Jan. 11, 1944. J. KALIX 2,338,724

DAM GATE AND OPERATING APPARATUS

Filed Jan. 3, 1942 5 Sheets-Sheet 1

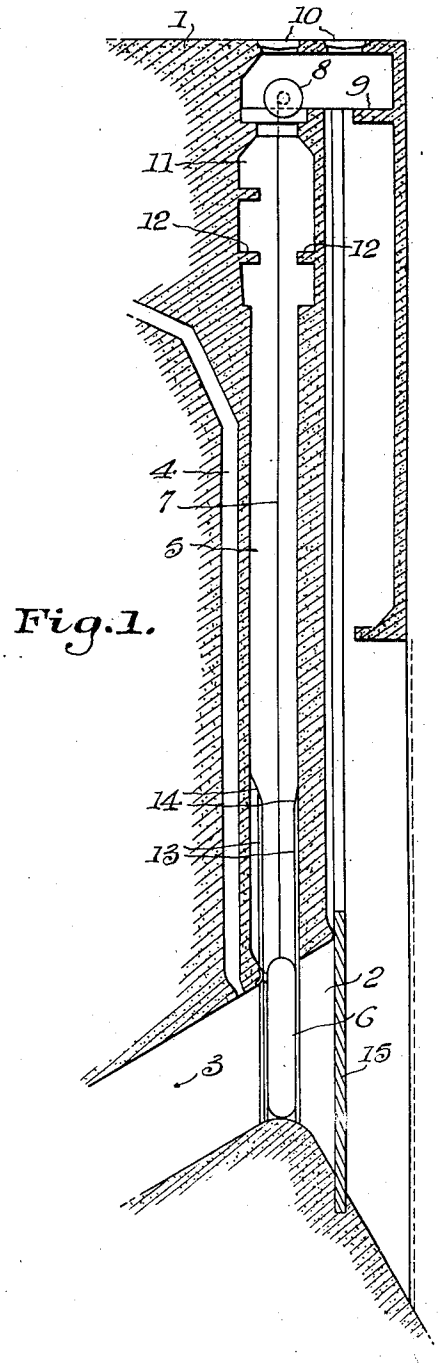


Fig.1.

Fig.7.

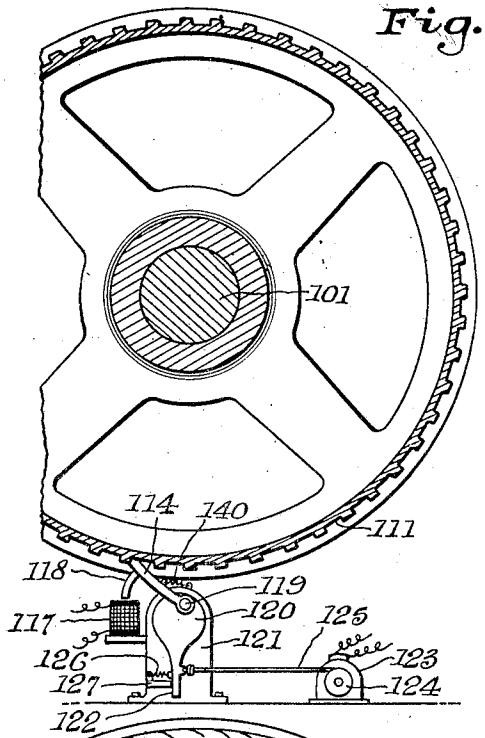
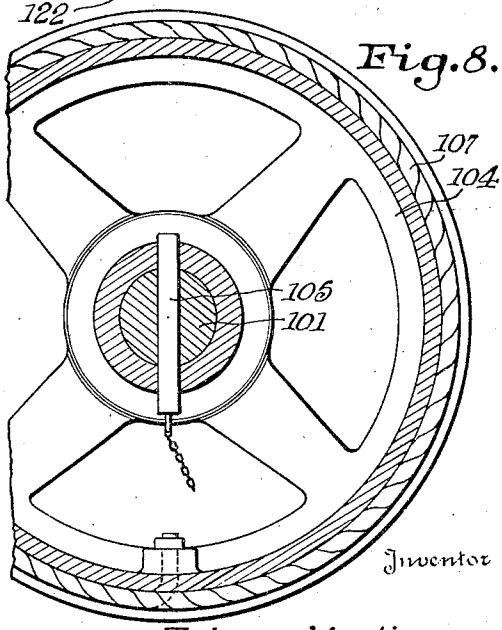


Fig.8.



