Sept. 13, 1927. 1,642,253

W. S. LEE ET AL

HYDRAULIC GATE

Filed Oct. 4, 1924 4 Sheets-Sheet 1

Fig. 1.

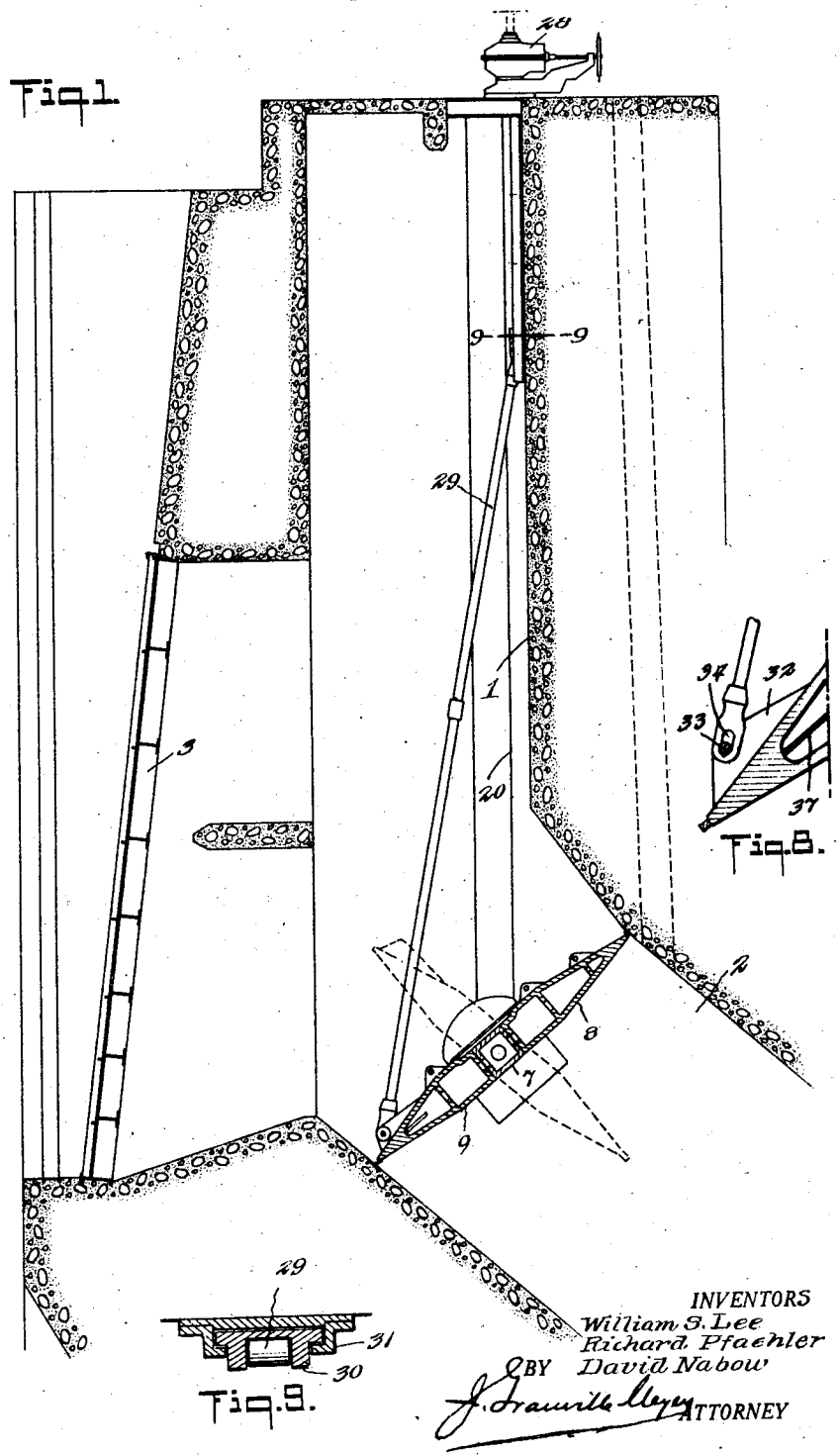


Fig. 8.

Fig. 9.

