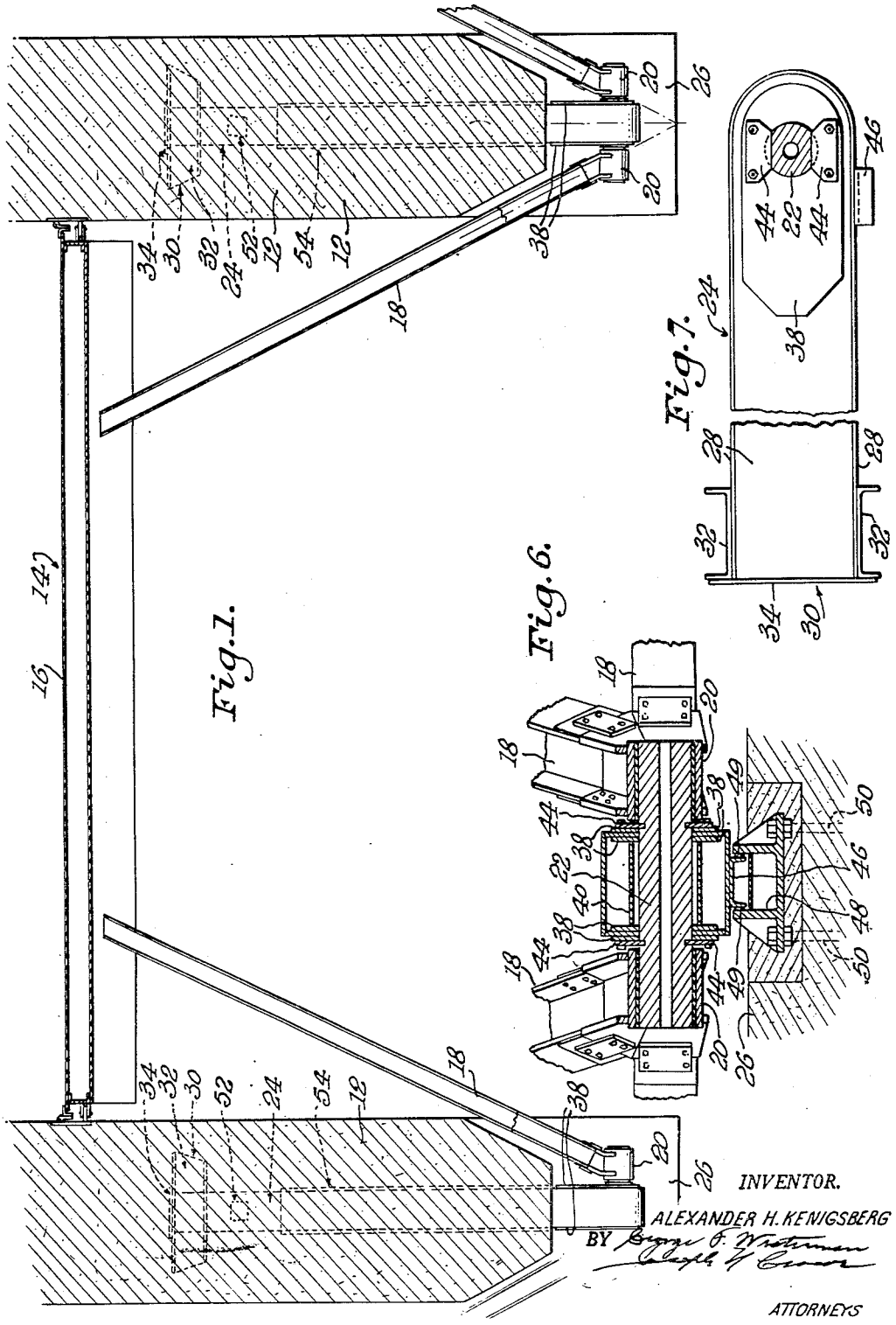
April 12, 1955 A. H. KENIGSBERG 2,705,871