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DAM GATE AND OPERATING APPARATUS

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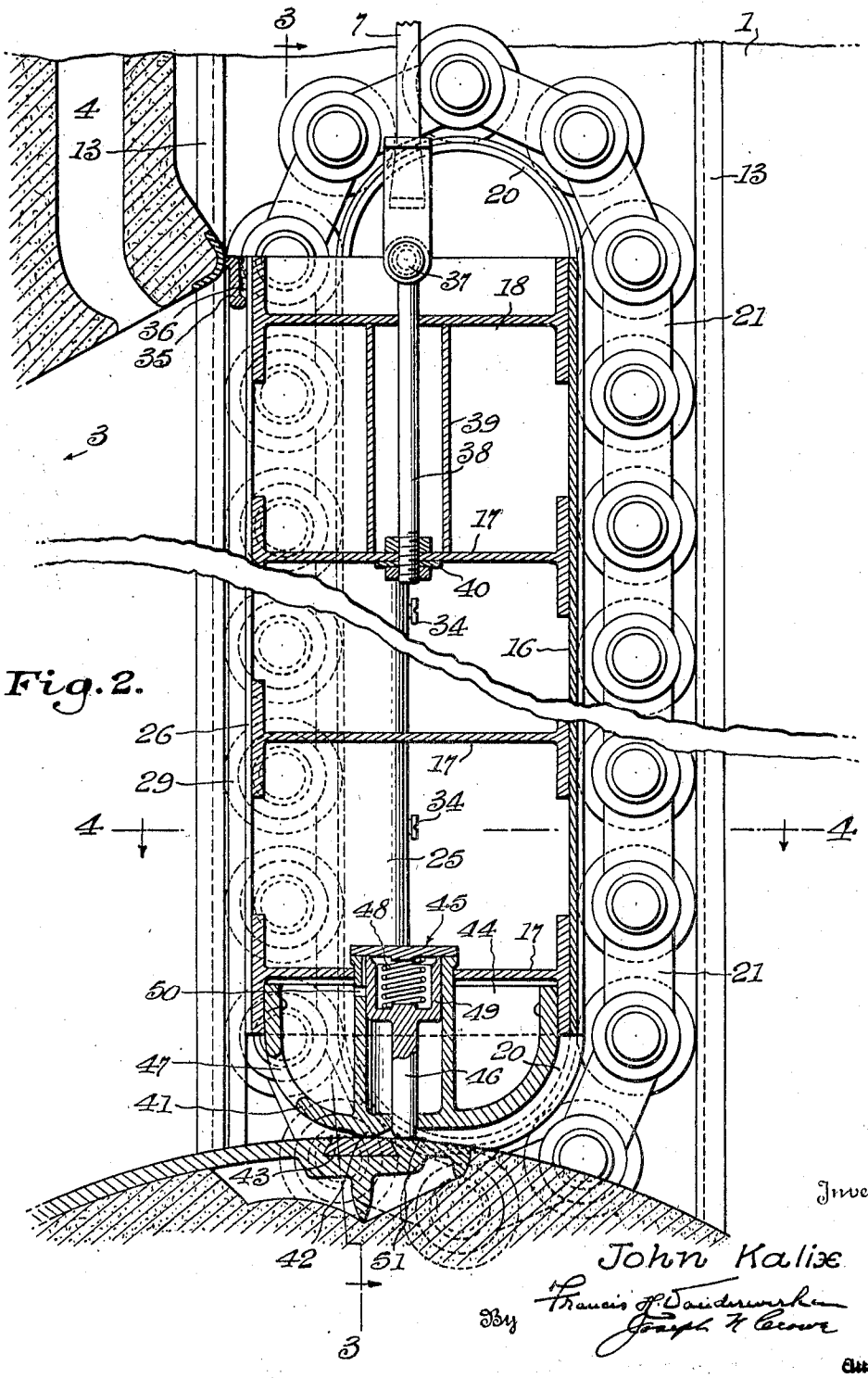

Fig. 2.

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DAM GATE AND OPERATING APPARATUS

