T. E. BROWN.

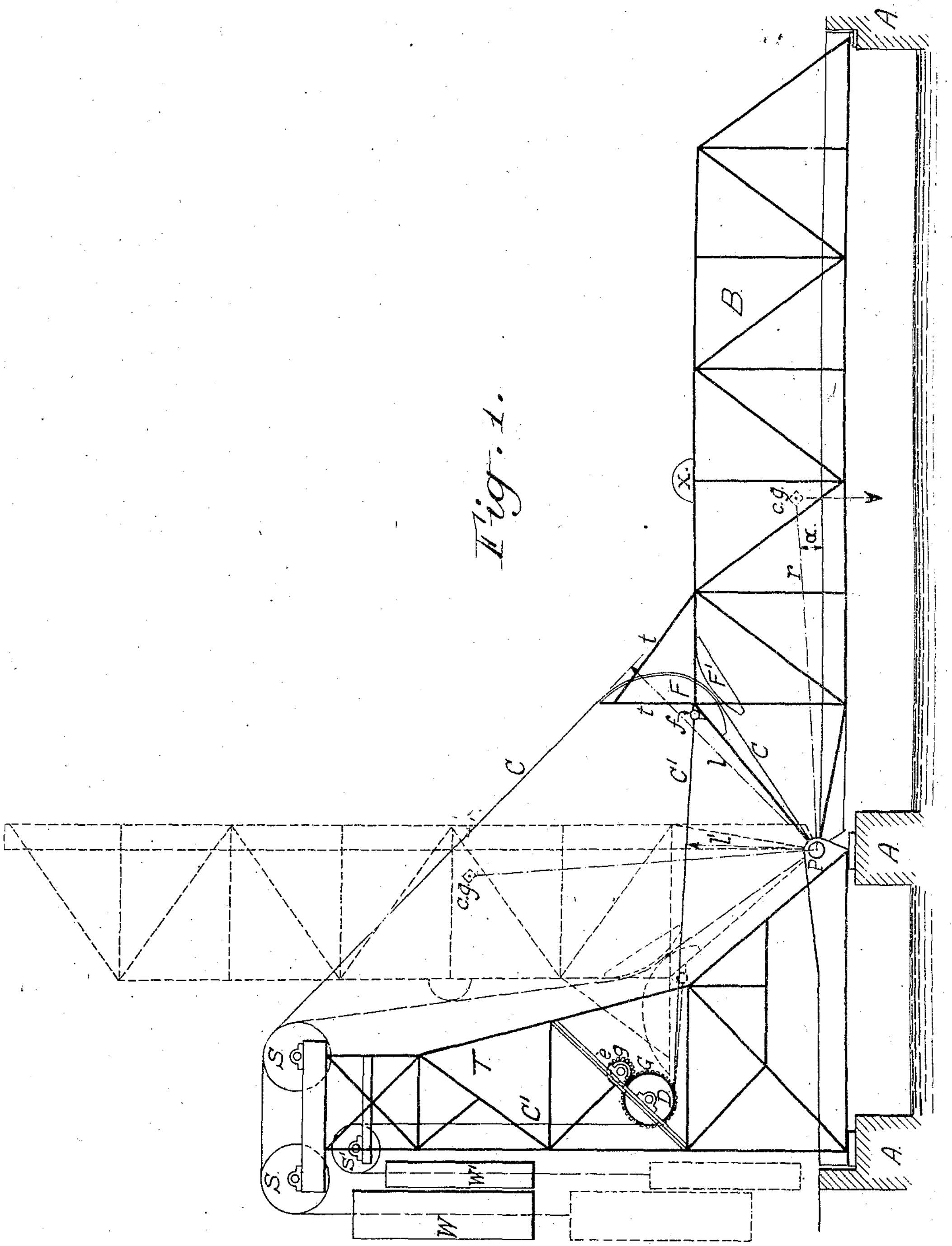
BASCULE BRIDGE.

APPLICATION FILED MAR. 20, 1913.

1,151,657.

Patented Aug. 31, 1915.

3 SHEETS—SHEET 1.



Witnesses:
C. B. Brown
G. A. Klimek.

Inventor
Thomas E. Brown

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3 SHEETS—SHEET 2.

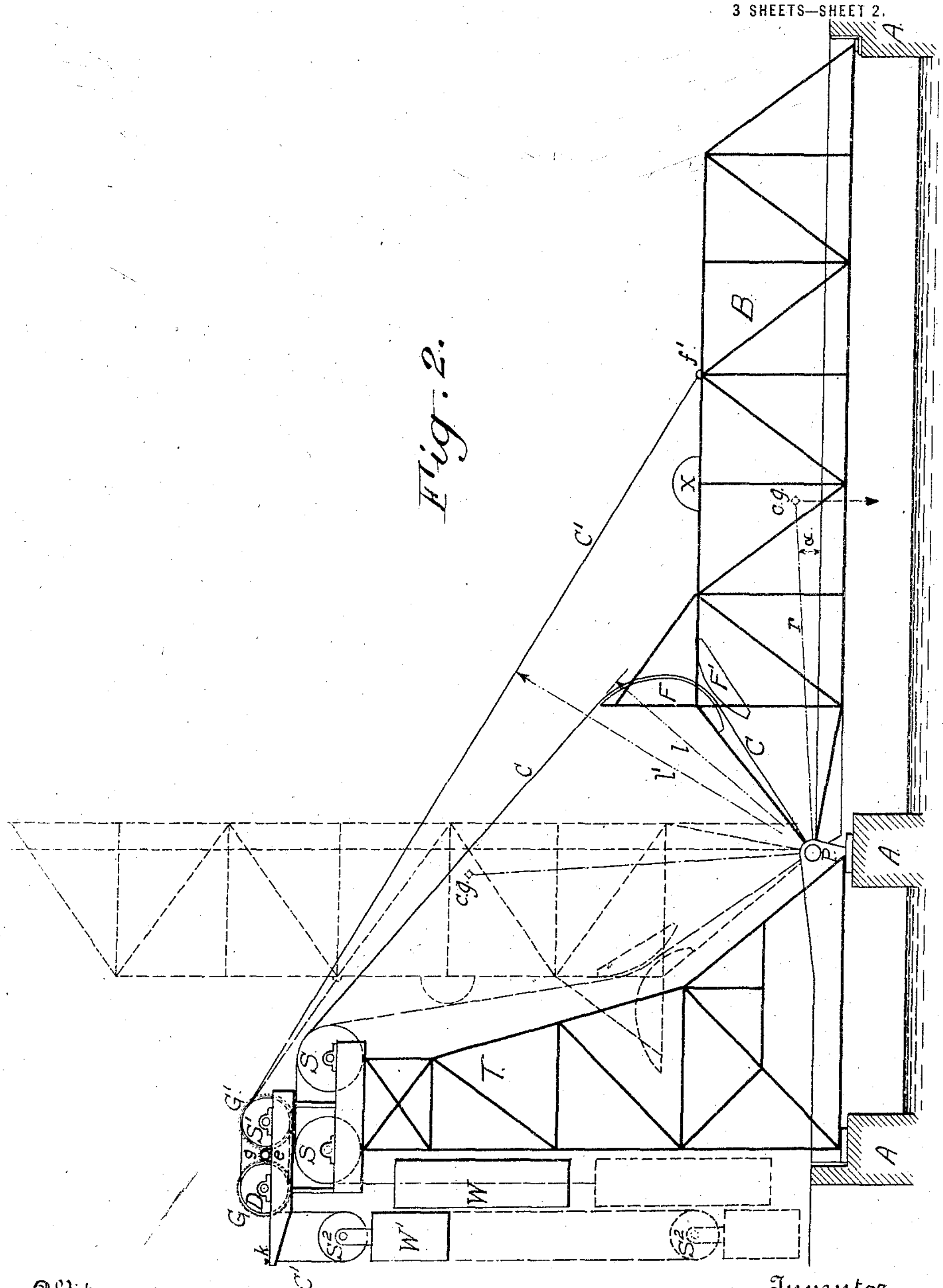

Fig. 2.

Witnesses:
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3 SHEETS—SHEET 3.

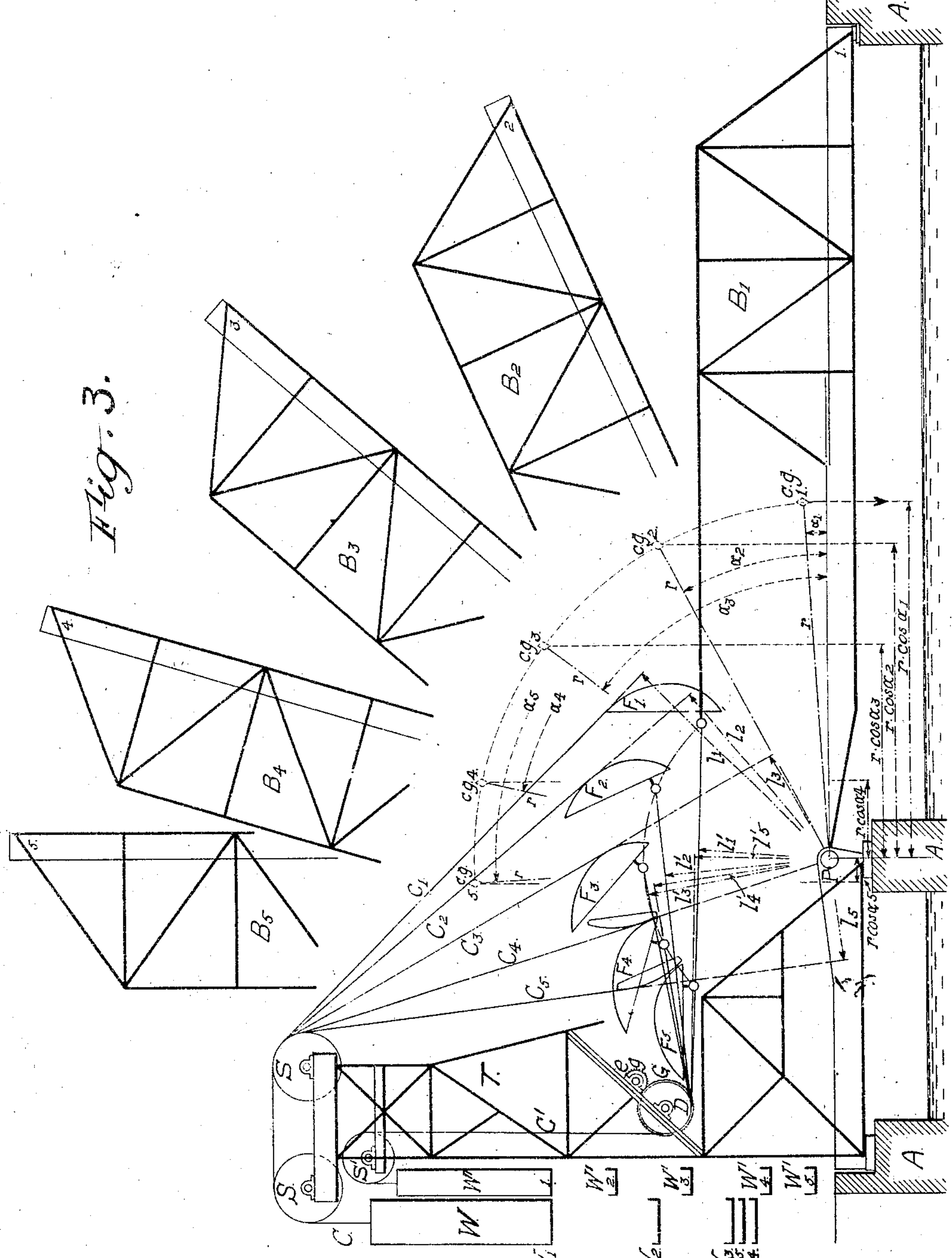

Fig. 3.