ANCHORAGE FOR HYDRAULIC GATES

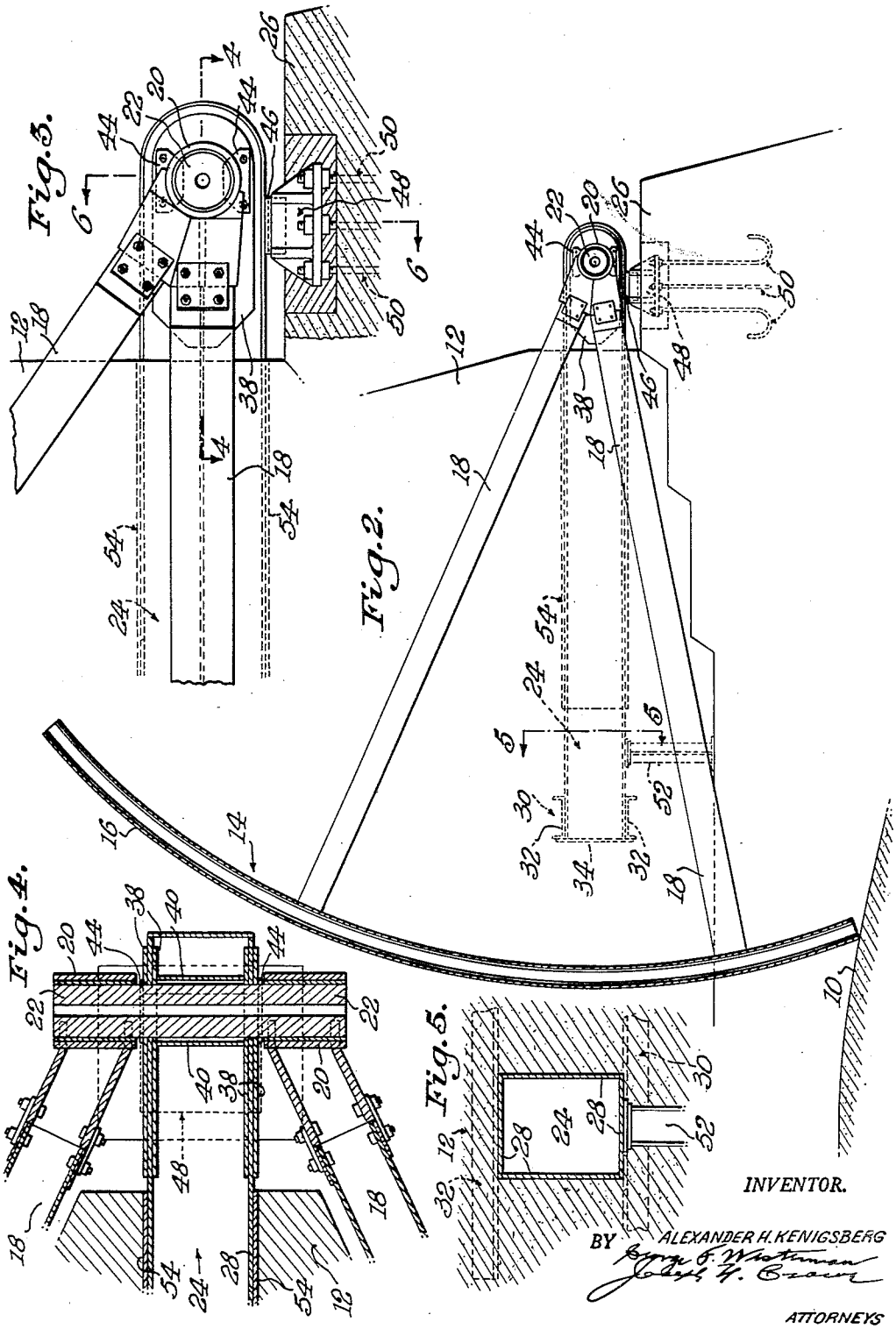
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ANCHORAGE FOR HYDRAULIC GATES

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ANCHORAGE FOR HYDRAULIC GATES

Filed Sept. 28, 1953 5 Sheets-Sheet 3

Fig. 8.

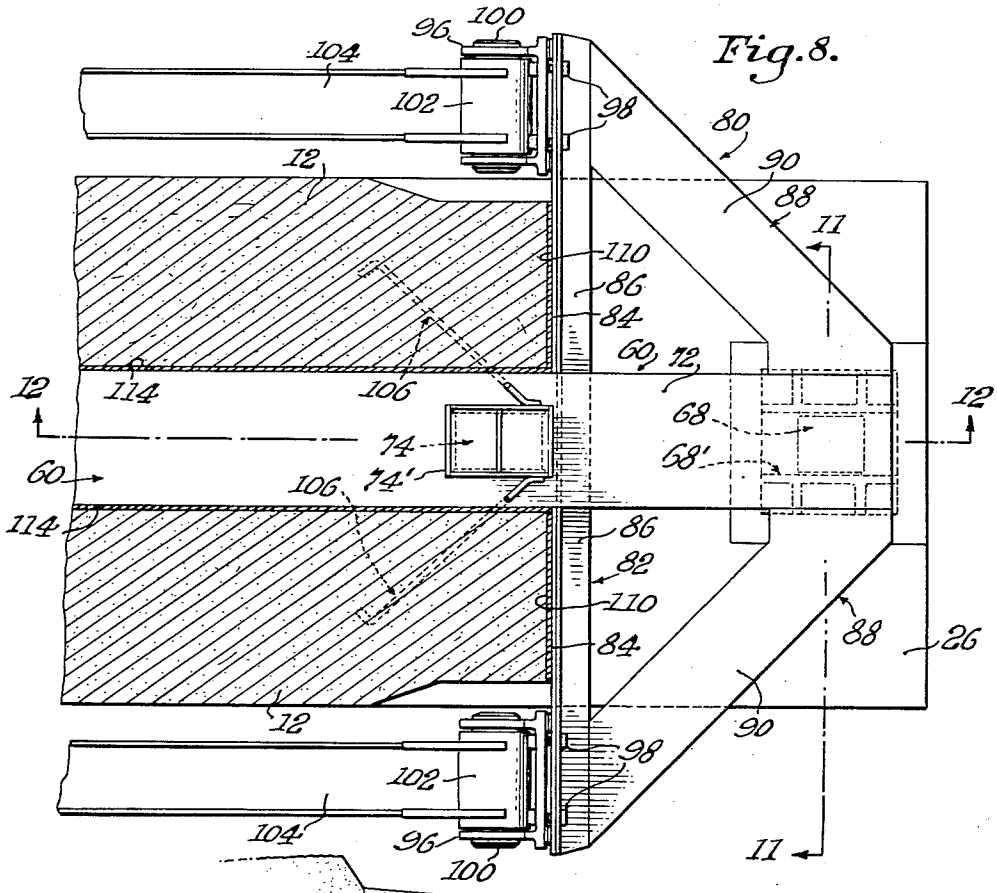
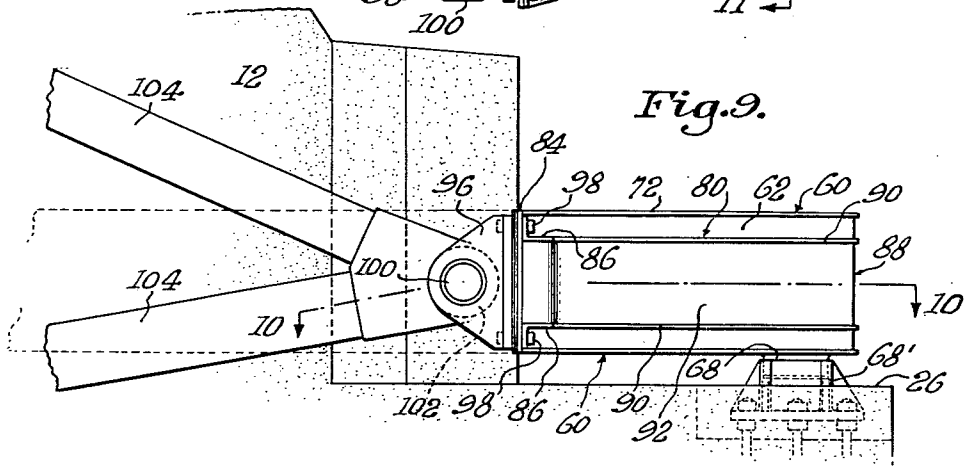