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HYDRAULIC GATE

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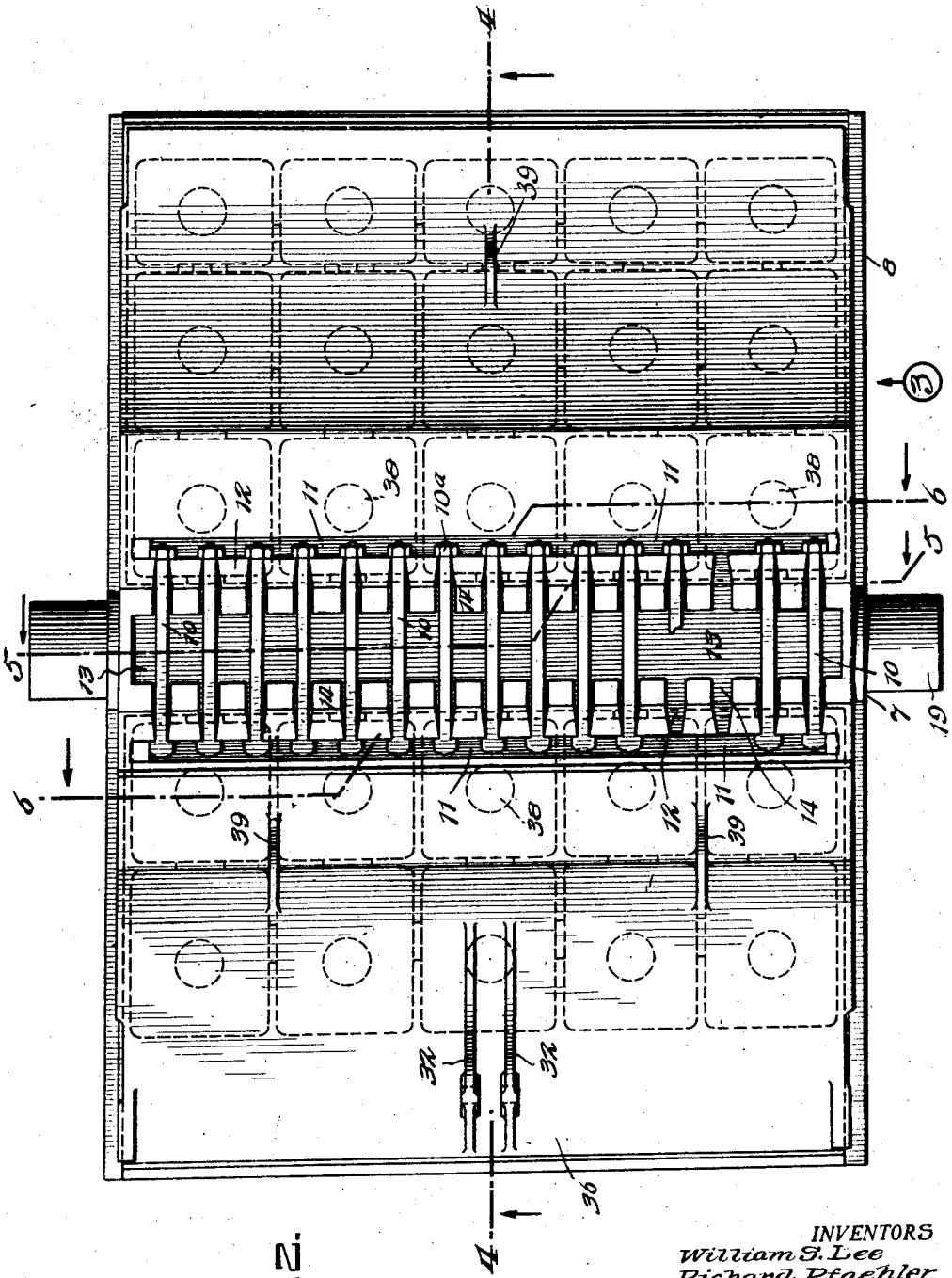


Fig. 2.

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Filed Oct. 4, 1924 4 Sheets-Sheet 3

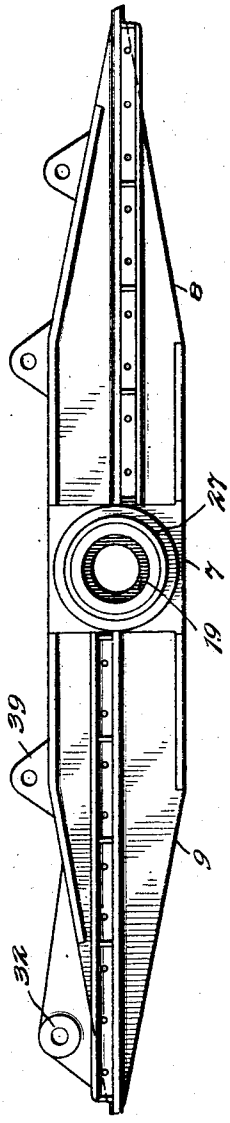


Fig. 3.