Witnesses:
C B. Brown
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Inventor
Thomas E. Brown

UNITED STATES PATENT OFFICE.

THOMAS E. BROWN, OF NEW YORK, N. Y.

BASCULE-BRIDGE.

1,151,657. Specification of Letters Patent. Patented Aug. 31, 1915.

Application filed March 20, 1913. Serial No. 755,600.

To all whom it may concern:

Be it known that I, THOMAS E. BROWN, a citizen of the United States, and a resident of the borough of Manhattan, in the county of New York and State of New York, have invented certain new and useful Improvements in Bascule-Bridges, of which the following is a specification.

This invention relates to improvements in bascule bridges, of the general kind described in my United States Letters Patent, numbered 590,787, and dated September 28th, 1897.

It is the especial purpose of the present invention to simplify and cheapen the construction and operation of such bridges, and particularly to effect the raising and lowering of the bridge with the minimum expenditure of power, and the secure holding of the bridge in its raised and in its lowered position merely by means of simply constructed and operated cables, weights and winding drums, so that the need of costly hydraulic rams or other costly machinery for effecting the movements of the bridge and for securely holding the bridge in its positions is obviated.

The present invention relates to bridges of that class wherein a counterweight is so connected with the bridge by rigging that the pull of the counterweight on the bridge automatically varies exactly as the turning moment of the bridge about its pivot varies, and thus the counter-weight automatically balances the bridge in all positions, notwithstanding that the turning moment of the bridge varies from one position to another of the bridge. Obviously a bridge so balanced with a single counter-weight connection, and when not in a vertical or nearly vertical position, can be raised or lowered simply by exerting a pull up or down on the counter-weight, or, to express the same principle in different terms, by a pull in one or other direction on the counter-weight connection. This method of operation is the simplest of any, and is practicable whenever such a bridge is not required to approach a vertical position. When, however, such a bridge approaches the vertical position the effective lever arm of its center of gravity about its pivot becomes less and less, becoming zero when the center of gravity of the bridge is vertically over the pivot. And, similarly, the lever arm of the counter-weight must also diminish as the bridge approaches the vertical, in order to maintain the said balance; and when the center of gravity of the bridge is vertically over the bridge pivot the line of pull of the counter-weight connection must also pass through the bridge pivot. Consequently, in this position, neither the weight of the counter-weight, nor any increased or diminished pull on the counter-weight connection, can have any effect on the bridge; and under such circumstances the counter-weight connection could not be utilized to hold the bridge securely in that position against the pressure of the wind.

The bridge, when in a vertical or nearly vertical position, is subjected to the greatest wind pressure, and it is then that the greatest force is required to control it, and, as in this position a pull on the counter-weight or its connection is not effective, other means must be employed. Heretofore such means have been external to the counter-weight system, and have consisted of hydraulic rams, rockers, connecting rods, gearing and the like. But such means are complicated and expensive, and are difficult to install without encroaching on the space required for roadways, sidewalks and necessary structural members; and it is the object of this invention to so arrange counter-weight connections that all such complicated means may be avoided and the bridge may be operated in all positions by simply pulling on a counter-weight connection or on a counter-weight itself. I effect this result by using two or more counter-weight connections, one or more being attached to the bridge by rigging so that the tensions on all the counter-weight connections together balance the bridge in all positions. By choosing suitable points of attachment to the bridge for the various counter-weight connections, then, when the line of pull of one counter-weight connection passes through the bridge pivot, the line of pull of others may be substantially distant from the pivot and these connections will be capable of controlling the bridge. Usually but two counter-weight connections are needed for each side of the bridge, and one of these can be so attached to the bridge as to always have a substantial leverage around the pivot, and the line of pull of the other counter-weight connection only need pass through the pivot during the motion of the bridge, and the bridge can be controlled completely by pulling on the first mentioned counter-weight connection or its counter-weight. Various means to produce the pull on the connection, and various arrangements of counter-weight and connections may be used, and I have shown in the accompanying drawings several of the preferred arrangements: but I do not confine myself to any particular means or arrangement. I prefer to use cables for the counter-weight connections, and hereinafter use the word "cable" when referring to such a connection, although the connections may be constructed of chains, link bars, and other suitable devices.

Referring to the said drawings which accompany the specification to aid the description, Figure 1 is an elevation of a bascule bridge equipped with my counterbalancing device, in the arrangement preferred for the case when it is desired to place the controlling machinery in a tower and immediately over the roadway. Fig. 2 is an elevation of the arrangement preferred when it is desired to place the winding machinery at the top of a tower. Fig. 3 is an explanatory diagram indicating various positions of the bridge shown in Fig. 1.

It will be understood that the figures show the counter-balancing devices for only one side of the bridge, but that generally in practice these devices will be duplicated, there being one set of such devices for each side of the bridge. Therefore in the description which follows reference is made to the devices on the one side only, the corresponding parts on the other side of the bridge being similar to those described.

Referring to Fig. 1,—B is a bascule bridge; A—A being the piers, P the pivot about which the bridge turns, T the tower, C the main counter-weight cable, and C^1 the secondary counter-weight cable. S and S^1 are guide sheaves respectively for said cables C and C^1 on the top of the tower; W and W^1 are the main and secondary counter-weights, and D is a winding drum for operating the secondary counter-weight cable C^1. The joint weight of said counter-weights W and W^1 is preferably just sufficient to balance said bridge B when the latter is in its lowest position. The secondary counter-weight cable C^1 is attached to some suitable point of the bridge, as the elbow of the upper chord f, and the said primary cable C passes around a saddle F, and is fastened to said bridge at some point back of said saddle F, and preferably at the pivot P, said saddle forming a curved way or guide on which the cable C is laid. Said saddle F is secured, preferably to the upper side of the bridge as shown, by any suitable framing such as the post and tie rods t—t. As the bridge rises to different positions the cable C will of course unwrap from the saddle, said cable forming the tangent to the curve. The curve of the face of said saddle F on which said cable C is laid, is formed so that the moment of the cables of the main weights W added to the moment of the cables of the secondary weights W^1 will equal the moment of the bridge around the pivot P—*i. e.* the primary weights W multiplied by the perpendicular distances from the pivot P to their cables C plus the secondary weights W^1 multiplied by the perpendicular distances from the pivot P to their cables C^1 must equal the weight of the bridge multiplied by the horizontal distance from the pivot P to the vertical through the center of gravity of the bridge; said perpendicular distances from the pivot P to the line of pull of the respective cables being their lever arms, or algebraically expressed,—

$$Wl + W'l' = Br \cos \alpha$$

in which W and W^1 represent the total weight of the respective weights, and l and l^1 the lever arms of the respective counter-weights, and B represents the weight of the bridge, r the radius from the pivot P to the center of gravity of the bridge, and α the angle which said radius makes with the horizontal. To effect the control of the bridge, the point of attachment f of said secondary cable C' is preferably so chosen that the lever arm l^1 of said cable C^1 is always of substantial length, and therefore the moment W^1l^1 will always be a substantial quantity. Therefore as the bridge rises and the angle α increases and its cosine diminishes the right hand member of the equation becomes less and less until at some point between the horizontal and the vertical positions of the bridge, it equals W^1l^1 and the term Wl then becomes equal to zero,—*i. e.* l must be equal to zero, and the line of the cable C then passes through the pivot P in this position of the bridge. As the bridge continues its upward motion the term Wl becomes negative, and the pull of the cable C becomes opposed in its effect on the bridge to the pull of the cable C', and thus an efficient and simple means of operating and controlling the bridge is provided. Moreover, as the bridge continues its said upward motion, the cables C being connected to the bridge at the pivot P, will no longer remain in contact with the said saddle F, and a second reversed saddle F' is preferably used to effect the aforesaid opposition to the pull of the cable C', and to complete the balance during the remaining upward movement of the bridge. If the point of attachment of the said cables C to the bridge is placed high enough above the pivot P, a single curve F can be used and the said reversed curve F' may be dispensed with, but this usually necessitates the introduction of otherwise superfluous structural members, and I prefer to use the reversed curve F′. The bridge being balanced in all positions by the combined weights W and W′, it is manifest that if we pull down on the weight W′ or pull on its cable C′, the balance will be destroyed and the bridge will rise, and conversely that if we pull up on the said weight W′ the bridge will descend. I accomplish this pull by attaching the secondary cable C′ to a winding drum D, preferably by wrapping it several times around said drum and attaching it to said drum, and of course said cable C′ may be in two separate parts, one extending from the point of attachment *f* to drum D, and the other from drum D to the counter-weight W′. When said drum D, arranged as in Fig. 1, is revolved in the direction of the hands of a clock the bridge rises, and when revolved in the reverse direction the bridge descends. Said drum D may be revolved by any suitable means, as by gear G and pinion *g* on shaft *e*; said shaft *e* being revolved by any suitable motive means such as a steam or gas engine or electric motor. Suitable brakes should be provided for stopping the motion of the said drum D. Obviously the power to lift the bridge is only limited by the power available to turn the drum D and the strength of the cable C′. But the maximum in lowering the bridge is obtained when the drum D lifts the entire weight W′; hence the weight W′ must be so heavy that its moment shall exceed the greatest moment that can be produced by wind pressure and friction on the bridge, at the greatest wind pressure against which it is intended that the bridge shall be operative. The said cables C and C′ for simplicity have been hereinbefore described as single members, but they will generally consist of a multiplicity of smaller ropes acting in unison.

Referring to Fig. 2, which shows the arrangement I prefer when the winding machinery is to be placed at the top of the tower, the secondary cable C′ is attached preferably to the top chord of the bridge at a suitable point *f′* beyond the saddle F, and is carried over the guide sheave S′ and around the drum D and down to the counter-weight W′. In this case the travel of the cable C′ is much greater than when arranged as in Fig. 1, and therefore, to avoid greatly increasing the height of the tower T, I prefer, instead of attaching the secondary cable C′ directly to the weight W′, to pass said secondary cable under a reduction sheave S^2 attached to the weight W′ and thence up to and attach it at some point as *k* near the top of tower T, and thus reduce the travel of the said weight W′ to one-half of the travel of the said secondary cable C′. If a greater reduction is required more reducing sheaves may be introduced. Obviously, as the motion of the weight W′ is thus reduced, its weight must be correspondingly increased. In the construction illustrated in said Fig. 2, the function of the main weight W, its cable C and the saddles F and F′ are the same as described in connection with Fig. 1; and the operation of the bridge by means of drum D is also the same, except that as shown in Fig. 2, the rotation of drum D for the up and down motion of the bridge is preferably the reverse of that indicated in Fig. 1; also we may drive the guide sheave S′ by the pinion *g* and a gear G′, and then by wrapping the cable C′ a sufficient number of times around drum D and sheave S′ we may obtain sufficient adhesion between the cable C′ and the drum D and sheave S′, to operate the bridge without positively fastening the cable C′ to the drum D.

Fig. 3, is a diagram showing elements of Fig. 1 in various positions, similar letters indicating similar parts and the numerals corresponding to the various positions. This diagrammatic figure shows clearly the action of the saddles F and F′ in varying lever arm *l* of the cable C in conformity with the aforesaid equation.