Fig. 9.




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ANCHORAGE FOR HYDRAULIC GATES

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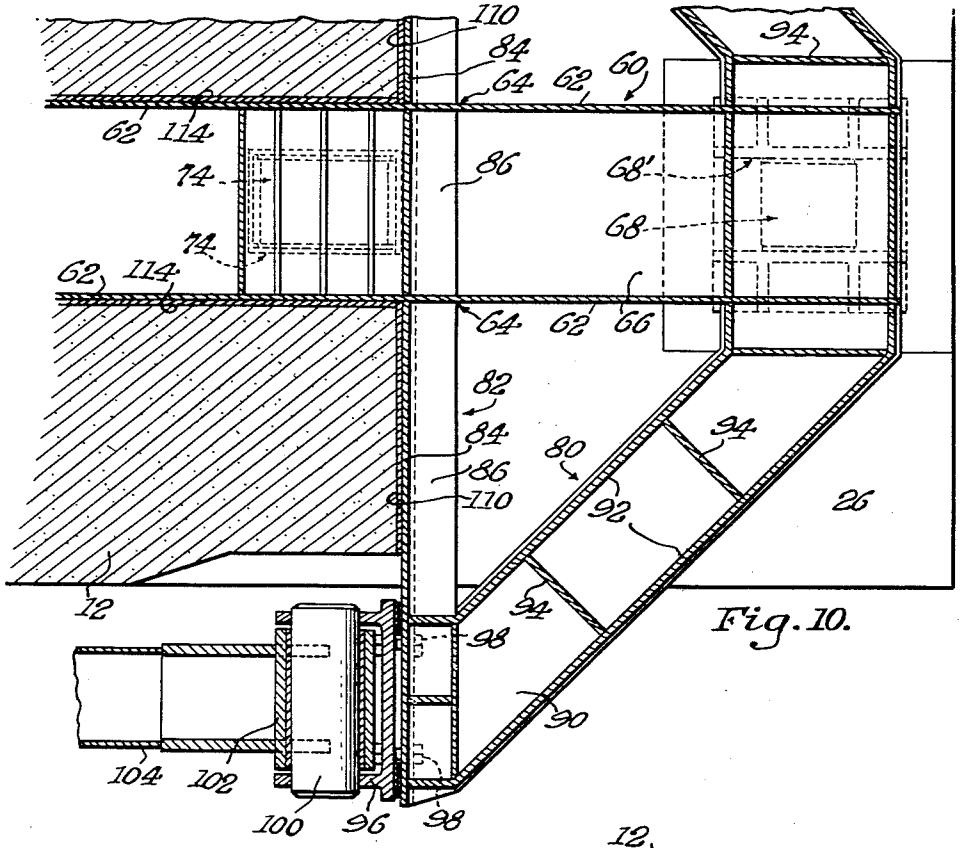



Fig. 10.