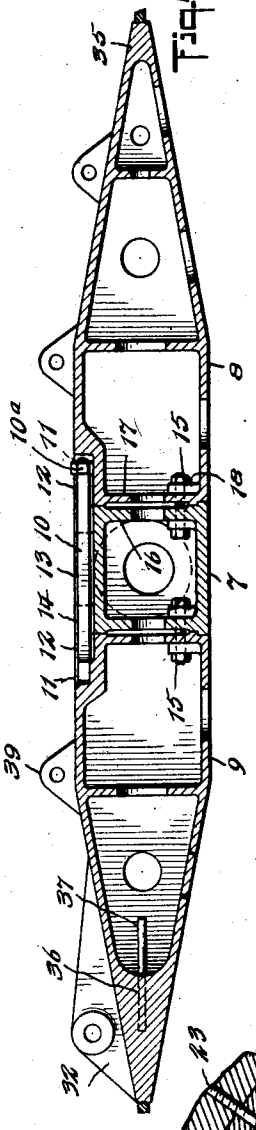


Fig. 4.

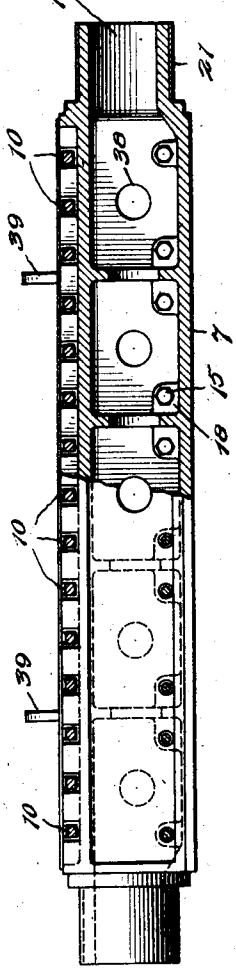


Fig. 5.

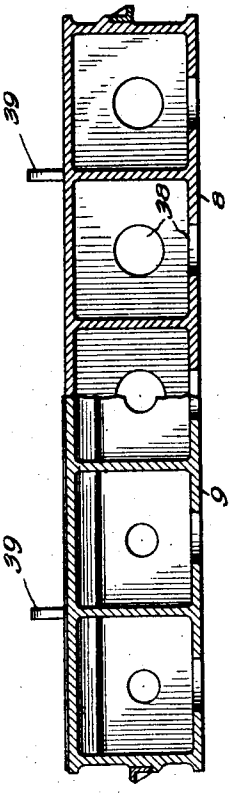


Fig. 6.

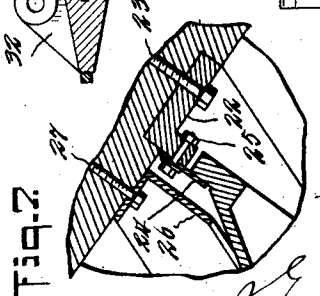


Fig. 7.

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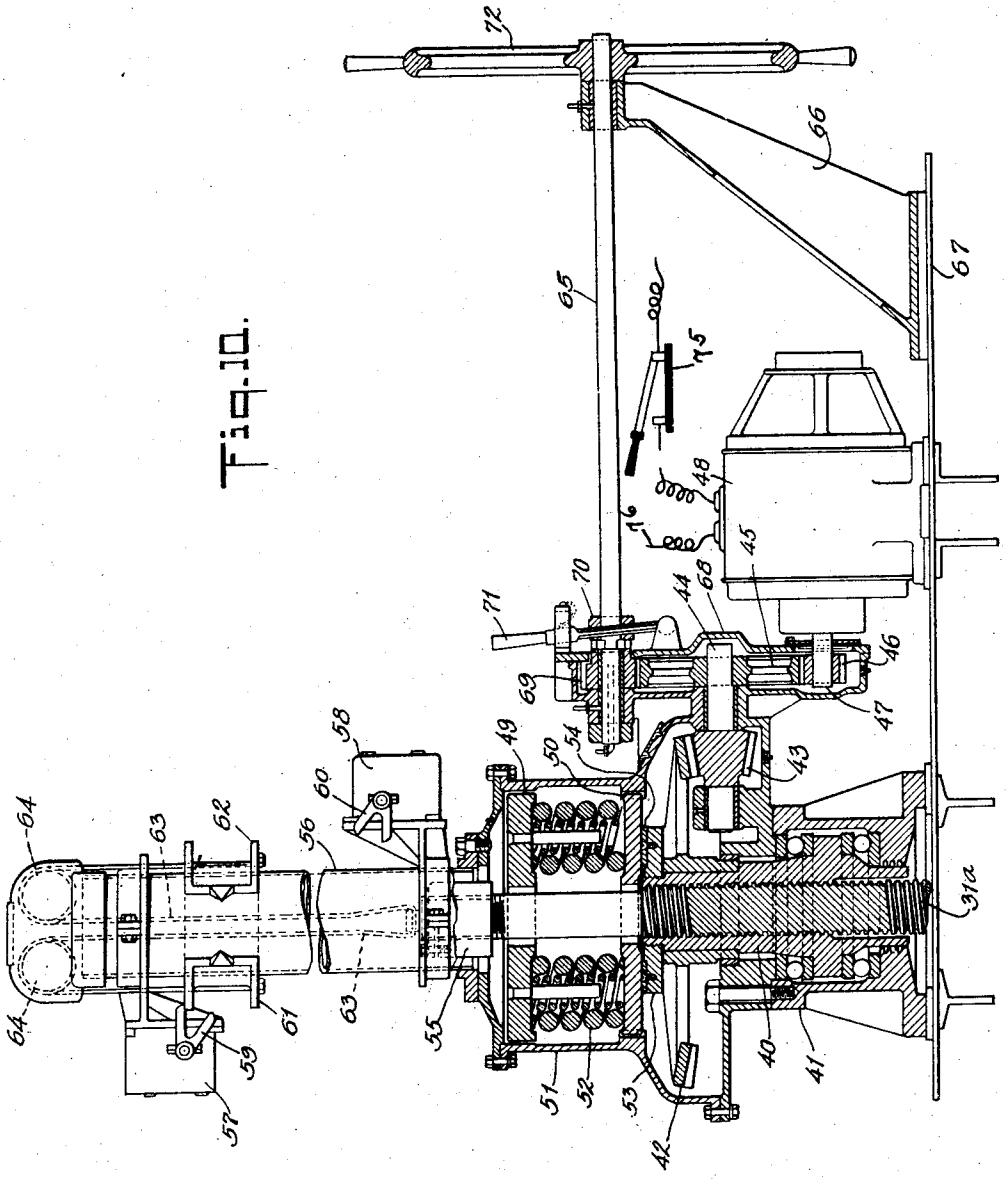
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Fig. 10.