To check the bridge on its upward motion, I prefer to provide a buffer X in all modifications of the invention, so located on the bridge B that when said bridge is approaching its vertical position said buffer will contact with said cable C, and should any cause, such as a stiff wind, tend to move said bridge back beyond its proper position, said buffer X will press on said cable C and cause said counter-weight W to resist any further backward movement of said bridge. The bearing surface of said buffer X is curved on a radius sufficiently easy to allow said cable C to bend without injury.

Now having described my improvements I claim as my invention—

1. The combination with a bascule bridge of a plurality of counter-weights, one of which counter-weights is operatively connected with said bridge at a point substantially distant from the pivot from said bridge, means to raise and lower said counter-weight, and operative connection from another of said counter-weight to said bridge, and curved members in contact with said last named connection and adapted to vary the leverage of said connection such that said plurality of said counter-weights in the aggregate balance said bridge in all its positions.

2. A combination with a bascule bridge of two counter-weight connections operatively connected with the bridge, a curved saddle adapted to vary the lever arm of one of said connections during a portion of the

motion of the bridge, and a reverse saddle to vary the lever arm of said connection during the remainder of the motion of the bridge so that the two connections together balance the bridge in all its positions.

3. The combination with a bascule bridge, of two counter-weight connections operatively connected with the bridge, a curved saddle adapted to vary the lever arm of one of said connections during a portion of the motion of the bridge, and a reverse saddle to vary the lever arm of said connection during the remainder of the motion of the bridge so that the two connections together balance the bridge in all its positions, and means to vary the tension on one of said connections.

4. The combination with a bascule bridge of counter-weight connections operatively connected with the bridge, curved saddles adapted to vary the lever arm of said connections during a portion of the motion of the bridge and reverse saddles to vary the lever arm of said connections during the remainder of the motion of the bridge.

5. The combination in a bascule bridge of two sets of counter-weights, connections from said sets of counter-weights to said bridge, the connection from one set of counter-weights having such position and direction as to possess a substantial lever arm in all positions of said bridge, means to raise and lower said set of counter-weights, and curved members adapted to vary the lever arm of the connections to the other set of counter-weights, so that said two sets of counterweights together balance the bridge in all its positions.

Signed at New York city in the county of New York and State of New York this eleventh day of March, A. D. 1913.

THOMAS E. BROWN.

Witnesses:
HARRY C. POILLON,
G. A. KLIMEK.

T. E. BROWN.

BASCULE BRIDGE.

APPLICATION FILED MAY 22, 1915.

1,203,695. Patented Nov. 7, 1916.

3 SHEETS—SHEET 1.

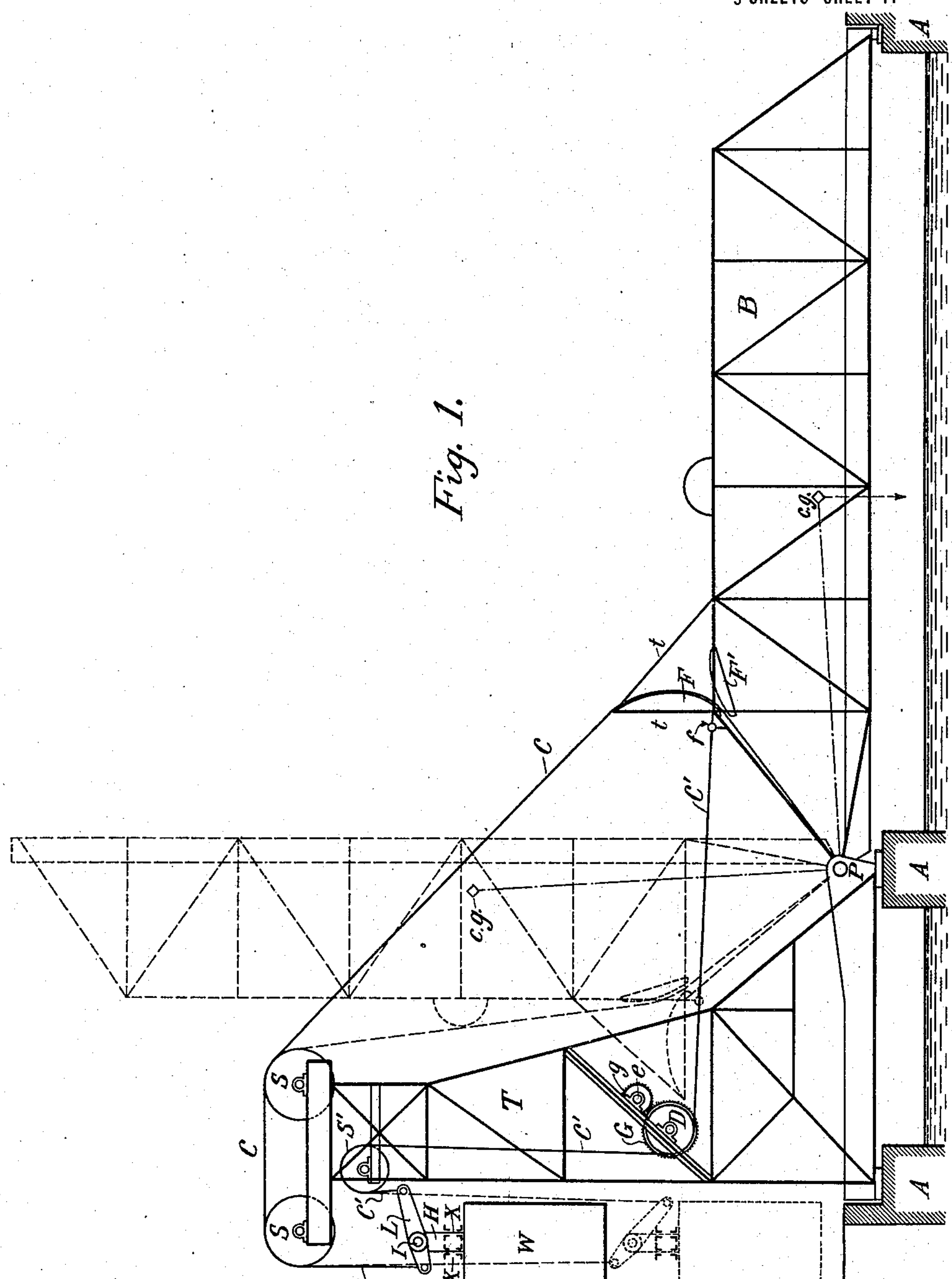

Fig. 1.

Witnesses:

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Carl T. Westlin

Inventor

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By Attorney

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T. E. BROWN.

BASCULE BRIDGE.

APPLICATION FILED MAY 22, 1915.

1,203,695.

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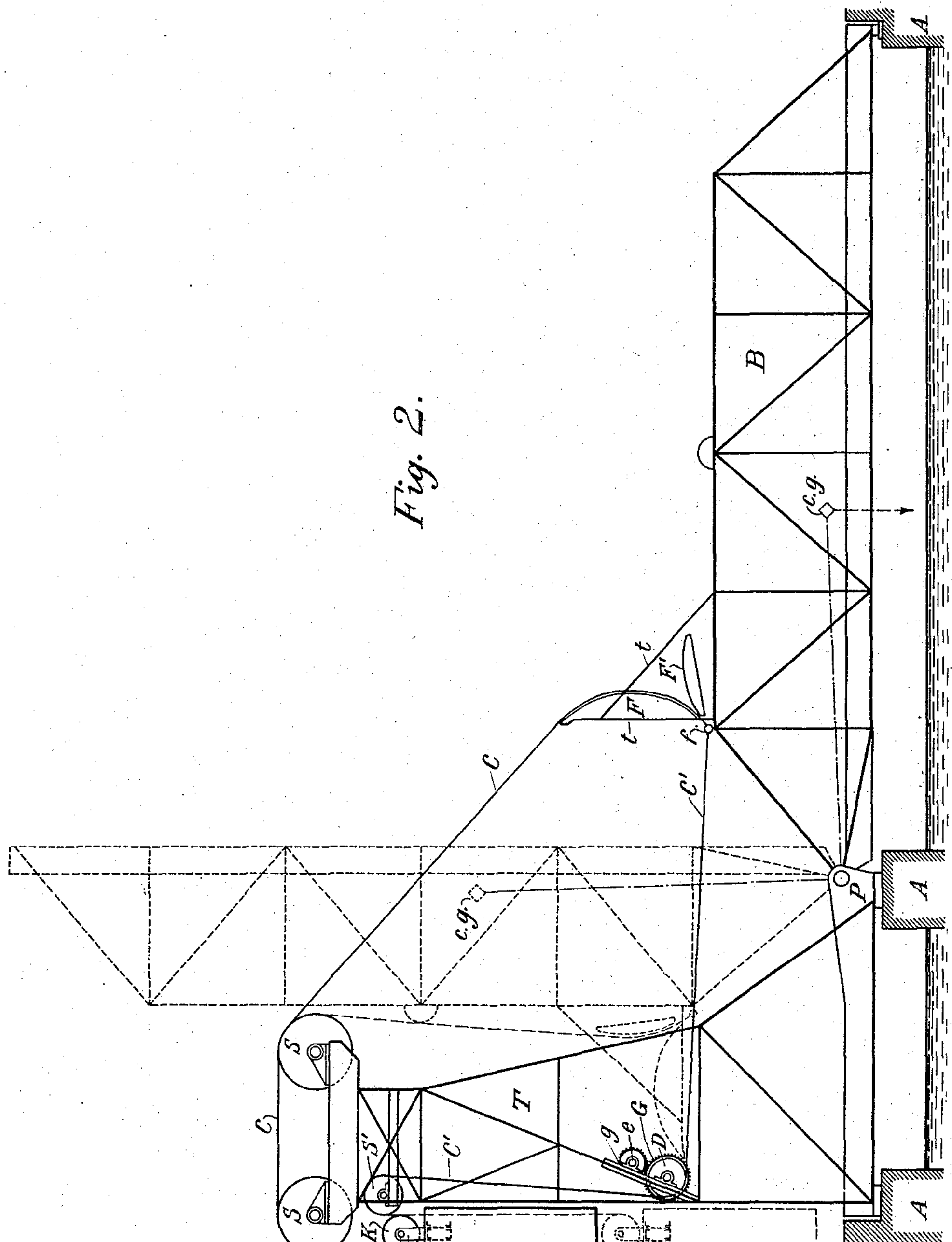

Witnesses:

Thos. E. Brown, Jr.

Carl T. Westlin

Inventor

Thomas E. Brown

By Attorney

THE NORRIS PETERS CO., PHOTO LITHO., WASHINGTON, D. C.