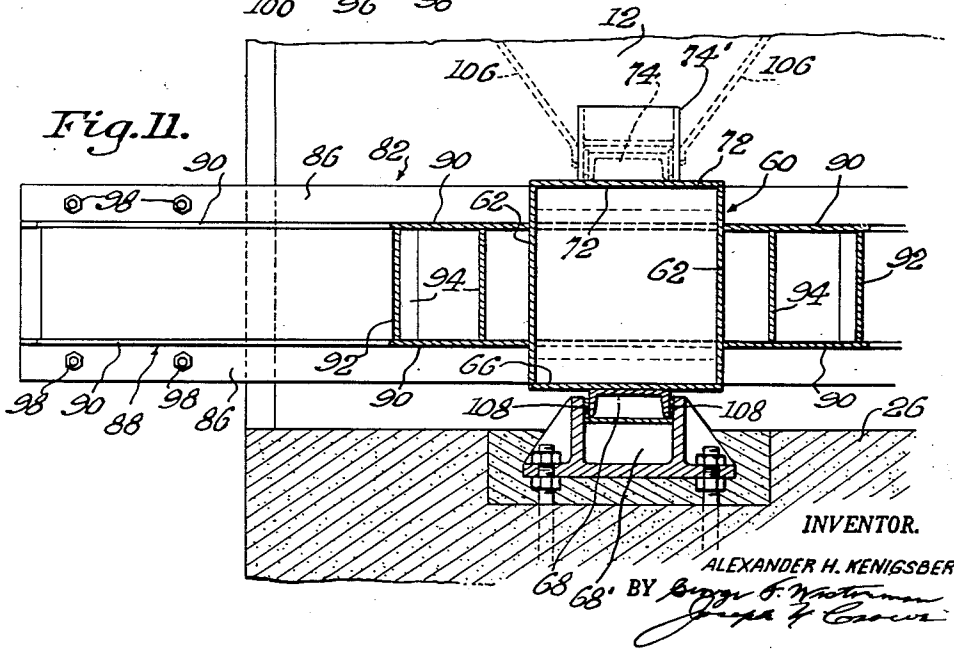



Fig. 11.

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ANCHORAGE FOR HYDRAULIC GATES

Filed Sept. 28, 1953 5 Sheets-Sheet 5

Fig. 12.

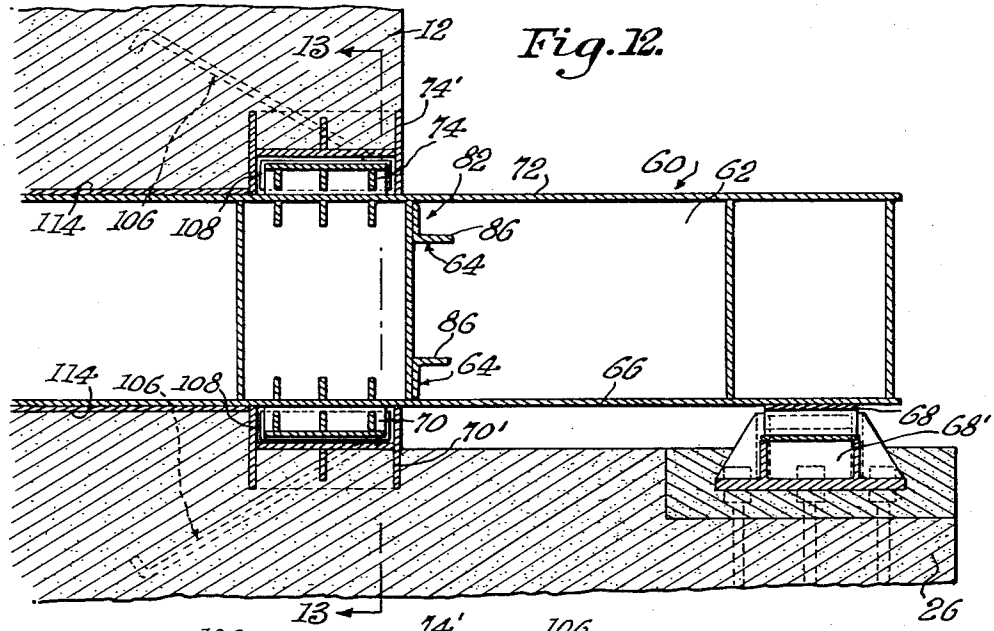
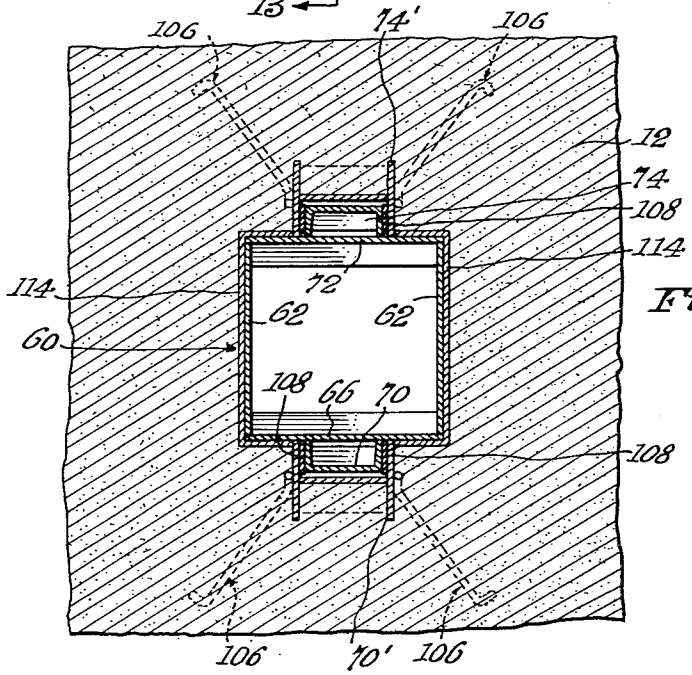



Fig. 13.