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Patented Sept. 13, 1927. 1,642,253

UNITED STATES PATENT OFFICE.

WILLIAM S. LEE, RICHARD PFAEHLER, AND DAVID NABOW, OF CHARLOTTE, NORTH CAROLINA.

HYDRAULIC GATE.

Application filed October 4, 1924. Serial No. 741,575.

This invention is an improvement in hydraulic gates, and with respect to its more specific features, in gates of the butterfly type.

Gates of the character in question are large and heavy and difficult to transport in a unitary structure. Moreover because of the great pressure of the water which they are designed to control, it is difficult to secure a liquid-tight joint between the gate and the frame. The pressure exerted by the water tends to cause deflection of the gate, and this deflection is along one axis of the gate, the axis upon which the gate swings.

It is desirable that along this line the gate be particularly resistant to bending stresses, but it may be less resistant along other axes. A feasible method of obtaining this increased resistance with a minimum increase in cost, is to make the gate of greater thickness along the said axis. There is a limit, however, beyond which increase in size is not practical, and additional strength must be gained by the use of materials of a nature more resistant to the peculiar stresses than those usually used, with a consequent increase in the cost of the gate.

The gates are usually operated to open and close by a rigid connecting member, which is moved longitudinally in either direction by a suitable motor. The gates are usually at a distance from the motor, and the operator thereof is not in a position to know when they are fully closed. An indicator is relied upon, and if there is a delay in the checking of the motor at the proper time, over travel of the rigid connecting member results, with consequent liability to buckling or bending of the same.

An object of the present invention is to provide a gate of a character such that any portion thereof along a selected axis may be of a material highly resistant to the stresses to which it will be subjected, while the remainder of the gate is of a material less highly resistant and less expensive, the arrangement permitting also the gate to be made in sections for convenience in transportation and setting.

To the accomplishment of the foregoing and such other objects as may be hereinafter appear, the invention consists in the elements and their relation one to the other, as hereinafter defined in the appended claims, reference being had to the accompanying drawings forming a part hereof, which show a preferred embodiment of apparatus for carrying out the method, and in which:

Fig. 1 is a vertical section through the penstock and gate.

Fig. 2 is a plan view of the gate looking at the inlet side.

Figs. 3, 4, 5 and 6, are sections on the lines 3—3; 4—4; 5—5 and 6—6, respectively, of Fig. 2.

Fig. 7 is an enlarged detail in section at the edge of the gate, showing the sealing mechanism for the edge.

Fig. 8 is a detail in section of the opposite edge of the gate.

Fig. 9 is a section on line 9—9 of Fig. 1.

Fig. 10 is a sectional view of the mechanism for moving the screw.

In the present embodiment of the invention the improved gate is shown in connection with a penstock 1, the gate to be described being arranged in a passage 2, leading from the bottom of the pen-stock, and near the commencement of the said passage. The usual rack 3 is provided for fending drift from the gate.