T. E. BROWN.
BASCULE BRIDGE.
APPLICATION FILED MAY 22, 1915.

1,203,695. Patented Nov. 7, 1916.
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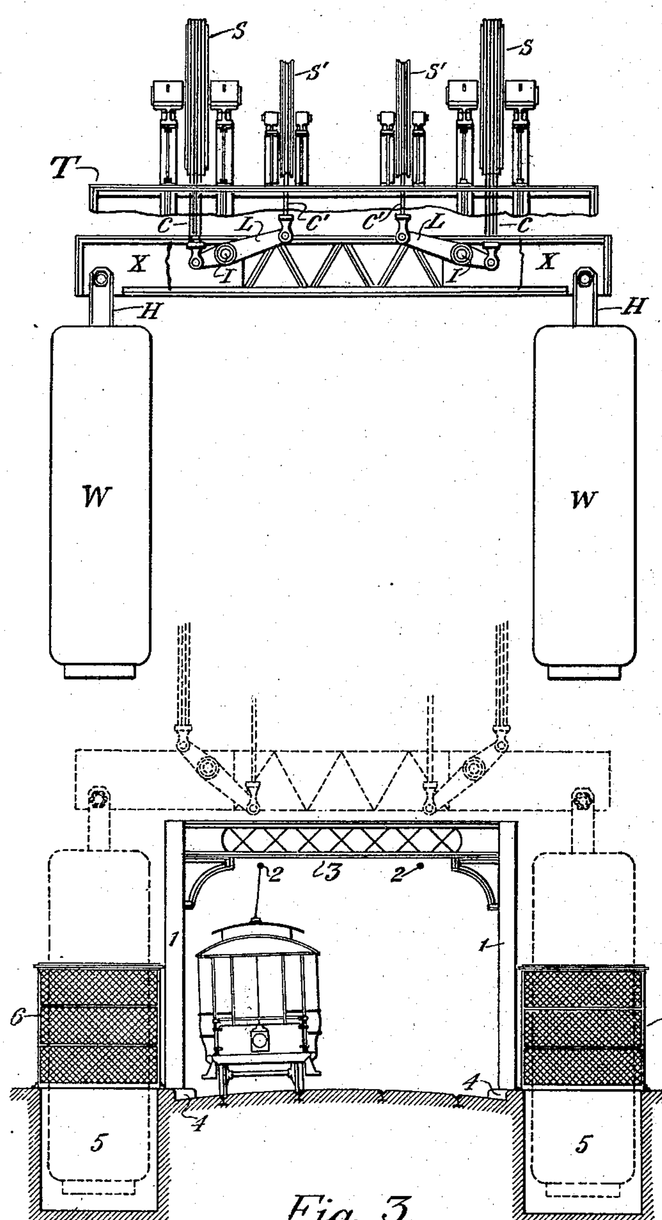

Fig. 3.

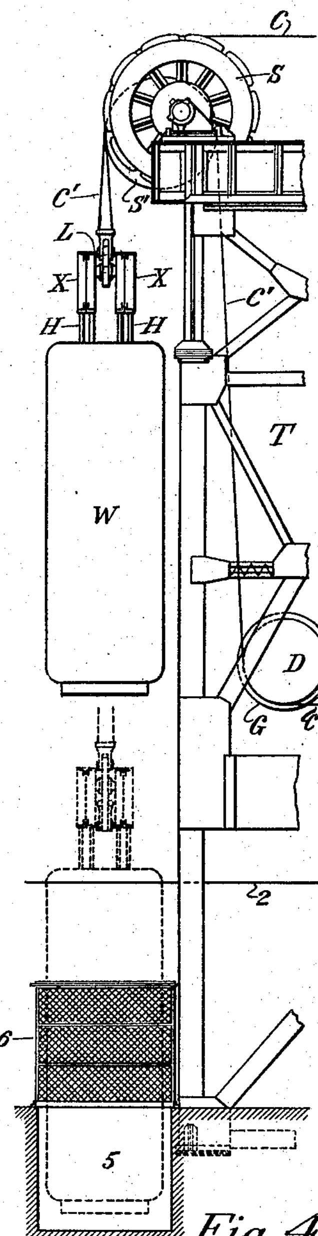

Fig. 4.

Witnesses:
Thos. E. Brown, Jr.
Carl T. Westlin

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Thomas E. Brown

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UNITED STATES PATENT OFFICE.

THOMAS E. BROWN, OF NEW YORK, N. Y.

BASCULE-BRIDGE.

1,203,695. Specification of Letters Patent. **Patented Nov. 7, 1916.**

Application filed May 22, 1915. Serial No. 29,815.

To all whom it may concern:

Be it known that I, THOMAS E. BROWN, a citizen of the United States, and a resident of the city of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Bascule-Bridges, of which the following is a specification.

This invention relates to improvements in bascule bridges of the class wherein a counterweight is so connected with the bridge by rigging that the pull of the counterweight on the bridge automatically varies exactly as the turning moment of the bridge about its pivot varies, and thus the counterweight automatically balances the bridge in all its positions, notwithstanding that the turning moment of the bridge varies from one position to another of the bridge.

It is a purpose of the present invention to simplify and cheapen the construction and operation of such bridges, and particularly to effect the raising and lowering of the bridge with the minimum expenditure of power and the secure holding of the bridge in its raised and its lowered position merely by means of simply constructed operating cables, weights and winding drums, and by simply pulling on a counterweight connection.

In my United States Patent No. 1,151,657, dated August 31st, 1915, I have shown and described means to accomplish these results with two counterweights and two counterweight connections on each side of the bridge, and it is a special purpose of the present invention to produce these results with one counterweight on each side of the bridge.

The usual practice in bascule bridge construction is to use a single massive concrete weight extending across the bridge with connections at each side of the bridge, or to use separate massive weights on each side of the bridge and supported in the planes of the trusses, and I may use weights so arranged; but when such bridges are traversed by electric cars the towers must be abnormally high to avoid interference of a single cross weight with the trolley wires, and when massive weights supported in the plane of the trusses are used said weights hang over the roadway and cannot travel below the roadway level, and it is an object of my invention to so support the counterweights outside of the plane of the trusses and outside of the roadway that said counterweights will not interfere with the trolley wires or the roadway, and may descend below the level of the roadway.

I prefer to use cables for the counterweight connections and hereafter use the word "cable" when referring to such a connection, although the connections may be constructed of chains, link bars or other suitable devices.

Referring to the drawings: Figure 1 is a side elevation of a bridge equipped with my said counterbalancing device. Fig. 2 is a side elevation of the bridge showing a special case of the application of my said invention. Fig. 3 is a broken rear view of the counterweight system, indicating the transverse girders X by solid lines in the upper part of said figure, and by dotted lines in the lower part of said figure. Fig. 4 is a broken side view of the counterweight arrangement shown in Fig. 3 and showing a portion of the supporting tower.

It will be understood that Figs. 1 and 2 show the counterbalancing devices for only one side of the bridge, but that generally in practice these devices will be duplicated, there being one set of such devices for each side of the bridge. Therefore, in the description of said figures which follows reference is made to the devices on one side only, the corresponding parts on the other side of the bridge being similar to those described.

Referring to Fig. 1, B is a bascule bridge; A A being the piers, P the pivot about which the bridge turns, T the tower; C the main counterweight cable, and C′ the secondary counterweight cable. S and S′ are the guide sheaves respectively for said cables C and C′ on the top of the tower, and W is the counterweight. D is a winding drum for operating the secondary counterweight cable C′; the letters *c. g.* representing the position of the center of gravity of the bridge; the weight of said counterweight W is preferably just sufficient to balance said bascule bridge when the latter is in its lowest position, and it will be evident that by rotating said drum D by any suitable power in the proper direction said bridge B will be raised or lowered. The secondary counterweight cable C′ is attached to some suitable point of the bridge, substantially distant from said pivot P, as the elbow of the upper chord *f*, and said primary cable C passes around a saddle F and is fastened to said bridge at some point back of said saddle F and preferably at the pivot P; said saddle forming a curved way or guide on which said cable C is laid. Said saddle F is secured preferably to the upper side of the bridge as shown by any suitable framing such as the post and the tie rods *t t*. L is a lever pivotally attached to the hanger H supporting said counterweight W, the main and secondary counterweight cables C and C′ being attached at opposite ends of said lever L. By suitably locating the position of the fulcrum I on said lever L, the weight W may be distributed in any desired proportion on the said cables C and C′. X are transverse girders supporting the counterweight W.

As the bridge rises to different positions the cable C unwraps from said saddle F, said cable forming the tangent of the curve. The curve of the face of said saddle F on which the said cable C is laid is formed so that the sum of the moments of the cables C and C′ around the pivot P of the bridge will equal the moment of the bridge around said pivot P, as described in my United States Patent, No. 1,151,657, dated August 31st, 1915, and in accordance with the formula given in said patent, namely,

$$Wl+W'l'=BR\cos\alpha$$

in which formula in this case W and W′ represent the amount of the portion of the counterweight W carried by the primary cable C and secondary cable C′ respectively, and l and l' represent lever arms of said cables respectively about the pivot P. B represents the weight of the bridge, R the radius from the pivot P to the said center of gravity (*c. g.*) of the bridge and α the angle which said radius makes with the horizontal.

To effect the control of the bridge the point of attachment *f* of said secondary cable C′ is preferably so chosen that the lever arm of said cable C′ is always of substantial length, and therefore the moment $W'l'$ will always be a substantial quantity; therefore, as the bridge rises and the angle α increases its cosine diminishes and the right hand member of the equation becomes less and less, until at some point between the vertical and horizontal positions of the bridge, it equals $W'l'$ and the term Wl then becomes equal to zero,—*i. e.*, l must then be equal to zero, and the line of the cable C then passes through the pivot P in this position of the bridge. As the bridge continues its upward motion the term Wl becomes negative, and the pull of the cable C becomes opposed in its effect on the bridge to the pull of the cable C′, and thus an efficient and simple means of operating and controlling the bridge by cable C′ is provided. Moreover, as the bridge continues its said upward motion, the cable C, being connected to the bridge at the pivot P will no longer remain in contact with the said saddle F, and a second reverse saddle F′ is therefore preferably used to effect the aforesaid opposition to the pull of the cable C′ to complete the balance during the remaining upward motion of the bridge. If the point of attachment of the said cable C to the bridge is placed high enough above the pivot P a single curve F can be used, and the said reverse curve F′ may be dispensed with, but this usually necessitates the use of otherwise superfluous structural members, and I prefer to use the reverse curve F′.

The bridge being balanced in all its positions by the combined tensions of the cable connections C and C′, it is manifest that with a pull on the cable C′ in either direction the balance will be destroyed and I accomplish such pull by attaching the secondary cable C′ to a winding drum D, and thus when said drum D, arranged as in Fig. 1, is revolved in the direction of the hands of a clock, the bridge rises and when revolved in the reverse direction the bridge descends. Said drum D may be revolved by any suitable means, as by gear G and pinion *g* on shaft *e*, said shaft *e* being revolved by any suitable motive power, such as a steam or gas engine or electric motor, and suitable brakes should be provided for stopping the motion of the said drum D.

Obviously the power to lift the bridge is only limited to the power available to operate the drum D and the strength of the cable C′; but the maximum power in lowering the bridge is attained when the torque of drum D equals the proportion of the counterweight W supported by the cable C′: hence the proportion of the weight W supported on the cable C′ must be sufficiently great that the moment of said cable C′ shall exceed the greatest moment that can be produced by wind pressure and friction on the bridge at the greatest wind pressure against which it is intended that the bridge shall be operated. This condition governs the amount of the portion of the weight W which must be carried on the operating cable C′ and therefore determines the ratio of the arms of the lever L. The length of the arms of the lever L, while conforming to this ratio, must be sufficient to provide for the differences of movement of the two connections C and C′ which not only do not move at the same speed but for the higher positions of the bridge move in opposite directions. Said cables C and C′ for simplicity have been hereinbefore described as single members but they will generally consist of a multiplicity of smaller ropes acting in unison.

Fig. 2 shows the preferred construction

when the conditions are such that it is desirable that the tension of the cables C and C′ shall be equal. In this case, instead of attaching the cables C and C′ to the lever L, and placing the fulcrum I in the center of said lever so as to make a lever of equal arms, we may omit said lever L and place on the pivot of hanger H a sheave wheel K which is the equivalent of a lever of equal arms, and which enables me to use a continuous cable for both parts C and C′ instead of the separate cables as shown in Fig. 1. The operation of Fig. 2 is obviously the same as described for Fig. 1.