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United States Patent Office 2,705,871 Patented Apr. 12, 1955



2,705,871

# ANCHORAGE FOR HYDRAULIC GATES

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Application September 28, 1953, Serial No. 382,882

9 Claims. (Cl. 61—25)

(Granted under Title 35, U. S. Code (1952), sec. 266)

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

The present invention relates generally to certain improvements in mounting means and anchorage instrumentalities for Tainter type hydraulic gates as installed in dam constructions for controlling flow of water through the dam.

More particularly, the present invention relates to an improved anchorage for Tainter type spillway or crest gates as used on any type of dam or similar structure, the improvements of the invention consisting of a single anchorage girder, that is, a single vinculum member or girder having an anchor block at its upstream or forward end and a trunnion pin at its downstream or rear end, both being substantially normal to the axis of the vinculum girder. The anchor block and a considerable portion of the anchorage or vinculum girder are embedded in the concrete spillway pier, and the trunnion pin accommodates trunnions located on side arms, the opposite ends of which are affixed to the gate. Additionally, a thrust block designed to overcome unbalanced lateral loadings from the side arms of the gate, is embedded in the concrete pier, and engages the bottom of the anchorage or vinculum girder almost directly under the trunnion pin. This arrangement differs from the conventional construction in two principal particulars, viz. (1) in that the latter normally has two embedded members corresponding to the single anchorage girder of the present improved construction, and (2) in that the trunnion girder in the conventional construction is eliminated in the present improved construction.

The above generalized statement of invention is indicative of the objects of the present invention, one of which objects is to provide an improved anchorage for Tainter type spillway or crest gates as used on any type of dam or similar structure, by means of which improved anchorage the gates may be operated under balanced loading conditions with the supporting members for the gates carrying only tensile stresses, instead of both direct and flexural stresses, and, when flexural stresses are present due to unbalanced gate loading, there results only a partial direct loading of the gate anchorage, thereby permitting a more economical design of the said anchorage. In the present construction, the center lines of all structural members converge in a single point, this structural arrangement resulting under normal loading conditions in the members carrying tensile stresses only instead of both direct and flexural stresses which occur in anchorages of conventional design. In the present construction, in the event that flexural stresses exist, due to unbalanced gate loading, the single vinculum anchorage is only partially loaded, whereas the conventional anchorage is under maximum stress as a result of cantilever action.

In the present construction, the stress distribution at the upstream end in the masonry of the pier is always symmetrical about its center line, since the major hydrostatic and gate loads are transmitted by the single vinculum or anchorage girder, to an upstream or forward anchor block centrally located midway between the faces of the pier, whereas, in the conventional anchorage having two vinculum girders, the stresses are concentrated near the face of the masonry and are unequally distributed whenever the gate loads are unbalanced.

Additionally, in the present construction, the gate girders or trusses spanning between the inclined gate



framing arms for a Tainter type gate having inclined arms, are shortened materially; also in the present construction, the masonry piers are shortened at their downstream or lower ends and are less difficult to construct. Since, in the present construction, the gate anchorage transfers to the pier the hydrostatic thrust on the gate, both the vinculum member and the anchor block are identical in loading and design regardless of whether the gate framing arms are parallel or inclined to the face of the pier. The single vinculum construction of the present construction is superior to the conventional anchorage owing to its greater structural efficiency, simplicity of fabrication due to elimination of members and components, economy due to shorter lengths and lesser weights of components including reduction of concrete volumes in piers, and ease of handling and erection.

It may be noted also that, differing from the conventional anchorages which are eccentrically loaded and employ two anchorage members, one for each trunnion, to transfer the gate thrust to eccentrically loaded anchors near the upstream or forward end of the masonry pier, the single vinculum anchorage of the present construction employs a single connecting member having a single, relatively short trunnion pin at its downstream or rear end and a single anchor block centrally loaded, at its upstream or forward end.

Further objects and advantages of the present construction will become apparent as the description proceeds and the features of novelty will be pointed out in particularity in the appended claims.

Before proceeding with a detailed description of the present construction, it may be noted, by way of exemplary explanation of the foregoing statements, that dam structures of the type now constructed generally include in a portion of their length a series of spillways which are separated by piers. The piers may be spaced apart any suitable distance and extend upwardly for a suitable height above the crest of the dam, and in order to increase the depth of the water back of the dam, a gate is pivotally mounted in the opening between each of the piers.

Heretofore, the conventional anchorages for such gates have been eccentrically loaded and have utilized two anchorage members, one for each gate trunnion, to transfer, through trunnion girders, the gate thrust to eccentrically loaded anchors near the upstream end of the pier. By the improvements comprised within the scope and concept of the present invention, the gate-mounting construction, constituting a single vinculum anchorage, has been so improved as to employ only a single anchorage member having a single, relatively short trunnion pin at its downstream or rear end and a single anchor block, centrally loaded, at its upstream or forward end.

With the foregoing and other objects and advantages in view, the invention consists in the construction and arrangement of the several parts which will be hereinafter more fully described and claimed.

