoid 21 is broken and the rockable contact body of the controller is returned by the spring 24 on the core extension 18' to the "off" position where it short circuits the subsidiary motor brushes 11. The serious hammer stroke which might be caused at the end of the door movement by the momentum of the rotating parts is cushioned by the effect of this short circuit, since the motor acts momentarily as a generator excited by the shunt windings 4, the series windings 2 being unexcited.

Movement of the control switch 25 to the "opening" position results in the door *a* being opened by a similar process, except that the armature 3 is reversed in its rotation. Owing to the taper grooves in which bulkhead doors are customarily arranged to run in order to ensure water-tightness, the properties of apparatus according to the invention are particularly adapted for the opening of a closed door, successive impacts being delivered to the door until the wedging effect in the taper grooves is overcome.

We claim:—

1. Apparatus for operating closures such as bulkhead-doors, sluice-gates and the like, comprising an electric motor whereof the rotor is movable axially into the stator with variation of its speed, a non-slip clutch device arranged between said rotor and said closure, means for automatically engaging said clutch abruptly upon the attainment of a predetermined rotor speed, and a connection between said means and said rotor, whereby axial movement of the latter is utilized to initiate engagement of the clutch.

2. Apparatus for operating closures such as bulkhead-doors, sluice-gates and the like, comprising an electric motor with a strong series field and an armature axially movable with variation of its speed, a non-slip clutch device between the armature and the closure, means for automat-

ically causing said clutch device to be engaged abruptly upon the attainment of a predetermined armature speed, and a connection between said means and said armature, whereby axial movement of the latter is utilized to initiate engagement of the clutch.

3. Apparatus according to claim 2, wherein the motor has a subsidiary shunt field and subsidiary armature brushes, and automatic means is provided for short circuiting said brushes towards

the termination of an operation of the closure, the motor being thereby braked by a regenerative action.

4. Apparatus according to claim 1, comprising a centrifugal governor device connected to the rotor and to one element of the clutch and adapted for causing abrupt engagement of the clutch at a predetermined armature speed.

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