Referring to Figs. 3 and 4; Fig. 3 is a view looking lengthwise of the bridge, with the lower parts of the tower T removed for the sake of clearness, and showing the counterweights and their supports and a section across the roadway, and Fig. 4 is a side view showing a portion of the tower and a counterweight and connections. S and S′ are the leading sheaves for the primary and secondary cables C and C′ respectively, L the levers, I their fulcrums and H hangers, all substantially as hereinbefore described for Fig. 1. X are transverse girders supporting the weights W by means of the hangers H, said girders in turn being supported on the cables C and C′ by means of the levers L. 2 are trolley wires, 4 are the curbs along the roadway, 5 are pits outside of the roadway into which the weights W descend, 6 are wire guards for said pits, 1 being the ends of the trusses and 3 the portal strut of the bridge as they would appear with the tower removed.

In Fig. 1 the levers are shown in the plane of the trusses, *i. e.* in the same plane as the cables C to more clearly show the principles of the invention, and this arrangement is useful when the weights are placed in the planes of the trusses, or when a single cross weight is used, but when the transverse girders X are used it is more convenient to place said levers L at right angles to the plane of the trusses as shown in Figs. 3 and 4.

The advantage attained by the use of the transverse girders X whereby the counterweights W W are carried outside of the roadway so that the trolley wires and roadway are not interfered with and do not limit the travel of the counterweights is clearly shown by Fig. 3.

Now having described my invention, I claim:—

1. The combination in a movable bridge of counterweights, counterweight connections and a girder supporting said counterweights on said connections, said girder being extended beyond the planes of the trusses and having the points of support of said counterweights outside of the planes of the trusses of said bridge.

2. The combination with a movable bridge of counterweights, counterweight connections descending over the roadway, and a transverse girder having its ends extended beyond the roadway and supporting said counterweights outside of the roadway of said bridge.

3. The combination with a movable bridge of counterweights adapted to balance said bridge, counterweight connections in the planes of the trusses and over the roadway and a transverse girder extended beyond the planes of the trusses and supporting said counterweights outside of the roadway of said bridge.

Signed at New York city, in the county of New York and State of New York this nineteenth day of May, A. D. 1915.

THOMAS E. BROWN.

Witnesses:
BACHE H. BROWN,
CARL T. WESTLIN.

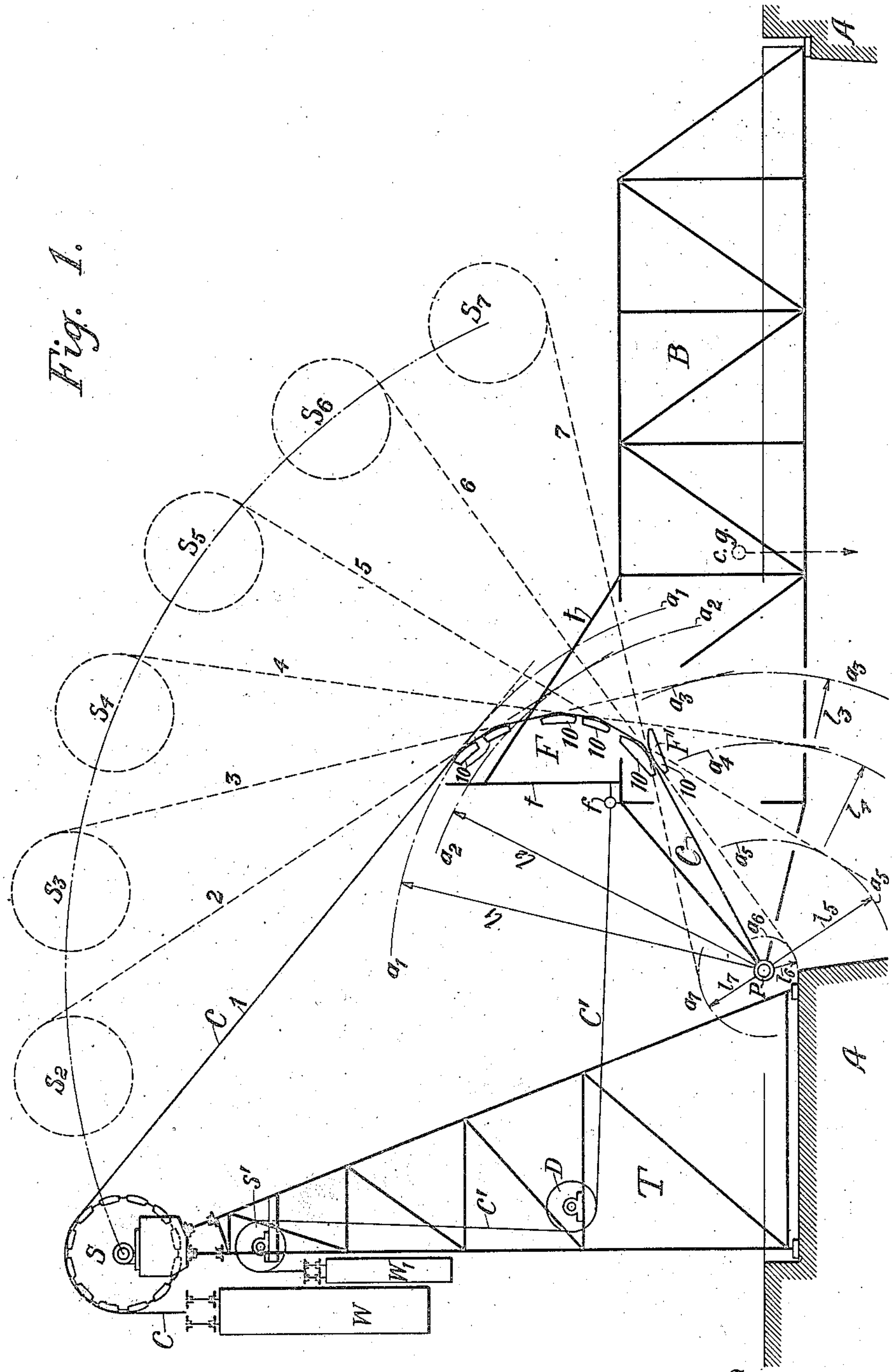
Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

T. E. BROWN.
BASCULE BRIDGE.
APPLICATION FILED OCT. 28, 1915.

1,210,410.

Patented Jan. 2, 1917.
3 SHEETS—SHEET 1.

Fig. 1.



Inventor
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T. E. BROWN.
BASCULE BRIDGE.
APPLICATION FILED OCT. 28, 1915.

1,210,410.

Patented Jan. 2, 1917.
3 SHEETS—SHEET 2.

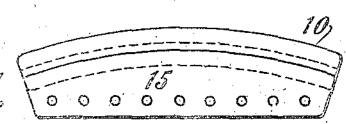


Fig. 4.

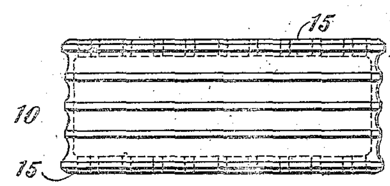
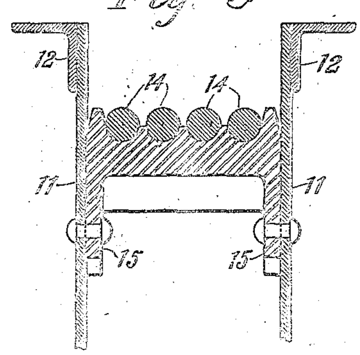


Fig. 5.

Fig. 3



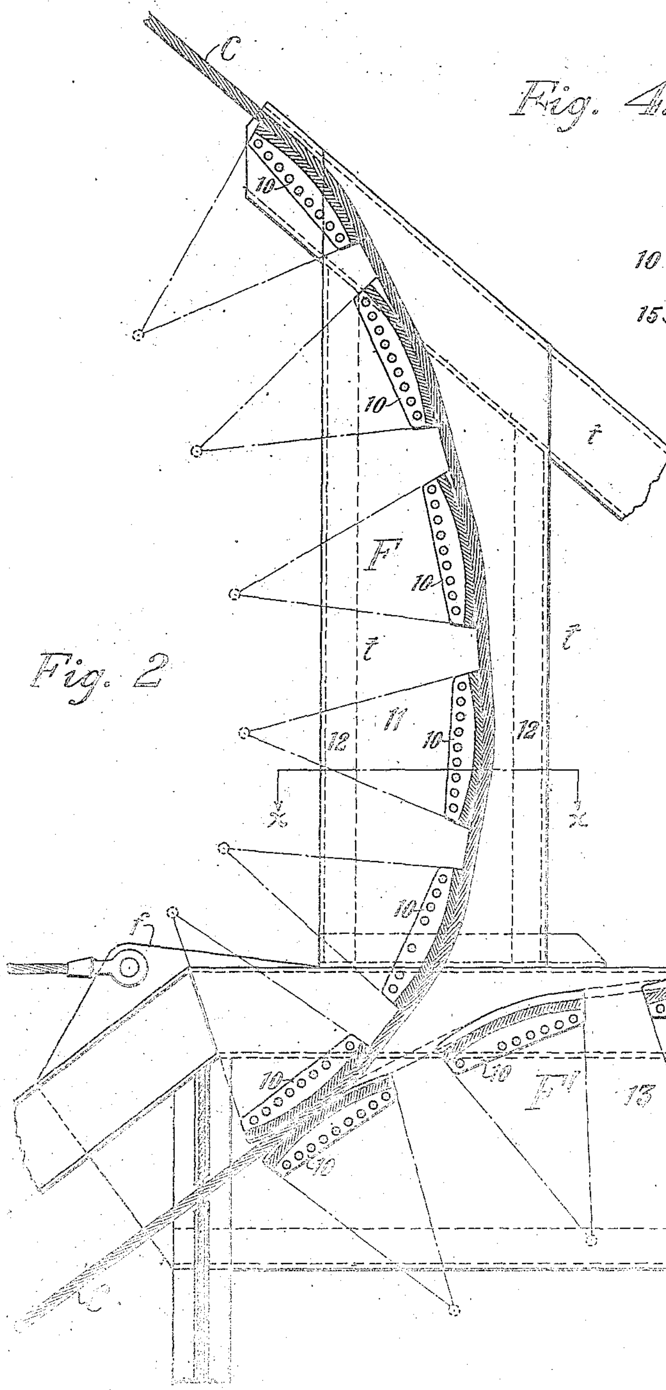


Fig. 2

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3 SHEETS—SHEET 3.