In the accompanying drawings:

Fig. 1 is a plan view of the gate;

Fig. 2 is a side elevation of the gate, a part thereof being shown in section;

Fig. 3 is a side elevation of a portion of the gate showing the gate anchorage and gate interconnecting joint;

Fig. 4 is a sectional view of the gate and anchorage interconnecting joint, taken along line **4—4** of Fig. 3;

Fig. 5 is a sectional view of the gate anchorage vinculum girder, taken along line **5—5** of Fig. 2;

Fig. 6 is a vertical sectional view of the gate interconnecting joint, taken along line **6—6** of Fig. 3;

Fig. 7 is a side elevation of the vinculum girder and anchor, the pivot or trunnion pin being shown in section;

Fig. 8 is a plan view of a portion of a modified form of Tainter gate anchorage;

Fig. 9 is a side elevation of the modified gate anchorage shown in Fig. 8;

Fig. 10 is a sectional view of a portion of the modified anchorage member taken along line **10—10** of Fig. 9;

Fig. 11 is a sectional end elevation of the modified form taken along line 11—11 of Fig. 8;

Fig. 12 is a vertical section of the modified form, taken along line 12—12 of Fig. 8; and

Fig. 13 is a transverse section of the vinculum girder for the modified form taken along line 13—13 of Fig. 12.

In the drawings, where like reference numerals are used to designate like parts, the reference numerals **10** and **12** designate respectively the crest of the dam and the structural pier or portion of the flume or spillway within which the Tainter gates **14** operate, the pier being preferably constructed of concrete.

The gate **14** is formed of a structural steel framework, carrying at its upstream end an arcuate wall **16** preferably formed from plate steel or the like. The framework of the gate **14** includes downstream divergently extending pairs of side arms **18**, Fig. 1, each pair of side arms being connected at its downstream or rear extremity to an interconnecting joint consisting of a journal **20** which is rotatably mounted on a pivot pin **22** carried by a vinculum girder **24** mounted within pier **12** as will be hereinafter described.

In Fig. 1 of the drawings, two piers **12** are shown, but it will be understood that the dam may be of any length and have as many piers as desired, each intermediate pier supporting, as shown in the right hand pier of Fig. 1, an anchorage designed to be used with a plurality of Tainter gates. As shown in Fig. 2, the top of each pier **12** is higher than the crest **10** of the dam and has at its rear end an offset **26** somewhat higher than the crest **10** of the dam providing thereby a base support for the gate and vinculum girder interconnecting joint.

As shown in Figs. 5 and 7, the vinculum girder **24** consists of a rectangular section built up from four plates **28** and has at its upstream or forward end a fabricated anchor **30**. This anchor **30** includes a pair of channel irons **32** welded to the top and bottom plates **28** of the vinculum girder, and an end plate **34** welded to the ends of the said channel irons. This end plate encloses the upstream or forward end of the vinculum girder. The downstream end of the vinculum girder **24**, Fig. 4, projects outwardly from each pier **12** to define a free end for the girder, and is provided with a passage through its side plates **28** reinforced by plates **38**, which as shown in Fig. 6 are welded to the inner and outer sides of the said side plates. The inner plates **38** are provided with a stiffener member **40**, Fig. 6, which extends between and is welded to the said inner plates. Through the passage of the vinculum girder passes the trunnion pin or pivot **22** which is positioned within the said girder by plates **44** which are secured to the outer reinforcing plates **38** and seated within recesses provided therefor in the said trunnion pin. To this pin are rotatably connected the journals **20** carried by the downstream or rearwardly extending gate arms **18**. Rigidly secured to the bottom plate of the girder adjacent to its downstream end is a sliding bar **46**, Figs. 3 and 6, which is adapted to be received by a thrust block **48** anchored within the pier offset **26** by concrete bonding hooks **50**.

In the assembled form shown in Fig. 2, the upstream or forward end and a large portion of the body of the vinculum girder are set within the pier **12** with a supporting member **52** providing vertical support for the forward end of the girder during construction of the dam. The body portion of the girder set within the pier is surrounded with a cork sleeve **54** to prevent bonding of the concrete thereto for a purpose which will be hereinafter explained. The rear or downstream end of the girder has the sliding bar **46** seated within the thrust block **48** and has the trunnion pin or pivot **22** rotatably carrying the journals **20** of the gate arms **18** locked within the girder passage. To permit longitudinal movement of the vinculum girder while resisting lateral movement, the thrust block is provided with suitable bearing means which as shown in Fig. 6 consists of a pair of stainless steel plates **49** positioned intermediate the sides of the sliding bar and thrust block. The gates in their lowered position have their lower edges resting upon the crest **10** of the dam, Fig. 2, and may be raised by a crane or any other suitable means as is commonly used for raising Tainter gates.

It is to be noted from Fig. 1 that the centerlines of all the structural members involved in the anchorage means converge in a single point. As has been mentioned previously herein, this structural arrangement results, under normal loading conditions, in these members carrying tensile stresses only, instead of both direct and flexural stresses which occur in anchorages of the conventional design. However, when flexural stresses are present, due to unbalanced gate loading, the single vinculum anchorage is only partially loaded, whereas the conventional anchorage is under maximum stress as a result of cantilever action. The resulting stress distribution in the pier from the vinculum girder and anchor block is always symmetrical about its center line since all the longitudinal gate loads are transmitted by the single vinculum or anchorage girder to the forward or upstream anchor block centrally located within the pier. This is insured by placing the cork sleeve **54** previously mentioned around the body portion of the vinculum girder preventing bonding to the body portion of the said girder by the concrete pier.