The improved gate comprises a central section or axis 7, substantially square in cross section, and preferably of material developing slight deflection under relatively high stresses, as for instance, cast steel, and lateral sections or wings 8 and 9, which may be of a material having lower tensile and deflecting properties, as for instance, cast iron. The wings 8 and 9 are somewhat similar, and they are secured to opposite sides of the central section or axis by connections at each face of the gate, the connections at one face being entirely independent of those at the other face.

In the present instance at the inlet face of the gate, that is that face toward which the water flows, the wings are directly connected across the face of the central portion, by means of a series of connecting means 10, bolts in the present instance. Referring to Figs. 2, 4 and 5, it will be noticed that each of the wings is provided on the inlet face of the gate with a groove 11 extending parallel with the axis of the gate, and there is a series of parallel grooves 12 extending from each groove 11 toward the central section of the gate. The inlet face of the central section of the gate is recessed at the center thereof along the axis of the gate as indi-

cated at 13, and a plurality of series of transversely extending grooves 14 is provided one at each side of the recess 13 and communicating therewith. The grooves 14 of the two series are in alinement, and they are spaced to aline with the grooves 12 of the wings, when the wings are properly placed with respect to the central section. Thus there is provided, when the parts are properly placed, a series of alining, transverse passages connecting the grooves 11 of the wings, and the connecting means, for directly connecting the wings are received within these passages. The bolts 10 are arranged in the passages above mentioned, with the heads of the bolts in the groove 11 of one wing, and the nuts 10^a of the bolts in the groove of the other wing. By means of the nuts the wings may be drawn tightly against the central section. While bolts and nuts are shown for directly connecting the wings, any other character of connection might be used with equal facility.

At the opposite face of the gate, the sections of the gate, that is the axis and the wings, are connected by a plurality of series of bolts and nuts 15. Referring to Figs. 4, 5 and 6, it will be seen that the axis of the gate and the wings are chambered, being in fact of hollow construction, and the bolts 15 are passed through openings in the webs or walls of the chambers. Referring to Fig. 4, it will be seen that the webs or walls 16 and 17 of the central and lateral sections respectively, do not abut, except near the faces of the gate, the central sections of the web being spaced apart. The bolts 15 are passed through these walls, and through reinforcing lugs 18 from within the axis, the nuts engaging the bolts within the chambers at the wings. A series of bolts and nuts 15 is provided for connecting each wing to the axis.

The axis 7 of the gate is shown as chambered, and at each end it is provided with means for mounting the gate to swing upon a diametrical axis, that is upon the axis of the central portion. The said means in the present instance are trunnions 19, a trunnion being provided at each end of the gate, and the trunnions are suitably journalled in the walls of the pen stock. In the present instance passages 20 are provided, leading from the top of the pen stock to the point where the trunnions are journalled, to facilitate the setting of the gate, or the removal thereof. Suitable bushing members 21, preferably of bronze, may be provided for the trunnions.

In order to provide a tight joint between the upper wing edge and the wall of the passageway, angle pieces 22 are inset in the top and side walls of the passage, being held in place by anchor bolts 23. One portion of each angle piece projects beyond the face of the wall, and a strip 24 of resilient material, as for instance thin copper, is secured to this extended portion of each piece, by means of bolts and nuts 25. The extended angle pieces 22 are inset in positions, such that when the gate is closed, the edge of the upper wing remote from the axis of the gate will register with the extended portion of each angle piece, and will contact with the resilient strip 24. When the gate is closed the strips span the opening at the free edges of the wing, making a watertight joint, since the water pressure forces the strips into close contact with the gate. In order to prevent the strips 24 from being bent out of shape by the rush of water when the gate is open or by the passage of the drift, a shield 26 is arranged on the inlet side of each strip, each shield being in the form of an angle bar, one portion secured to the opposite wall by screw bolts 27 or the like, and the other extending in front of the adjacent strip 24 on the inlet side.

Mechanism is provided for moving the gate to open and closed position, the said mechanism including a suitable motor, indicated at 28, of any preferred construction, and a rigid connecting member 29 for transmitting the movement of the motor to the gate. The connecting member 29 is pivoted at one end to the gate, and at the other end to a cross head 30, which moves in guides 31 on the pen stock wall. The cross head is connected to means moved directly by the motor, as for instance, a screw 31^a, and it will be obvious that when the screw is moved in either direction, by the motor, the movement thereof will be transmitted to the gate. At its lower end the connecting member is received between a pair of lugs 32 on the gate, and near that edge of the gate which will be lowest when the gate is closed. A lost motion connection is provided between the cross-head and the gate. In the present instance this connection is provided for by pivotally and slidably connecting the connecting member to the lugs, by means of a cross pin 33 connecting the lugs and passing through a slot 34 in the connecting member. A lost motion connection is thus provided between the motor and the gate, to compensate for over travel of the motor.