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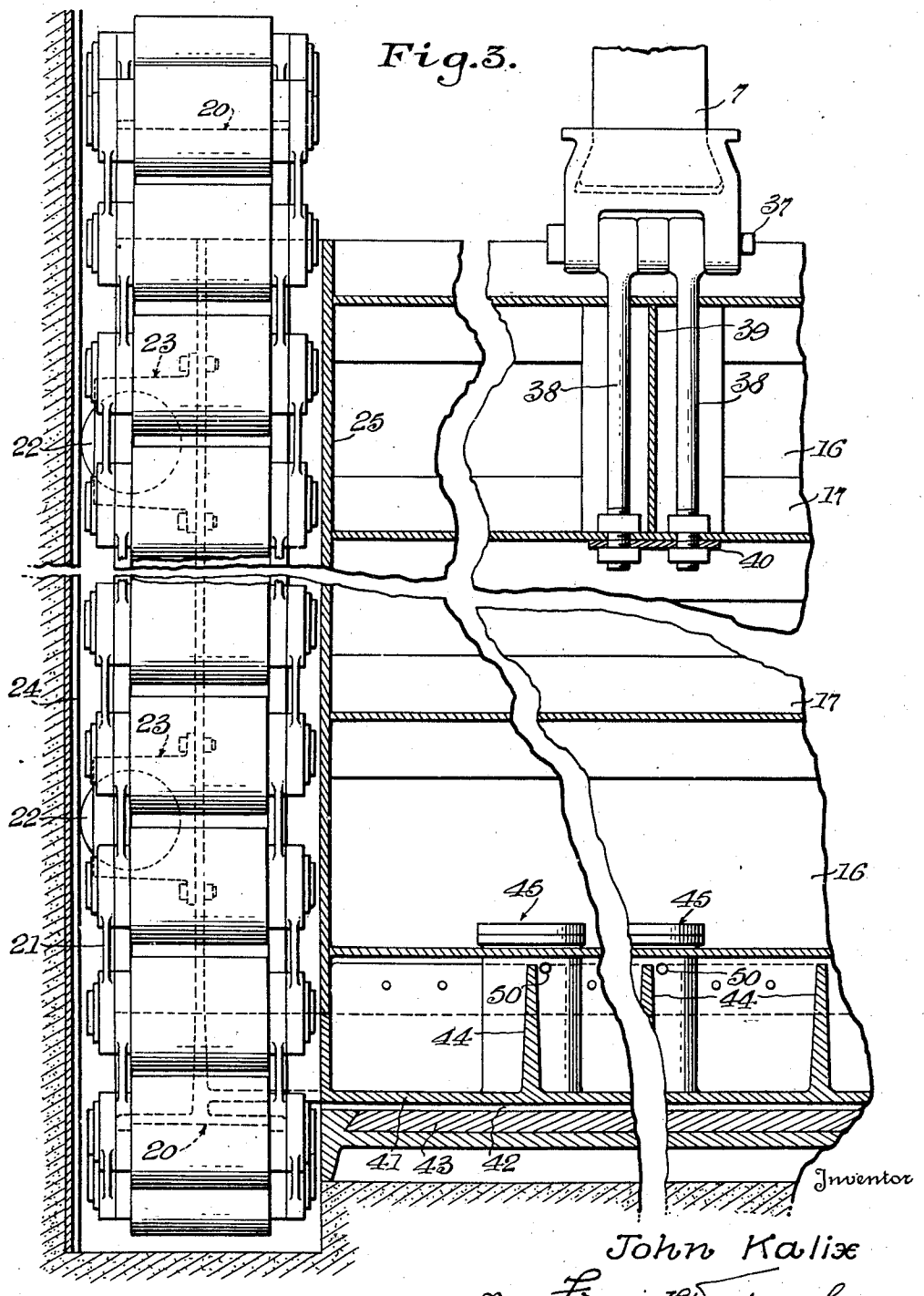
Fig. 3.



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DAM GATE AND OPERATING APPARATUS