It is to be recalled that the above-described structure is for downstream divergently extending gate arms **18**. It is therefore believed axiomatic that, for gate arms which are straight or parallel to the piers, a modification of the above structure is required. Figs. 8 through 13 illustrate such a modification, which consists in modifying the construction of the vinculum girder **24** to include a trapezoidal trunnion frame **80**, and additional thrust block means to carry the added flexural stresses presented through the longer moment arm occasioned by connecting the said downstream extending gate arms **104** to the outer extremities of the said trunnion frame which extends beyond the ends of the piers.

The numeral **60** is used to designate the modified vinculum girder, the forward or upstream end of which is identical in construction to the forward or upstream end of the girder **24**, previously described, and for this reason is not shown in Figs. 8 through 13. The girder **60** includes side plates **62** having passages **64** adapted to receive the trunnion frame as will be hereinafter described, and a bottom plate **66** having a pair of sliding bars **68** and **70** secured adjacent to the downstream end of the girder and the upstream side of the girder passages **64** respectively. A top plate **72** completes the frame structure of the girder **60** and carries another sliding bar **74** directly above the sliding bar **70**.

The trunnion frame **80** is a fabricated frame member including an upstream member **82** consisting of a pair of base plates **84**, normal to the vinculum girder **60** and interconnected by a pair of angle irons **86** passing through the passages **64** of the said girder, and a pair of side members **88** extending downstream in a converging manner to the downstream end of the vinculum girder **60** to which they are welded. The side members **88** include top and bottom plates **90** secured in a vertically spaced relation to each other by side plates **92** welded to the edges of the said top and bottom plates thereby forming a box construction having spaced stiffener members **94** mounted within.

The trunnion frame **80** carries a pair of steel castings or ears **96** secured to the base plates **84** by fasteners **98** which receive trunnion pins or pivots **100** carrying journals **102** secured to the straight gate arms **104**, providing thereby a pivotal interconnection between the gates and vinculum girder.

The girder **60** is installed within the downstream face of the pier **12** with its sliding bars **68**, **70**, and **74** resting within corresponding thrust blocks **68'**, **70'**, and **74'** anchored within the piers by means of concrete bonding hooks **106**. The thrust blocks are arranged to permit longitudinal movement of the girder, while providing resistance to any lateral movement. This resistance to lateral movement while permitting longitudinal movement is developed by providing the thrust blocks with suitable non-rusting plates **108** positioned intermediate the sides of the slide bars and the thrust blocks which will act as a bearing surface for the longitudinal movement of the girder, but which will resist any lateral movement of the said girder. It has been found that by using stainless steel plates in the thrust block **68'** and bronze plates in the thrust blocks **70'** and **74'** the desired result is achieved.

In this assembled form the trunnion frame base plates **84** abut against a cork liner **110**, Figs. 8 and 10, preventing bondage of the concrete pier to the base plates as well as to the body portion of the girder which is covered by a cork sleeve **114** as was the girder **24**,

thereby permitting free longitudinal movement of the downstream end of the vinculum girder which is centrally located within the pier **12**, as it was with the girder **24**.

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

1. In a dam structure provided with a series of successive water gates for controlling flow of water through the dam, the improvements which comprise means for mounting, anchoring and operating the gates into a plurality of structural piers, there being a pier intermediate each pair of successive gates, said piers comprising a base portion and an upper portion, the base portion projecting beyond the upper portion and defining a projecting ledge, the said means including a vinculum girder embedded in each pier with an end of each girder projecting outwardly from the pier above the ledge thereof, a single pivot mounting extending transversely through the projecting end of the girder so that the pivot mounting is common to successive sets of side arms interconnecting successive gates of successive pairs thereof, bearing means in the girder for the pivot mounting preventing rotation of the pivot mounting relative to the girder, supporting and anchoring means for the projecting end of the girder extending from the end of the girder into the base ledge of the pier and embedded therein, and additional anchoring means for the girder embedded with the girder in the pier.

2. In a dam construction provided with a series of successive water gates for controlling flow of water through the dam, the improvements which comprise means for mounting, anchoring and operating the gates, which means include a plurality of structural piers, there being a pier intermediate of successive gates, a vinculum girder embedded in each pier for the major length of said girder with the downstream end of the girder projecting outwardly from the pier, a single pivot member mounted transversely or laterally through the projecting end of the girder and extending laterally from the said girder on opposite sides thereof, bearing means in the said girder for the pivot member preventing rotary motion of the pivot member relative to the girder, actuating arms for the gates connecting successive gates to the said single pivot member on each side of the girder so that a single pivot mounting holds and anchors operating arms from successive gates, one on either side of the pier in which the vinculum girder is embedded, supporting and anchoring means for the projecting end of the girder extending from the said end into the pier and embedded therein, and additional anchoring means for the girder attached to portions of the girder embedded in the pier, the said anchoring means also being embedded in the pier.