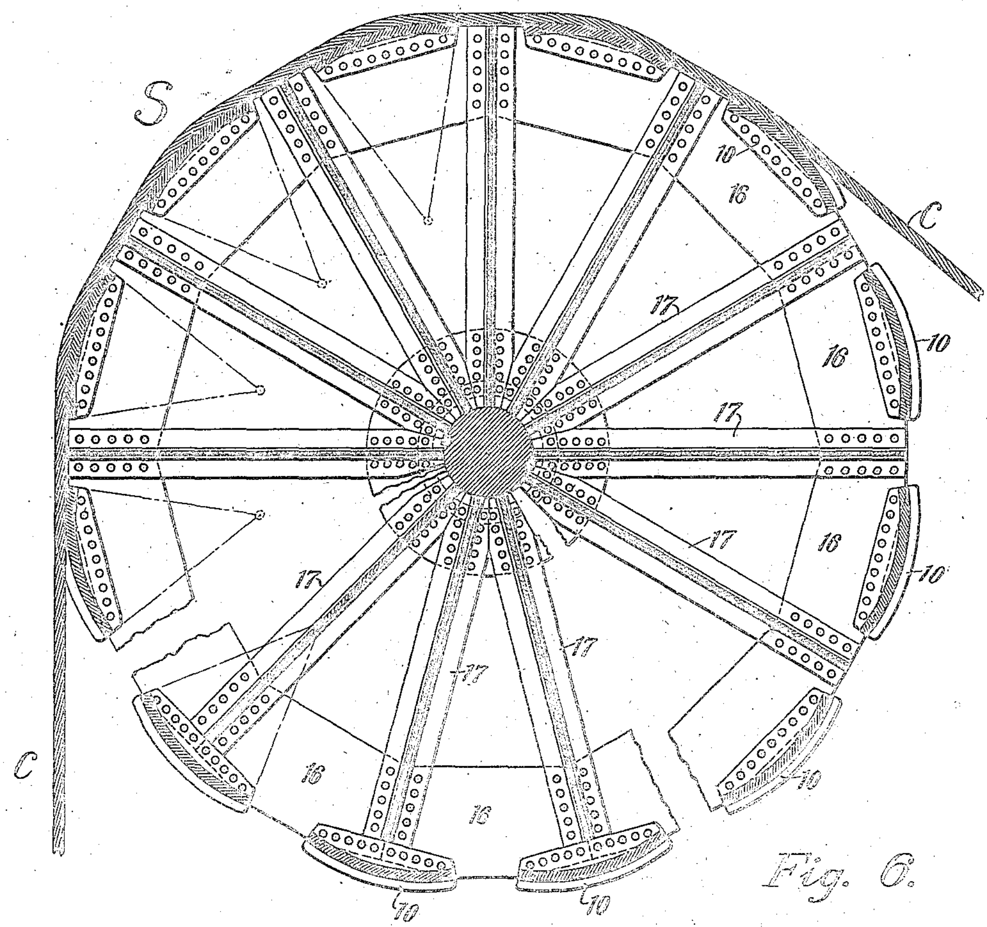

Fig. 6.

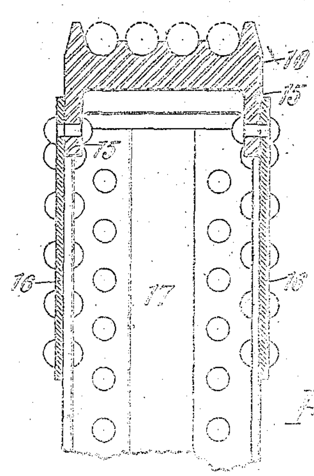

Fig. 7.

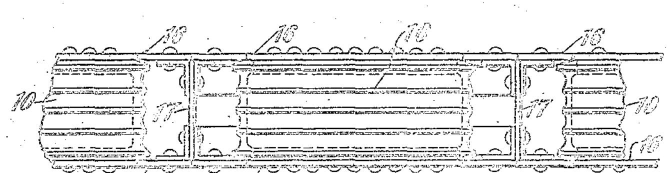

Fig. 8.

Inventor
Thomas E Brown

UNITED STATES PATENT OFFICE.

THOMAS E. BROWN, OF NEW YORK, N. Y.

BASCULE-BRIDGE.

1,210,410. Specification of Letters Patent. Patented Jan. 2, 1917.

Application filed October 28, 1915. Serial No. 58,324.

To all whom it may concern:

Be it known that I, Thomas E. Brown, a citizen of the United States, and a resident of the borough of Manhattan, in the county of New York and State of New York, have invented certain new and useful Improvements in Bascule-Bridges, of which the following is a specification.

This invention relates to improvements in bascule bridges, of the class which are balanced by counterweights and flexible counterweight connections, and wherein said connections are supported by curved members, and especially where said supports are curved in a manner to maintain the balance of the bridge in all its positions.

In my United States Letters Patent No. 1,151,657, August 31, 1915, I have shown and described a method of effecting the balance and operation of bascule bridges by means of counterweights and flexible connections supported by curved members, and the objects of this invention are to simplify and cheapen the construction of such curved members and provide a form of construction in which the several parts of said curved members can be easily and accurately placed in position, and in which said positions can readily be determined by a simple graphic process, and especially in which the construction of the bridge may proceed before said calculations are finally completed.

In bascule bridges the position and curvature of the balancing devices depend upon the position of the center of gravity of the moving portion of the bridge. An accurate determination of the position of the center of gravity can not be made until the shop drawings of the bridge are completed, and in fact, in some cases, not until a considerable portion of the bridge structure has been completed; and said position may be altered by addition of tracks, changes in flooring and other details even after the bridge has been substantially completed.

It is therefore another important object of my invention to so provide for the construction of the aforesaid curves by sectional elements that said curves need not be finally determined before the commencement of the construction of the bridge and may readily be changed even after the erection of the bridge. Where flexible members are used for the connection of the counterweight to the bridge large sheave wheels are required to support said connections, and said sheave wheels are frequently of too large diameter to be turned in ordinary lathes, and another object of my invention is a method of construction of such supporting wheels which avoids the necessity of turning their rims, and also enables the strength of their parts to be determined by the simple method used in the calculation of ordinary framed structures.

I prefer to use cables for the counterweight connections, and hereinafter use the word "cable" when referring to such a connection, although the connection may be constructed of chains, link bars or other suitable devices.

Referring to the drawings which accompany the specification to aid the description, Figure 1 is a side elevation of a bridge equipped with my counterbalancing device. Fig. 2 is a broken section of a portion of the bridge, on large scale, showing the method of constructing the curves for effecting the balance of the bridge. Fig. 3 is a broken section on a larger scale, on line X—X of Fig. 2. Fig. 4 is a side view and Fig. 5 a plan view of a saddle, on large scale. Fig. 6 shows a section of a leading sheave constructed on the same principle as the curve shown in Fig. 2, and on the same scale. Fig. 7 is a broken section on the scale of Fig. 3, of the leading sheave rim showing a detail of its construction, and Fig. 8 is an edge view of a portion of the sheave rim showing the preferred arrangement of the spokes and saddles.

It is to be understood that Figs. 1 and 2 show the counterbalancing devices for only one side of the bridge, but that generally, in practice, these devices will be duplicated, there being one set of such devices for each side of the bridge; therefore, in the description of said figures which follows, reference is made to the devices on one side only, the corresponding parts on the other side of the bridge being similar to those described. Referring to said Fig. 1, B is a bascule bridge; A A being the piers; P the pivot about which the bridge turns; T the tower; C the main counterweight cable; C′ the secondary counterweight cable; S and S′ guide sheaves for said cables C and C′ on the top of the tower; D a winding drum for said cable C′, and W and W′ counterweights respectively suspended on the cables C and C′.

The letters *c g* represent the position of the center of gravity of the bridge.

The total weight of the two counterweights W and W′ is preferably just sufficient to balance the bascule bridge when in its lowest position, and by rotating said drum D by any suitable power in the proper direction said bridge B may be raised or lowered.

The secondary counterweight cable C′ is attached to some suitable point of the bridge, as the elbow of the upper chord *f*, and said primary cable C passes around a curve F, (Figs. 1 and 2) and is fastened at some point of the bridge, preferably at the pivot P; said curve F forming a curved way or rim supporting the said cable C. Said curved way or rim is secured preferably to the upper side of the bridge, as shown, by suitable framing such as the post and tie rods *t t*.

As the bridge rises to different positions the cable C unwraps from said curve F, said cable forming the tangent of the curve. Said curve F is formed so that the sum of the moments of the cables C and C′ around the pivot P of the bridge will equal the moment of the bridge around said pivot P, that is to say, the primary weights W multiplied by the perpendicular distances from the pivot P to their cables C plus the secondary weights W′ multiplied by the perpendicular distances from said pivot P to their cables C′ must equal the weight of the bridge multiplied by the horizontal distance from the said pivot P to the vertical line through the center of gravity of the bridge; said perpendicular distances from the said pivot P to the line of pull of the respective cables being their lever arms, or algebraically expressed

$$Wl+W'l'=Br\cos\alpha$$

in which W and W′ represent the total weight of the respective counterweights, l and l' represent the lever arms of the respective counterweight cables around the pivot of the bridge, B represents the weight of the bridge, r the radius from the pivot P to the center of gravity of the bridge, and α the angle which said radius makes with the horizontal.

The operation of the bridge is fully described in my aforesaid Letters Patent No. 1,151,657, and it is only necessary herein to show the method of laying out the curves F and F′.

Having found various values of the lever arm of cable C, (which are represented by l in said formula) for various positions of the bridge by means of the aforesaid formula, we describe arcs from pivot P as a center, with said values of l as radii. See the dotted arcs numbered 1, 2, 3, 4, etc., respectively Fig. 1. We then rotate the leading sheave S about the pivot P into corresponding positions, as obviously the relative positions of the bridge and the leading sheave S are the same whether we rotate the bridge about the pivot P in one direction, the sheave remaining fixed, or whether we rotate the sheave about the pivot P in the opposite direction, the bridge remaining fixed. Having rotated the sheave into its corresponding positions 2, 3, 4, etc., as indicated by the dotted sheaves in Fig. 1, we draw lines 1, 2, 3, 4, etc., tangent to both the sheave and arc of corresponding positions, and the intersecting portions of these lines form a polygon consisting of a series of tangents to the required curve on the bridge, the closeness of approach of said polygon to the actual curve depending on the number of positions taken.

The construction of a continuous curve of continually varying radius of curvature is difficult and expensive, and I prefer to use, instead of a continuous curve, a plurality of short segments or saddles 10, as shown in Figs. 1 and 2, each being of a radius less than the radius of curvature of the true curve. Such segments may be easily fitted to the tangents of the curve found as above described and their positions can be accurately determined on a large scale drawing, and also said segments may be easily and cheaply placed in their proper positions on the bridge.

Referring to Figs. 2 and 3, *t* and *t* are the posts and tie as shown in Fig. 1. Each post is preferably made of wide plates 11 with angle iron flanges 12, said plates 11 being wide enough to contain the curve F with allowance for any variation in said curve F likely to be caused by possible change in the position of the center of gravity of the bridge as hereinbefore described, and 13 are similar plates for the reversed curve F′. 10 are short segmental saddles preferably grooved to receive the parts 14 forming the cable C. Said segments 10, one of which is shown in side view in Fig. 4 and in plan view in Fig. 5, have flanges 15 which fit between said plates 11 and 13, and by which they may be bolted or preferably riveted to said plates 11 and 13. Said segments 10 are of a radius equal to or shorter than the minimum radius of curvature of the curves F and F′, and when in place cause the cable C to lie in a series of short chords and arcs, so closely approximating the true continuous curve, that the error need not exceed one-fifth of one per cent., a degree of accuracy closer than is actually needed in practice.

It will be readily understood, especially from Figs. 2 and 3, that the rivet holes need not be drilled and the segments need not be placed until the position of the center of gravity of the bridge has been finally determined and their correct positions found, and even if placed may readily be changed in position by cutting out rivets and drilling new holes, and the construction of the bridge therefore need not be delayed pending exact determination of the center of gravity.

Figs. 6, 7 and 8 show the preferred construction of the leading sheave S; Fig. 6 being a broken section in the central plane of the sheave and Fig. 7 a section through the rim on a larger scale. The sheave S is preferably built up of structural shapes, and the rim preferably consists of plates 16 between which are riveted short segments or saddles 10 similar to the segments 10 before described for the curves F and F′. The segments 10 may be placed between the spokes 17 of the sheave S as shown on the upper part of Fig. 6, or may if preferred be placed at the spokes 17 as shown on the lower broken part of Fig. 6.

The saddles 10 are of a radius less than the radius of the sheave S and the cable lies on the saddles in a series of short chords and arcs. By using a suitable templet for drilling the rivet holes in the saddles 10 and plates 16 the saddles may be accurately placed and sheaves of any desired diameter may be made, as the diameter is not limited by the necessity of turning the rims, as in the usual practice.