In order to insure closing of the gate in all positions, should the connecting member 29 become broken, for instance, or fail to function for any reason, the gate is suitably counter-weighted. Referring to Fig. 4, it will be noticed that the wings 8 and 9 taper toward their free edges, and that a portion of each wing adjacent to the free edge is solid, as indicated at 35 and 36, respectively. The solid portion 36 is of greater width than the portion 35, thus providing additional weight at that portion of the gate which will be lowest when the gate is closed. Addi-

tional weight may be necessary at this side, and means is provided to facilitate the addition of more weight. The said means is in the form of rods 37, which are cast integral with the counter-weight 36, so that additional weight may be connected therewith, as for instance, more metal, or concrete, the additional weight being inserted through sundry of the openings 38, with which the webs and walls of the axis and wings are provided. In order to facilitate the handling of the gate portions during transportation, or during installation, perforated lugs 39 are provided on the inlet face of the wings, the said lugs being adapted for the attachment of hoisting or securing mechanism. It will be noticed, referring to Fig. 4, that the openings 38 are on the outlet side of the gate, none being provided on the inlet side.

In order to facilitate opening of the gate, which involves the lifting of the counter-weighted side of the gate, and against the weight of water, the wing 8 is of some greater width than the wing 9. Since the improved gate is used in practically a horizontal plane, the horizontal component of the water is substantially negligible.

In Fig. 10 mechanism is shown for moving the screw, which opens and closes the gate, means being provided in connection therewith, operated by the screw, to control the usual overload release forming part of the motor control thereby to stop the motor when the gate is fully closed.

As shown, the screw 31ª is threaded through a nut 40 arranged within a gear housing 41 supported at the top of the penstock.

The nut 40 has rigid therewith a miter gear wheel 42, which meshes with a similar gear 43 on a horizontal stub-shaft 44 journaled in bearings, supported by the gear housing. A gear 45 is secured to the shaft outside of the gear housing, and the wheel meshes with a pinion 46 on the shaft 47 of a suitable electric motor 48. By means of the motor, the nut 40 may be rotated, thereby to lift and lower the screw, to open and close the gate.

Just above the miter gear 42 a pair of disks 49 and 50 is mounted, loosely on the screw, and the disks, which are within an extension 51 of the gear housing, are normally pressed away from each other by coil springs 52, the said springs being arranged between the disks. The lower disk 50 rests upon a collar 53 which is rigid with the miter gear and nut, and which has a friction ring 54 secured to the edge thereof, for engagement by the disk. A head 55 is threaded onto the upper end of the screw, the head extending through the upper end of the extension 49, into a substantially cylindrical casing 56, which is supported by the head of the extension 51, being secured thereto.

The operation of the parts just described, is as follows. When the motor is running, the screw 31ª will be moved longitudinally, the direction depending upon the direction of movement of the motor. When the screw is moved downward, and the gate is fully closed, should for any reason there be a failure to stop the motor, the head 55 will engage the disk 49 and will press the disk downward toward the disk 50. The springs 52 are compressed, and the disk 50 is pressed closely against the friction ring 54 of the miter gear 42. As the friction increases, the load upon the motor increases, and when the increase has reached a selected degree, the overload release of the motor control will be operated to stop the motor, thereby to prevent buckling of the screw 31ª.

Limit switches 57 and 58 are interposed in the motor circuit, for opening the circuit at selected periods in the travel of the screw. Each of these switches is operated by a rocker 59 for the switch 57, and 60 for the switch 58. The rockers are engaged by indicators 61 and 62, respectively operated by the screw, in a manner to be presently described. These indicators indicate the extent of travel of the screw, and at the end of its movement in each direction, one of the indicators will engage a rocker to open the motor circuit. On the upstroke the rocker 59 is operated by the indicator 61, and on the downstroke the rocker 60 is operated by the indicator 62. The indicators are connected to the head 55 by flexible members 63, which pass upwardly from the head over suitable pulleys 64 and downwardly to the respective indicators.

Manually controlled mechanism is provided for turning the shaft 44. The said mechanism comprises a shaft 65 journaled in a bearing arm 66 on the platform 67 which supports the motor and the gear housing, and in a casing 68 which houses the gears 45 and 46. The said shaft has loosely journalled thereon a pinion 69 meshing with the gear wheel 45, and the pinion may be coupled to the shaft 65 by a clutch 70. The clutch is operated by a lever 71, and a shaft wheel 72 is secured to the shaft 65 for turning the same. With this arrangement, when it is desired to operate the screw by hand, the clutch 70 is operated to connect the shaft 65 with the pinion 69. When now the shaft is rotated, the drive shaft 44 of the screw will also be operated.