Filed Jan. 3, 1942 5 Sheets-Sheet 4

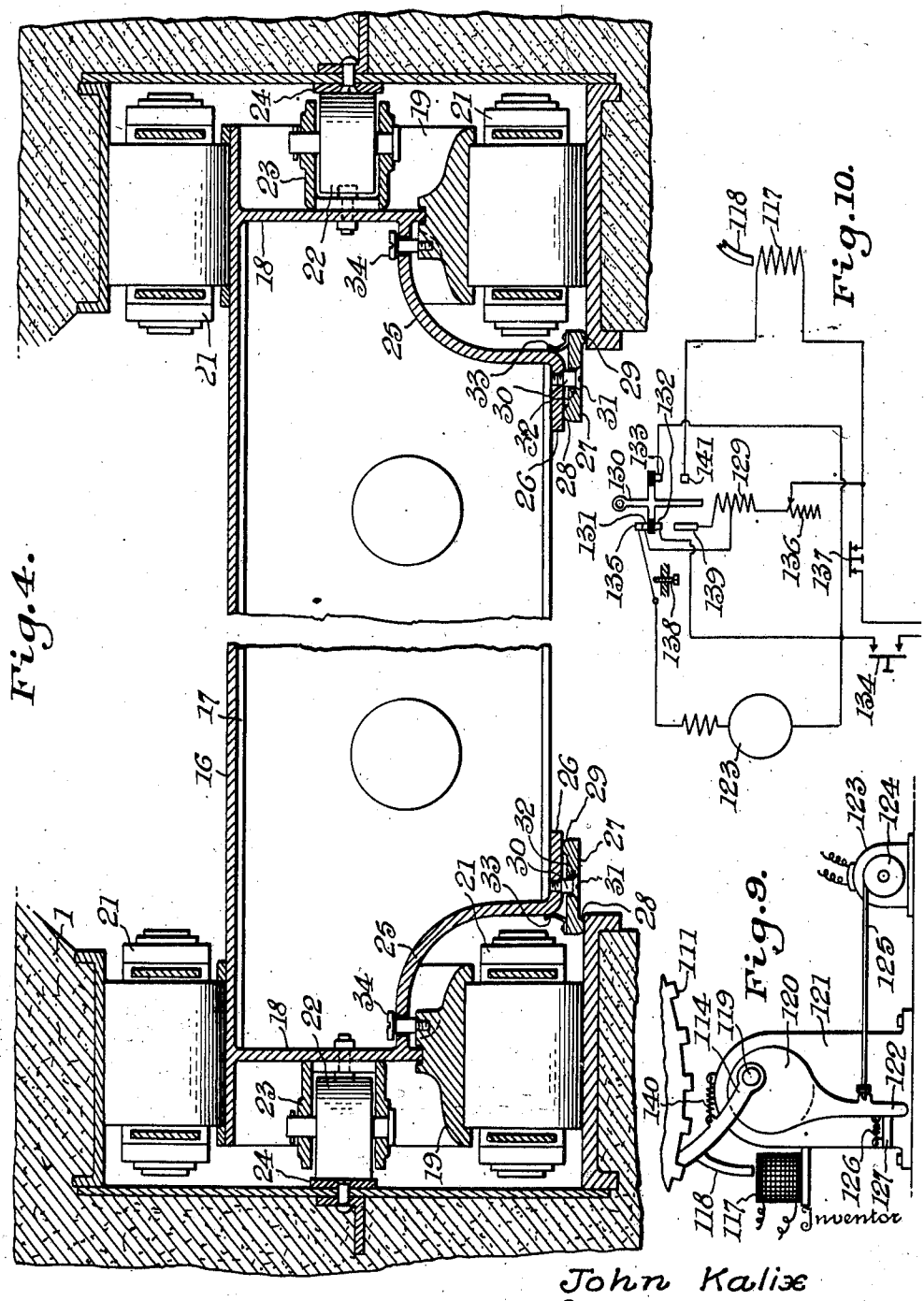

Fig. 4.

Fig. 10.

Fig. 9.

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DAM GATE AND OPERATING APPARATUS

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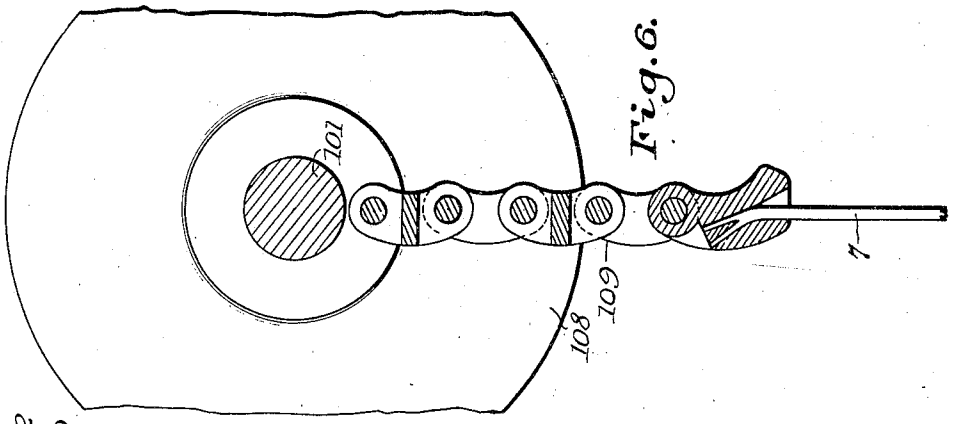

Fig. 6.