The load carried by each segment or saddle of such a sheave can be accurately calculated and the stresses on the various parts such as spokes, rivets, etc., easily determined and therefore the details of the sheave may be proportioned with confidence and economy.

Obviously, sheave wheels constructed as herein shown and described may be used advantageously with other forms of movable bridges.

Now having described my improvements, what I claim as my invention is:—

1. In a bridge, the combination of a counterweight, tensional counterweight connections therefor and curved members forming supports for said connections, and said curved members consisting of a plurality of short saddles of a radius less than the radius of curvature of said curved members.

2. In a bridge, the combination of a counterweight, a tensional connection therefor and a plurality of curved supports adapted to support said tensional connection in a curve and each of said supports being of radius less than the radius of said curve and together forming said curve.

3. In a bridge, the combination of a counterweight, a tensional connection therefor, a curved structure adapted to support said connection, and having its supporting rim composed of short segments of a radius less than the radius of curvature of said structure.

4. In a bridge, the combination of a counterweight, a tensional connection therefor, a curved member to support said connection provided with a supporting surface consisting of short saddles, each saddle being of a radius less than the radius of said member, and plates between which said saddles are secured.

Signed at New York city, in the county of New York, and State of New York this 26th day of Ocotober, A. D. 1915.

THOMAS E. BROWN.

Witnesses:

THOS. E. BROWN, Jr.,
CARL T. WESTLIN.

Jan. 29, 1929. **1,700,464**

T. E. BROWN, JR

INDICATOR FOR BASCULES

Filed June 1, 1927 3 Sheets-Sheet 1

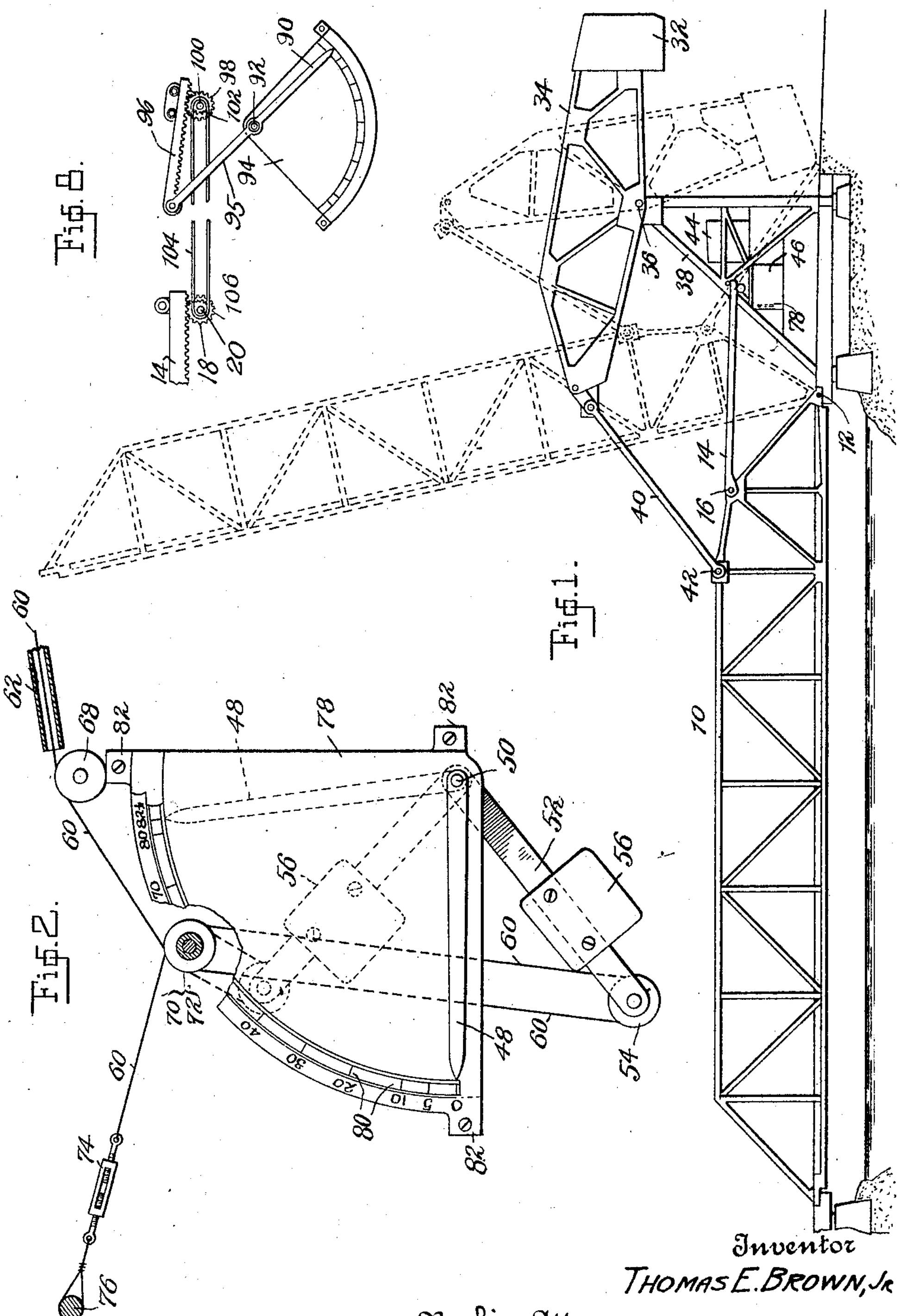

Fig. 8.

Fig. 1.

Fig. 2.

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Jan. 29, 1929. T. E. BROWN, JR 1,700,464

INDICATOR FOR BASCULES

Filed June 1, 1927 3 Sheets-Sheet 2

Fig. 3.

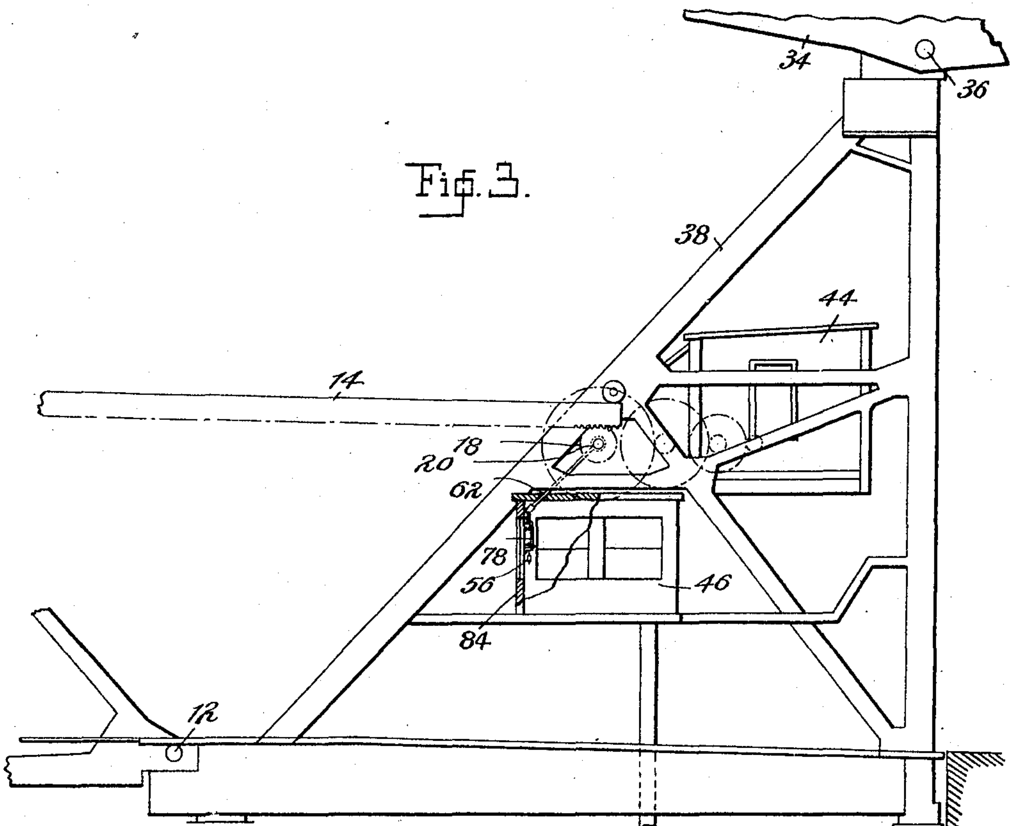
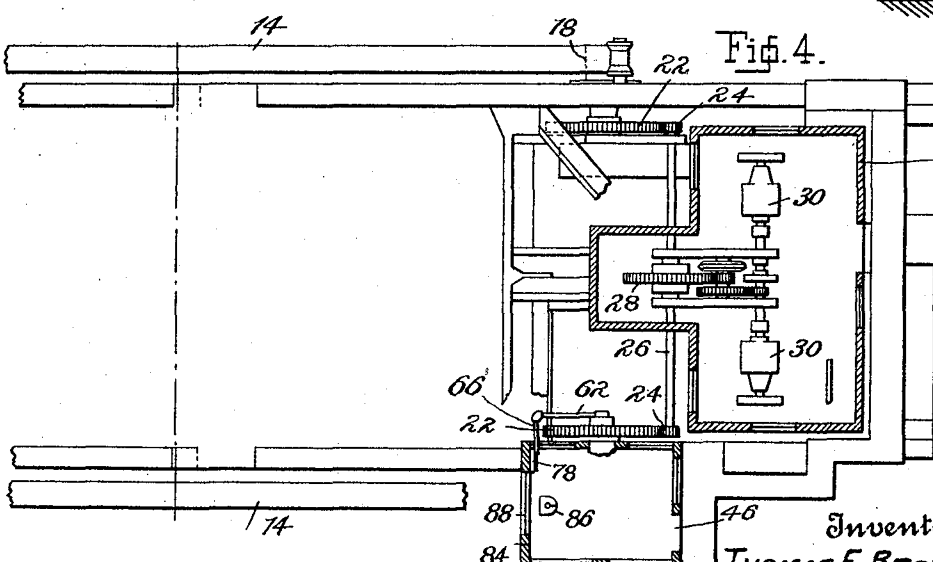


Fig. 4.