3. In a dam construction provided with a series of successive water gates for controlling flow of water through the dam, the improvements which comprise means for mounting, anchoring and operating the gates, which means include a plurality of structural piers, there being a pier intermediate of successive gates, each of which piers is constituted of a base portion and an upper portion, the base portion projecting rearwardly beyond the upper portion and forming and defining a projecting ledge, a vinculum girder embedded in the upper portion of each pier from a forward end of the girder to a location adjacent to the rear end of the girder, the said rear end of the girder projecting outwardly from the pier above the said ledge, a single pivot mounting through the projecting rear end of the girder, bearing means in the girder for the pivot mounting preventing rotation of the latter relative to the girder, the said pivot mounting projecting laterally beyond the girder on each side thereof, actuating arms for the gates connecting successive gates to the single pivot member on each side of the girder so that a single pivot mounting anchors and holds operating arms from successive gates, one on each side of the pier, a thrust block for the girder embedded in the pier ledge almost directly beneath the pivot mounting which engages the girder beneath the exposed end thereof, anchoring means for the thrust block embedded in the ledge, and an anchor block for the girder adjacent to the embedded forward end of the girder, this also being embedded in the pier.

4. In a dam construction provided with a series of successive water gates for controlling flow of water through the dam, the improvements which comprise means for mounting, anchoring and operating the gates which means include a plurality of structural piers, there being a pier intermediate of successive gates, a vinculum girder embedded in the pier from a forward end of the girder to a location adjacent to a rear end thereof, an anchor block embedded in the pier secured to the girder adjacent to the embedded forward end of the girder, the said girder having rear end portions projecting rearwardly from the pier, a single trunnion pin extending through the projecting rear end portions of the girder and extending laterally therefrom on each side thereof, both the anchor block and the trunnion pin being substantially normal to the longitudinal axis of the girder, the said pin accommodating trunnions on the side arms of successive gates on each side of the pier, a thrust block embedded in the pier engaging the projecting end portions of the girder directly beneath the trunnion pin, and anchoring means for the thrust block projecting therefrom into the pier and being deeply embedded in the pier, the said thrust block and anchoring means therefor overcoming unbalanced lateral loadings from the side arms for the gates.

5. In a dam structure wherein there are successive upright concrete piers and spillway openings between them and water gates mounted in the spillway openings, side arms for the successive gates, a vinculum girder anchoring successive gates and having a forward end, a body portion, and a rear end, the forward end and the body portion being embedded in the pier with the rear end projecting from the said pier, a trunnion pin in the projecting end of the girder extending substantially beyond the girder on each side of the girder, side arms for the gates having an end secured to the gates and an opposite end mounted on the trunnion pin, anchor means for the girder rigidly secured thereto adjacent to the forward end of the girder and embedded in the pier, jacketing means enclosing the body portion of the girder and embedded within the pier, a thrust block embedded in the pier beneath the projecting rear end of the girder, anchoring means for the thrust block deeply embedded in the pier, the thrust block being positioned beneath the trunnion pin in the girder, and means engaging the girder to the thrust block, the said jacketing means for the girder preventing bonding of the girder to the pier and facilitating the transmission of longitudinal forces from the gate side arms to the anchor means adjacent to the forward end of the girder, while the thrust block acts to overcome unbalanced lateral loadings from the gate side arms.

6. In combination with a dam structure having a plurality of spillway openings, each of the openings having vertical, or near vertical, side walls, rotatable spillway gates for controlling flow of water through said openings, the said gates including a plurality of side arms having an end secured to said gates and trunnions on opposite ends of said arms, a vinculum girder embedded within each of the vertical walls with rear end portions of the girder projecting from the said walls as a free end, a trunnion pin mounted in the free end of the girder and extending laterally of the girder on each side thereof, the said trunnion pin being received in the trunnions of successive side arms of successive gates on opposite sides of the vertical side wall intermediate successive gates and spillway openings.

7. The combination with a dam structure having a plurality of spillway openings, successive openings being separated by a structural pier, rotatable gates mounted in the openings for controlling extents thereof, the said gates including a plurality of side arms having an end secured to said gates, trunnions on opposite ends of the side arms, a vinculum girder embedded in each pier but having a free end projecting therefrom, a single trunnion pin mounted in the free end of the girder transversely thereof and substantially normal to the longitudinal axis of the girder, the single trunnion pin being received in the trunnions on the side arms of successive gates, and thrust means for the free end of the girder anchored in the pier.

8. The construction defined in claim 7 including means operatively connecting the trunnions of successive gate side arms to the girders, the said means including a trunnion frame secured to the girder and extending laterally therefrom on each side thereof, and pivot means connecting the trunnions of successive side arms to the trunnion pin.

9. The construction defined by claim 7 wherein the

girder comprises an assembly including side plates, a top plate and a bottom plate, the girder having a forward end, a body portion, and a rear end, an anchor secured to the forward end of said girder, a plurality of sliding bars in engagement with the girder, the body portion of the girder having a sliding bar rigidly secured to its top plate and a second sliding bar rigidly secured to its bottom plate, the rear end of said girder also having a sliding bar rigidly secured to the bottom plate, a corresponding plurality of thrust blocks, the said thrust blocks being anchored within the structural pier intermediate successive gates and adapted to receive the aforesaid sliding bars, a trunnion frame rigidly secured to the rear end of the girder, means enclosing the body portion of the girder for preventing bonding of the pier to the said body portion of the girder while permitting stresses resulting



from balanced gate loadings to be transmitted to the anchor carried by the forward end of the girder, and anchoring means for the thrust blocks embedded in the pier, the said thrust blocks acting in conjunction with the sliding bars to overcome unbalanced lateral loadings from successive side arms of successive gates connected to the said trunnion frame at both sides thereof.

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