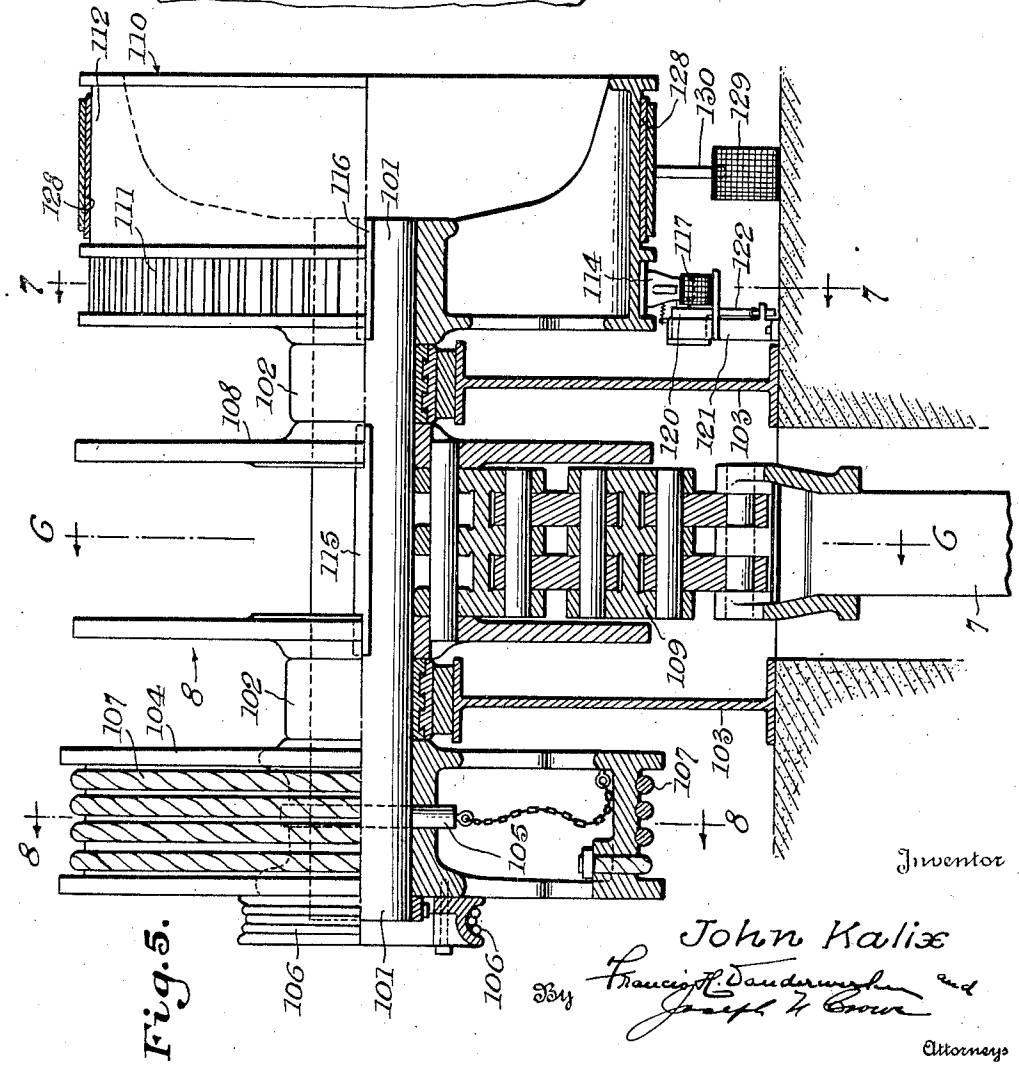

Fig. 5.

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UNITED STATES PATENT OFFICE

2,338,724

DAM GATE AND OPERATING APPARATUS

John Kalix, Nashville, Tenn.

Application January 3, 1942, Serial No. 425,508

13 Claims. (Cl. 61—28)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

This invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to an improved gate of the type employed as a barrier to control the flow of water from reservoirs of various kinds such, for example, as penstocks leading to water wheels in power installations and to an improved mechanism for operating and handling such gates.

Gates of this type are ordinarily provided with anti-friction rollers or other anti-friction means to facilitate the actual opening or closing of the gate. When the closing operation is at comparatively great depth, the kinetic force of the water is immerse. It is obvious that for the best operation of such rollers they must be accurately machined and so hung that they bear evenly over their full face. Gates as now constructed have an overhung roller cage requiring an extremely heavy gate to reduce deflection. It is, accordingly, an object of this invention to provide a means of mounting the rollers which will permit the maximum amount of gate deflection and at the same time transmit the forces perpendicularly to the guideway. By the use of such means a gate of much lighter weight than is now practical may be used.

When, for example, the opening of the penstock is one hundred or more feet below the pond level, the hydrostatic pressure on the closed gate may be as great as four million pounds or more. The problem of sealing the gate against these pressures and at the same time keeping the opening resistance to a minimum is immense. Gates as now generally used are bronze lined, built on an incline, the wedge effect of which produces an indeterminate amount of pressure which, under sliding friction, requires an uncertain amount of pull to overcome. The screw adjustment as now used tends to leak and stick in the wedge-shaped seal. It is, accordingly, a further object of this invention to provide a vertically reciprocating gate which will obviate these objections and at the same time offer a substantially water-tight seal whereby the power requirements for hoisting or lowering will be reduced.

I further propose to use tailrace gates for the turbines, instead of, as is now the general practice, the head gates, in order to prevent vacuum, hammer and the collapse of the penstock when a quick gate closure is needed. No critical position exists at any place during the closure when the spouting velocity together with the air vent supply is not filling up the penstock and especially so at the runaway speed. The use of the head gates creates vacuum and then creates more vacuum when the water in the penstock is reaching the lower level of the distributor, while the penstock is kept at the same diameter througout this length. Vacuum is also created by the underside of the water stream and the supplied air must break through these, creating turbulence, waves, hammer, and, as has actually happened, collapse of the pipe. It is, therefore, a still further object of this invention to make use of a tailrace gate whereby all of the dangers and costly possibilities are eliminated and a quick closing of the water passage by the gate, as a necessity, can safely be applied.