It will be evident from the description that mechanism is provided, in the form of limit switches for opening the circuit of the motor at the limit of the travel of the screw in each direction. Other mechanism is provided, positively controlled by the movement of the screw, for operating the overload release of the motor control near the limit of the movement of the screw in each direction.

Furthermore, mechanism is provided for permitting the screw to be operated manually in case of an emergency. When the gate is closed, the pin and slot connection 33—34, permits a limited movement of the screw after the closing. It is during this period that the head 55 compresses the springs 52 to operate the overload release.

In practice a controlling switch for the current is installed in the power house, in order that the circuit may be controlled from this point. This is of especial advantage when the power house is at a distance from the gate house motor, and of especial importance when the gate is used at the entrance of the passageway to a water turbine, in case the turbine governor should fail to cause the turbine guide valves to be closed. In such event the motor could be at once operated to close the gate. This switch is shown at 75 in Fig. 1, it being understood that the switch may be arranged wherever desired. The switch is interposed in the circuit 76 of the motor, and it will be obvious that the motor may be started or stopped by means of the switch. The switch may be arranged at any desired point, or other switches may be provided, if desired.

What is claimed as new is:

1. In combination, a gate for controlling the flow through relatively large passageways, such as pen stocks and turbine flumes in hydro-electric power development, a pivotal connection between the gate and the walls of the passageway enabling the gate to swing on a fixed substantially horizontal axis intermediate the top and bottom of the gate, sealing means on the passage walls engaged by the top and bottom of the gate when it is substantially perpendicular to the direction of flow through the passage, the gate composed of a plurality of separable sections including an axis and wings, the wing above the axis when the gate is closed of greater area than the wing below the axis, and means connected with said last named wing on the inlet side of the gate to lift said wing to open and to lower said wing to close the gate.

2. In combination, a gate for controlling the flow through relatively large passageways, such as pen stocks and turbine flumes in hydro-electric power development, a pivotal connection between the gate and the walls of the passageway enabling the gate to swing on a fixed substantially horizontal axis intermediate the top and bottom of the gate, sealing means on the passage walls engaged by the top and bottom of the gate when it is substantially perpendicular to the direction of flow through the passage, the gate composed of a plurality of sections including an axis and wings, the wing above the axis when the gate is closed of greater area than the wing below the axis, and means connected with said last named wing on the inlet side of the gate to lift said wing to open and to lower said wing to close the gate, each section having integral eyes for the attachment of hoisting mechanism and the like for handling the sections during transportation and installation.

3. In combination, a gate for controlling the flow through relatively large passageways, such as pen stocks and turbine flumes in hydro-electric power development, a pivotal connection between the gate and the walls of the passageway enabling the gate to swing on a fixed substantially horizontal axis intermediate the top and bottom of the gate, sealing means on the passage walls engaged by the top and bottom of the gate when it is substantially perpendicular to the direction of flow through the passage, the gate composed of a plurality of sections including an axis and wings, the wing above the axis when the gate is closed of greater area than the wing below the axis, and means connected with said last named wing on the inlet side of the gate to lift said wing to open and to lower said wing to close the gate, the axis having oppositely disposed plane substantially parallel faces, and the wings abutting said faces, and means to connect the wings to the axis at both faces of the gate.

4. In combination, a gate for controlling the flow through relatively large passageways, such as pen stocks and turbine flumes in hydro-electric power development, a pivotal connection between the gate and the walls of the passageway enabling the gate to swing on a fixed substantially horizontal axis intermediate the top and bottom of the gate, sealing means on the passage walls engaged by the top and bottom of the gate when it is substantially perpendicular to the direction of flow through the passage, the gate composed of a plurality of separable sections including an axis and wings, the axis having oppositely disposed plane substantially parallel faces, and the wings abutting said faces, and means at each face of the gate extending in the plane of the gate to connect the sections, each of the said means being independent of the other.

5. In combination, a gate for controlling the flow through relatively large passageways, such as pen stocks and turbine flumes in hydro-electric power development, a pivotal connection between the gate and the walls of the passageway enabling the gate to swing on a fixed substantially horizontal axis intermediate the top and bottom of the gate, sealing means on the passage walls engaged by the top and bottom of the gate when it is substantially perpendicular to the direction of flow through the passage, the gate composed of a plurality of sections including an axis and wings, the axis having

oppositely disposed plane substantially parallel faces, and the wings abutting said faces, and means to connect the sections at each face of the gate, each of the said connecting means being independent of the other, the connecting means at the inlet side of the gate being directly between the wings.