Inventor
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By his Attorney

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INDICATOR FOR BASCULES

Filed June 1, 1927 3 Sheets-Sheet 3

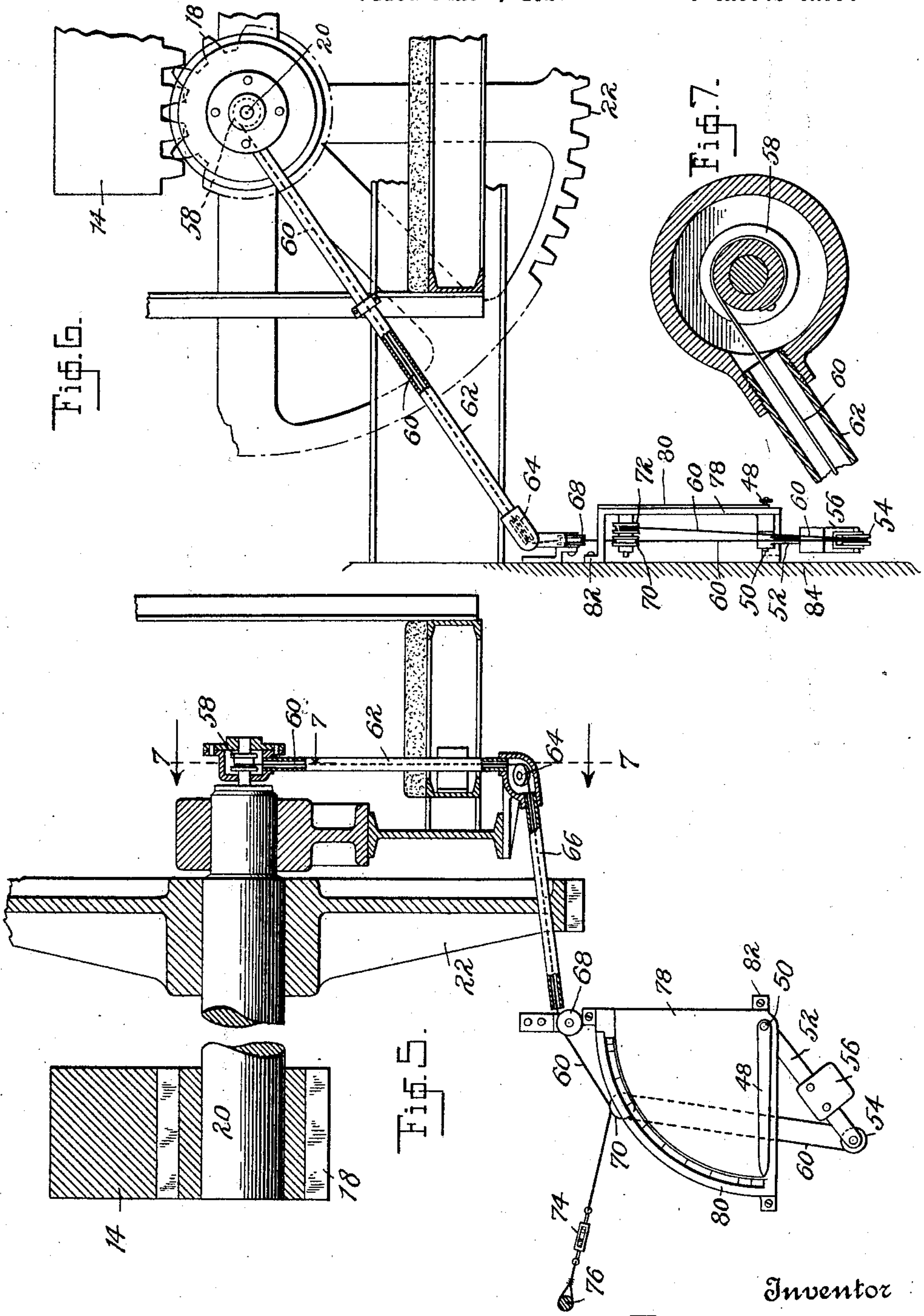

Fig. 6.

Fig. 7.

Fig. 5.

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UNITED STATES PATENT OFFICE.

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INDICATOR FOR BASCULES.

Application filed June 1, 1927. Serial No. 195,656.

This invention relates to bridges and aims to provide means for indicating the position of a movable part of the bridge.

While not limited thereto the embodiment of the invention illustrated is particularly adapted for use in connection with bascule bridges such as those operated by a pinion and rack strut; and includes a pointer operatively connected with bascule power transmission mechanism in such manner that the pointer moves at the same angular rate as the bascule, so that the pointer always occupies an angular position corresponding to the angular position of the bascule.

The invention will be apparent from the following specification when read in connection with the accompanying drawing in which—

Fig. 1 is a side elevation of a bascule bridge equipped with my improved indicator;

Fig. 2 is an enlarged detail of the indicator;

Fig. 3 is an enlarged detail of a portion of the bridge showing the control house and indicator located therein;

Fig. 4 is a plan of Fig. 3 with parts in horizontal section;

Fig. 5 is a detail view showing the operative connection between the bascule operating mechanism and the indicator;

Fig. 6 is a view from the left of Fig. 5;

Fig. 7 is a detail section on line 7—7 of Fig. 5;

Fig. 8 is a diagrammatic view of a modification.

Referring in detail to the drawings the bridge illustrated includes a bascule 10 adapted to be swung about a substantially horizontal pivotal axis 12 by means of a pair of rack struts 14—14 which are pivoted at 16 to each side of the bascule. The rack struts 14 mesh with pinions 18 secured to shafts 20. Each shaft 20 also carries a gear 22 which meshes with a pinion 24 carried by a cross shaft 26 which in turn is driven through suitable reduction gearing of known arrangement by the motors 30.

The bascule is counterbalanced by a weight 32 carried by a balance beam 34 pivoted at 36 to the stiff leg truss 38, the beam 34 being connected at each side to the bascule by a hanger link 40 and a span pin 42.

The motors and transmission mechanism elements described are capable of swinging the bascule from the full line position of Fig. 1 to a position slightly beyond the dotted position. It is important that the operator should at all times know correctly the position of the bascule leaf, to prevent overrunning or undue shock in seating and to permit of proper clearance for different sized vessels and so forth.

The operating mechanism is located in a house 44 above the center of the roadway, and the bridge tender's or operator's house 46 is located at one side of the bridge at a level lower than the machinery house 44.

The house 46 has windows facing the bascule but its position is of necessity so located that the operator cannot accurately determine the angular movement of the bascule by observation.

To guard against the possibility of accident due to the bascule being moved beyond a predetermined upright position, I provide an indicator in the house 46 which moves at the same angular rate at which the bascule moves. This indicator in the embodiment illustrated in Figs. 1 to 7 includes a pointer 48 secured to a stub shaft 50 which carries an arm 52 having a sheave 54 mounted on the free end thereof. This arm carries a weight 56 which tends to move the pointer toward the horizontal position shown in full line in Fig. 2. For moving the pointer at the same angular rate as the bascule, I provide a drum 58 of predetermined diameter which is secured to the shaft 20. One end of a cable 60 is made fast to this drum. The cable passes through a tube 62 to a guide sheave 64, thence through a second tube 66 and over guide sheaves 68 and 70 thence around sheave 54 carried by arm 52 and over guide sheave 72 to a take-up device preferably a turn-buckle 74 which is anchored at 76 to a fixed pin or other suitable fixed member. The shaft 50 which carries the pointer 48 and arm 52 is journalled in a panel board 78 having a scale 80 which is calibrated in degrees. This panel is provided with feet 82 which are secured to the wall 84 of the operator's house facing the bascule. The controller 86 for the motors 30 is conveniently located in front of a window 88 at the left of the indicator. Thus the operator can watch the movement of the bascule and glance also at the indicator.

The diameter of the drum 58 and the length of arm 52 is such that the pointer moves at the same angular rate as the bascule hence when the motors are moving the bascule, the pointer will indicate the corresponding successive angular positions thereof.

In Fig. 8 I have illustrated a modification in which the indicator includes a pointer 90 pivoted at 92 on a panel 94. The pointer carries an arm 95 to one end of which is pivoted a rack 96 which meshes a pinion 98 on a shaft 100 which also carries a sprocket 102. A chain 104 connects with a sprocket 106 on the cross shaft 20 which drives the pinions 18 for actuating the bascule operating rack struts 14.

It is clear that the angular motions of the bascule leaf 10 and the operating pinion 18 have a constantly varying ratio to each other. Any indicating pointer therefore with a constant gear ratio to pinion 18 will not move in true relation to the motion of the bascule leaf. I, therefore introduce on a miniature scale between pinion 18 and the pointer of the indicator, a mechanical motion which reproduces the motion of the operating mechanism.

In the arrangement shown in Fig. 2, this similar mechanical motion is comprised of the stub shaft 50, the arm 52, the sheaves 70 and 54, and the portion of the cable 60 connecting said sheaves. These correspond respectively with the axis 12, the end post of the bascule (i. e. the part between points 12 and 16), pinion 18, pivotal point 16, and the rack strut 14. The diameter of drum 58 and the location of sheave 70 with respect to shaft 50 and arm 52, are so chosen as to cause the line which joins the centers of sheaves 70 and 54 and arm 52 to have the same motions as the rack strut 14 and the end post of the span. Arm 52 and pointer 48 will therefore always have the same angular motion as that of the bascule.

Many modifications of my device may be made without departing from the spirit of the invention. For example, in Fig. 2, sheaves 72 and 54 can be dispensed with a rope 60 attached directly to the end of arm 52. In such case sheave 70 would be placed in the same position, relative to shaft 50 and arm 52, that pinion 18 is located in relation to axis 12 and the end post of the bascule. The diameters of drum and sheave 70 would be varied to suit. I prefer, however, the multiplying sheave arrangement I have shown in Fig. 2 as permitting of any convenient location of the adjusting turn-buckle 74 and of a more convenient size of drum 58.

In Fig. 8, I have shown diagrammatically a modification in which the miniature reproduction of the bridge actuating mechanical motion is more readily seen. A miniature pinion 98 is connected to the shaft 20 by any convenient mechanical drive such as sprocket wheels 102 and 106 and sprocket chain 104. Pinion 98 in turn reciprocates rack 96, thereby oscillating arm 95 about shaft 92. It is clear that if the size and arrangement of this miniature mechanism be made in exact proportion to the operating mechanism of the bascule, the arm 95 together with pointer 90 will move in synchronism with the bascule leaf 10.

While I have described my invention with particular reference to the embodiment illustrated, it is not to be construed that I am limited thereto since various changes may be made within the scope of the appended claims.

What I claim is:

1. In combination with a bascule bridge a motor and power transmission mechanism arranged to swing the bascule about a substantially horizontal axis, a graduated scale, a pointer swingable in juxtaposition thereto, a drum turned by said mechanism, a flexible cable having one end secured to said drum, a pivoted arm carrying a sheave at its free end, said cable passing around said sheave and having its other end fastened to a fixed support, said pointer being movable with said arm and adapted to indicate the angular movement of the bascule.

2. In combination with a bascule bridge a motor and power transmission mechanism arranged to swing the bascule about a substantially horizontal axis, a graduated scale, a pointer swingable in juxtaposition thereto, a drum turned by said mechanism, said pointer being adapted to indicate the extent of movement of the bascule and means including a flexible transmission element having an end secured to said drum arranged to move said pointer in synchronism with the movement of said bascule.

3. An indicator of the class described comprising a pivoted pointer, a pointer actuating drum having one end of a cable fastened thereto, a sheave operatively connected to said pointer and around which said cable passes, a member to which the other end of said cable is fastened and means tending to swing the pointer in one direction.

4. An indicator of the class described comprising a pivoted pointer, a counterweighted arm movable therewith, a rotary drum having one end of a cable fastened thereto, a sheave carried by the free end of said arm around which the cable passes, fixed guide sheaves and a fixed anchorage for the other end of said cable, and a graduated scale juxtaposed to said pointer.

5. In combination with a bascule bridge and a pinion and rack strut for moving the bascule, an indicator including a pointer and motion transmission mechanism operatively connected with said pinion arranged to reproduce the angular motion of the rack strut and the bascule.

6. In combination with a bascule bridge a rack strut and pinion for swinging the bascule leaf, an indicator including a pointer swingable in an arc, and motion transmission mechanism between the pinion and said pointer arranged to reproduce the motion of the rack strut so as to move the pointer to

successive angular positions corresponding to the angular positions to which the bascule is moved.

7. In combination with a bascule bridge, a motor driven pinion and rack strut arranged to swing the bascule about a substantially horizontal axis at a variable angular rate, a graduated scale, a pointer swingable in juxtaposition thereto and motion transmission mechanism between said pointer and said pinion comprising devices similar to the rack strut and bascule arranged to move the pointer to successive positions corresponding exactly to the angular positions to which the bascule is moved.

In witness whereof, I have hereunto signed my name.

THOMAS E. BROWN, Jr.