These and other objects of my invention will become apparent upon a consideration of the following description and the accompanying drawings in which:

Fig. 1 is a cross section view of a dam incorporating my improved gate;

Fig. 2 is an end cross-sectional view of my improved gate.

Fig. 3 is a view along the line 3—3 of Fig. 2.

Fig. 4 is a view along the line 4—4 of Fig. 2.

Fig. 5 is a view, partly in cross section, of an improved hoisting apparatus.

Fig. 6 is a cross-sectional view along the line 6—6 of Fig. 5.

Fig. 7 is a cross-sectional view along the line 7—7 of Fig. 5.

Fig. 8 is a cross-sectional view along the line 8—8 of Fig. 5.

Fig. 9 is an enlarged view of the rack and pawl mechanism shown in Fig. 7.

Fig. 10 is a schematic diagram of the electrical circuit utilized to accomplish push-button lowering of the gate.

Referring to Fig. 1, the numeral 1 represents the body of the dam in which my improved gate is to be used. The dam is provided with a gate opening 2 through which the water supply passes to the penstock 3. An air shaft 4 is provided and has its lower end opening into the penstock 3. The numeral 5 represents the well through which the gate 6 is raised or lowered by means of rope 7 and hoisting means 8. The operating floor 9 is reached by means of manholes 10. The upper portion of the well 5 is provided with an enlarged section 11 arranged so that with the gate 6 raised to its top position it is readily accessible. Working platforms 12 may be provided at desired points to facilitate repairs. Gate guides 13 extend into the lower portion of the well a dis-

tance somewhat greater than the height of the gate 6. The gate guides 13 are provided with tapered ends 14 to insure the proper entry of the gate 6. The stop log 15 is of any conventional design.

Referring to Figs. 2, 3, and 4, my improved gate consists of a back plate 16 to which are attached at equal intervals H members 17. End members 18 are welded adjacent the ends of the back plate 16. Rocker trackways 19 are flexibly held in position against the free side of the end members 18. Semicircular track sections 20 are attached to the ends of the back plate 16 and the trackway 19 and completes the track for the endless chain bearing 21. Side bearings 22, mounted on supports 23 and riding against the bearing strip 24 insure against the binding of the sides of the gate. Adjacent the rocker end of the end members 18 is welded a semicircular plate 25 having a turned lip 26. A flat plate 27 having oppositely raised end portions 28 and 29 and loosely supported at suitable intervals by bearing posts 30 extends along the lip 26 on both sides of the gate. The bearing posts 30 are provided with rounded heads 31 adapted to fit snugly into similarly recessed portions 32 in the flat plates 27. Springs 33 tend to force end portions 28 into contact with the side of the gate channel. Similar bearing posts 34 are used to hold the rocker 19 in place. A flat plate 35 similar to flat plate 27 is fastened by bearing posts 36 across the top of the gate to the free side of the top H member.

Referring particularly to Figs. 2 and 3, the hoisting rope 7 is fastened to the gate by a bumper hitch. Eye bolts 38 are fastened to the shaft 37 of the bumper and extend through the webs of the first two H beams. An I beam 39, extending between said H beams, is centrally located between the bolts 38 and together with reinforcing plate 40 forms a secure attachment for the hoist rope 7.

The bottom construction of my improved gate will be clear from a consideration of Figs. 2 and 3. A substantially semicircular member 41 is secured to the inner sides of the lowermost H member. It is provided with a raised portion 42 adapted to coact with the dam base member 43. Strengthening ribs 44 extend across the bottom member 41 at suitable intervals.

In order to provide for the easy seating of the gate, hydraulic valves 45, having projecting rods 46, are provided. Holes 47 are placed at intervals along the penstock side of the bottom 41 in order to admit water for the operation of the hydraulic valves. The operation of these valves will be clear from a consideration of Fig. 2. When the gate is raised the spring 48 will force the piston 49 down, extending the rod 46 through the bottom 41 uncovering ports 50 which, in turn, allow water to enter the piston chamber. As the gate is lowered the extended rods 46 will be engaged by the step 51. The continued lowering of the gate will force the piston 49 upward against the water pressure. The ports 50 will limit the egress of water and the valve will thus cushion the seating of the gate.

The above-described construction will permit a gate of relatively light weight to be used since by means of the rocker construction an even distribution of the water pressure is transferred to the roller and seat and a maximum permissible deflection of the gate can be used.

The side and top water seal, as illustrated, together with the bottom seal provide a substantially water-tight gate. The water pressure acting on the flat plates 27 and 35 is balanced about the bearing posts 30 and 36 carried on the gate. The contact points are arranged so as to be equidistant from the bearing posts. The springs 33, placed at intervals exert a gentle contacting pressure. Thus when hoisting or lowering the gate substantially no seal friction exists and no additional hoisting capacity is needed.