6. In combination with a water flow passage way, a gate, means in connection with opposite walls of the passage way and the gate for supporting the gate to swing on a relatively fixed axis, means on the passage way walls adapted to be engaged by the gate when said gate is in closed position substantially perpendicular to the axis of the passage way, the gate comprising a plurality of sections including an axis, and wings connected to the axis, the wing above the axis of greater width than the other for the purpose specified, said other wing counterweighted.

7. In combination, a gate comprising a central portion provided at its ends with means to mount the gate for swinging movement, lateral wings connected to the central portion and extending in opposite directions therefrom, the central portion and each wing chambered, and rods in one of the wings extending into the chambers thereof for the purpose specified.

8. In combination, a gate comprising a central portion provided at its ends with means to mount the gate for swinging movement, lateral wings connected to the central portion and extending in opposite directions therefrom, the central portion and wings chambered, and means within the chambers of one wing to connect counterweighting material to the wing.

9. In combination, a passageway, a butterfly gate pivoted therein, and means cooperating with the gate for sealing the space between the gate and the passageway at the upper side of the gate, said means including a strip of resilient metal extending radially of the passageway against which the gate closes.

10. In combination, a passageway, a butterfly gate pivoted therein, means cooperating with the gate for sealing the space between the gate and the passageway at the upper side of the gate, said means including a strip of resilient metal extending radially of the passageway against which the gate closes, and a rigid support for the strip.

11. In combination. a passageway, a butterfly gate pivoted therein, means cooperating with the gate for sealing the space between the gate and the passageway at the upper side of the gate, said means including a resilient strip secured to the wall of the passageway and extending radially thereof and against which the gate closes, and a rigid guard extending from the passageway wall beyond the strip on the inlet side thereof.

12. A gate for controlling the flow through relatively large passageways, such as pen stocks and flumes in hydro-electric power development, of sectional construction, comprising a plurality of separable sections including an axis substantially rectangular in cross section, and wings having plane edges of substantially the same thickness as the axis and abutting opposite faces of the axis, and means connecting the sections, said means extending in the plane of the sections separable and accessible to enable the assembling of the sections in the place of installation.

13. A gate for controlling the flow through relatively large passageways, such as pen stocks and flumes in hydro-electric power development, of sectional construction, comprising a plurality of separable sections including an axis substantially rectangular in cross section, and wings having plane edges abutting opposite sides of the axis and connected thereto, the connections being separable from the sections, located at both faces of the gate within the planes of said faces and accessible to enable assembling of the gate at the place of installation.

14. A gate for controlling the flow through relatively large passageways, such as pen stocks and flumes in hydro-electric power development, of sectional construction, comprising a plurality of separable sections including an axis substantially rectangular in cross section, and wings having plane edges of substantially the same thickness as the axis and abutting opposite faces of the axis and connected thereto, the connections extending in the plane of the gate and being separable from the sections and located at both faces of the gate, and within the planes of the said faces and accessible to enable assembling of the gate at the place of installation, the connections at one face being directly between the wings and spanning the axis.

15. A gate or valve for large passageways, comprising a plurality of independent sections, including an axis and wings, a plurality of removable connections between the wings and the axis at one side of the gate, and separate removable means directly connecting the wings across the axis at the other side of the gate, said means spanning the axis and independent thereof.

16. A gate or valve for large water passage ways comprising a plurality of sections including an axis and wings, connections between the wings and the axis at the outlet side of the gate, and means directly connecting the wings across the axis at the inlet side of the gate, said means spanning the axis, and comprising headed members, the wings having spaced lugs between which the headed

members pass, the heads engaging outside of the lugs.

17. A gate or valve for large water passage ways comprising a plurality of sections including an axis and wings, connections between the wings and the axis at the outlet side of the gate, and means directly connecting the wings across the axis at the inlet side of the gate, said means spanning the axis, and comprising headed members, the wings having spaced lugs between which the headed members pass, the heads engaging outside the lugs, the axis having at each wing spaced lugs between which said means pass.

18. A gate or valve for large water passage ways comprising a plurality of sections including an axis and wings, connections between the wings and the axis at the outlet side of the gate, and means directly connecting the wings across the axis at the inlet side of the gate, said means spanning the axis, and comprising headed members, the wings having spaced lugs between which the headed members pass, the heads engaging outside of the lugs, the first named connections comprising bolts, the sections chambered, and the bolts within the chambers, the sections at the outlet side of the gate having openings to enable access to the bolts.

Signed at Charlotte, in the county of Mecklenburg, and State of North Carolina this sixth day of September A. D. 1924.

WILLIAM S. LEE.
DAVID NABOW.

Signed at New York in the county of New York and State of New York this third day of September A. D. 1924.

RICHARD PFAEHLER.