To provide a simple and efficient hoisting system I have designed the mechanism illustrated in Figs. 5, 6, 7, 8, and 9. Referring to these figures, the numeral 101 represents the main shaft. It is carried by bearings 102 supported on beams 103. The power drum 104 is keyed to the shaft 101 by means of a readily removable key 105. Mounted on the power drum 104 is an endless rope pulley 106. The power rope 107 is attached to any suitable power source such as a gantry crane. The hoisting drum 108 carries a link chain 109 to which is fastened the upper end of the hoisting rope 7. The wheel 110 carries a racked section 111 and a brake section 112. The brake lining is represented by the numeral 128 and may be of any conventional material. The brake is of conventional design and is operated by solenoid 129. A one-way pawl 114 operates in conjunction with the racked section 111 to normally limit the direction of rotation of the main shaft 101 to its elevating sense. Hoisting drum 108 and wheel 110 are fixed to the main shaft by means of keys 115 and 116 respectively. A solenoid 117 is provided to hold the pawl 114 out of engagement with the racked section 111.

The operation of my improved hoisting mechanism is as follows: The key 105 is inserted between the loose power drum 104 and the main shaft 101. The hook on the end of the power rope is pulled by the gantry for the stroke length while the pawl 114 will suspend it automatically at any, or mainly at the stroke end, position. The diameter of the power drum and the gantry stroke are arranged so that a single stroke will serve to lift the gate to its fully open position. The hoist rope 7 is of the rectangular type and will build up successive layers with each revolution of the main shaft 101. Thus, with the gate in its lowered position, at which position the friction drag is greatest, the lever arm between the hoist rope 7 and the main shaft 101 will be a minimum. Since it is the force produced about this lever arm which must be overcome the power requirements will be least when the load is heaviest. As the gate is raised the hoist rope lever arm increases while at the same time the drag decreases. The result is a substantially uniform power requirement of the gantry, which, consequently, can be designed to be operated always at its point of highest efficiency. A further advantage derived from the use of spiral layers of the hoist rope is the fact that, due to the change in circumference per layer, the speed of the gate near its seat, when raising or lowering, will be reduced, with constant angular velocity of the main shaft.

Assuming the gate to be in its fully open position after a single stroke of the gantry, if it is desired to lower the gate, the hook is lowered, the power rope 107 forming a loop which will be rewound upon the power drum 104 by the lower-

ing of the gate. If it is desired to further elevate the gate, the key 105 is removed, the apparatus being held from rotation by the pawl 114, and the power rope 107 rewound upon the power drum 104 by means of the endless rope pulley 106. The key is then replaced when a further stroke of the gantry will elevate the gate a stroke length. The process is repeated until the gate is in the desired position. With the gate in its uppermost position, its entire removal will only necessitate the lifting of the compactly wound durm and associated apparatus which will be of minimum weight.

The means I have provided for lowering the gate will be apparent upon a consideration of Figs. 7, 9, and 10. The pawl 114 is provided with an extended arm 118 of magnetic material which is adapted to coact with the solenoid 117. The pivoted end of the pawl 114 pivots about shaft 119 carried by the eccentric 120. The eccentric 120 is free to rotate in the support 121 and carries a lever arm 122. Spring 140 tends to force the pawl 114 into contact with the racked portion 111 of the wheel 110. A small motor 123 carries a pulley 124 about which is wound the rope 125. The free end of the rope 125 is attached to the lever arm 122. Spring 126 tends to return the lever arm 122 to its clockwise position against the stop 127 and is strong enough to overcome the resistance of the unergized motor 123. For the purpose of clarity I have not illustrated the brake mechanism, which is of conventional design, other than to illustrate the brake lining 128 on the brake section 112 of the wheel 110. A solenoid 129 and plunger 130 serve to actuate the brake. The plunger 130 is attached to the brake lever and carries an insulated portion having contacts 131, 132, and 133 mounted thereon.

Referring particularly to Figs. 9 and 10, a push button 134 is placed in the power line lead at any convenient location. The closing of this button completes the circuit through the motor 123, contact 135, contact 131, a portion of the solenoid 129, variable resistance 136 and closed circuit button 137. The energization of the motor imparts, through rope 125 a counterclockwise rotation to the eccentric 120, which in turn forces the pawl 114 to the left against the racked section 111 of the wheel 110. At the same time the solenoid 129 is energized and lowers the plunger 130 tightening the brake shoes against the lining 128 and thus holding the main shaft against further rotation in either direction. As the plunger 130 is lowered, stop 138 engages the arm of contact 135 and a further lowering of the plunger 130 opens the motor circuit. Just prior to the opening of the motor circuit, contact 132 engages contact 139 so that upon opening of the motor circuit the solenoid 129 is fully energized and the brake fully applied. As the motor circuit is opened, the spring 126 imparts a clockwise rotation to the lever arm 122 releasing the pawl 114 from tight engagement with the racked section 111. The complete motion of the plunger 130 engages contacts 133 and 141 completing the circuit to solenoid 117. The energization of solenoid 117 withdraws the pawl 114 from possible contact with the racked section 111 against the action of spring 140. The tension on the brake is regulated by the resistance 136 and by this means the gate is lowered. Closed circuit button 137 is placed on the gate and is arranged so that when the gate is seated the circuits will be opened. The opening of the circuits deenergizes the solenoids releasing the brake, freeing pawl 114 and placing the apparatus in readiness for further operation. The push button 134 is released after the gate is fully lowered.

While I have described my invention with particularity it is to be understood that I do not wish to be limited to the particular elements and arrangements disclosed since various modifications within the spirit of the invention will suggest themselves to one skilled in the art.

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

1. A seal for a sluice gate in a gateway including a bearing post attached to said gate and a member pivotally mounted on said bearing post and having oppositely extended arms, one of said arms having an inwardly offset portion arranged to contact said gate, the other of said arms having an outwardly offset portion arranged to contact said gateway.

2. A seal according to claim 1 wherein said member is mounted on said bearing post at a point substantially equidistant from said offset portions.

3. A seal according to claim 1 including, in addition, means for insuring contact of said offset portions with said gate and gateway.

4. Sealing means for a sluice gate in a gateway including a bearing post attached to said gate, a member on said bearing post and having oppositely extended arms, one of said arms having an inwardly offset portion arranged to contact said gate, the other of said arms having an outwardly offset portion arranged to contact said gateway, said member being mounted on said bearing post at a point substantially equidistant from said ends, and means for insuring contact of said ends with said gate and gateway.

5. An arrangement for forming a seal between a gate and a gate opening, including, a bearing post and a member pivotally attached to said bearing post, said member having oppositely extended arms, one of said arms having an inwardly offset portion arranged to contact said gate, the other of said arms having an outwardly offset portion arranged to contact said gateway adapted to engage said gate and said gateway at points substantially equidistant from said bearing post.

6. A sluice gate, a relatively light back plate, a plurality of horizontally disposed bracing members attached to said back plate, the sides of said bracing members away from said back plate being unattached, end members attached to said back plate, a sectionalized endless trackway mounted on each end of said gate, the rear vertical sections of said trackways being formed by guide members attached to said back plate, the front vertical sections of said trackways being pivotally attached to the free edge of said end members, and roller trains supported by said trackways.

7. A sluice gate according to claim 6 in which said roller trains extend past the front and rear of said gate whereby the rollers at both front and rear vertical positions may be engaged when said gate is lowered.

8. A sluice gate comprising, in combination, means for mounting said sluice gate for vertical movement, said means including laterally arranged, vertically disposed gateways extending to a base member positioned within a step, and hydraulically controlled means in connection with the lower end of said gate and coacting with said step for retarding the seating movement of said gate onto said step.

9. A sluice gate comprising, in combination, means for mounting said sluice gate for vertical movement, said means including laterally arranged, vertically disposed gateways extending to a base member positioned within a step, hydraulically controlled seating means carried by said gate, said means including cylinders, spring-pressed pistons mounted within said cylinders, and downwardly projecting piston rods connected to said pistons adapted to cushion the closing contact of said gate upon said base member.

10. A sluice gate comprising, in combination, means for mounting said sluice gate for vertical movement, said means including laterally arranged, vertically disposed gateways extending to a base member positioned within a step, hydraulically controlled means in connection with the lower end of said gate and coacting with said step for retarding the seating movement of the gate onto said step, said means including cylinders, spring-pressed pistons mounted within said cylinders, and downwardly projecting piston rods connected to said pistons and adapted to effect a gradual closing of said gate.

11. A sluice gate comprising, in combination, a back plate provided with laterally spaced rear tracks, semicircular track sections disposed at upper and lower extremities of said gate in alignment with rear tracks, laterally spaced end members attached to said back plate and projecting perpendicularly thereto, and rocker trackways flexibly connected to said end members to complete an endless track around said gate.

12. A sluice gate comprising, in combination, a back plate provided with laterally spaced rear tracks, H members connected to said back plate, semicircular track sections disposed at the upper and lower extremities of said gate in alignment with said rear tracks, laterally spaced end members attached to said back plate and projecting perpendicularly thereto, rocker trackways flexibly connected to the outer edge of said end members to complete endless tracks around said gate, and semicircular plates connected to said end members adjacent their outer extremities and to said end members to provide forward track chambers.

13. A sluice gate comprising, in combination, a back plate provided with laterally spaced rear tracks, H members connected to said back plate, semicircular track sections disposed at the upper and lower extremities of said gate in alignment with said rear tracks, laterally spaced end members attached to said back plate and projecting perpendicularly thereto, rocker trackways flexibly connected to the outer edge of said end members to complete endless tracks around said gate, semicircular plates connected to said end members adjacent their outer extremities and to said end members to provide forward track chambers, and means for sealing said track chambers.

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