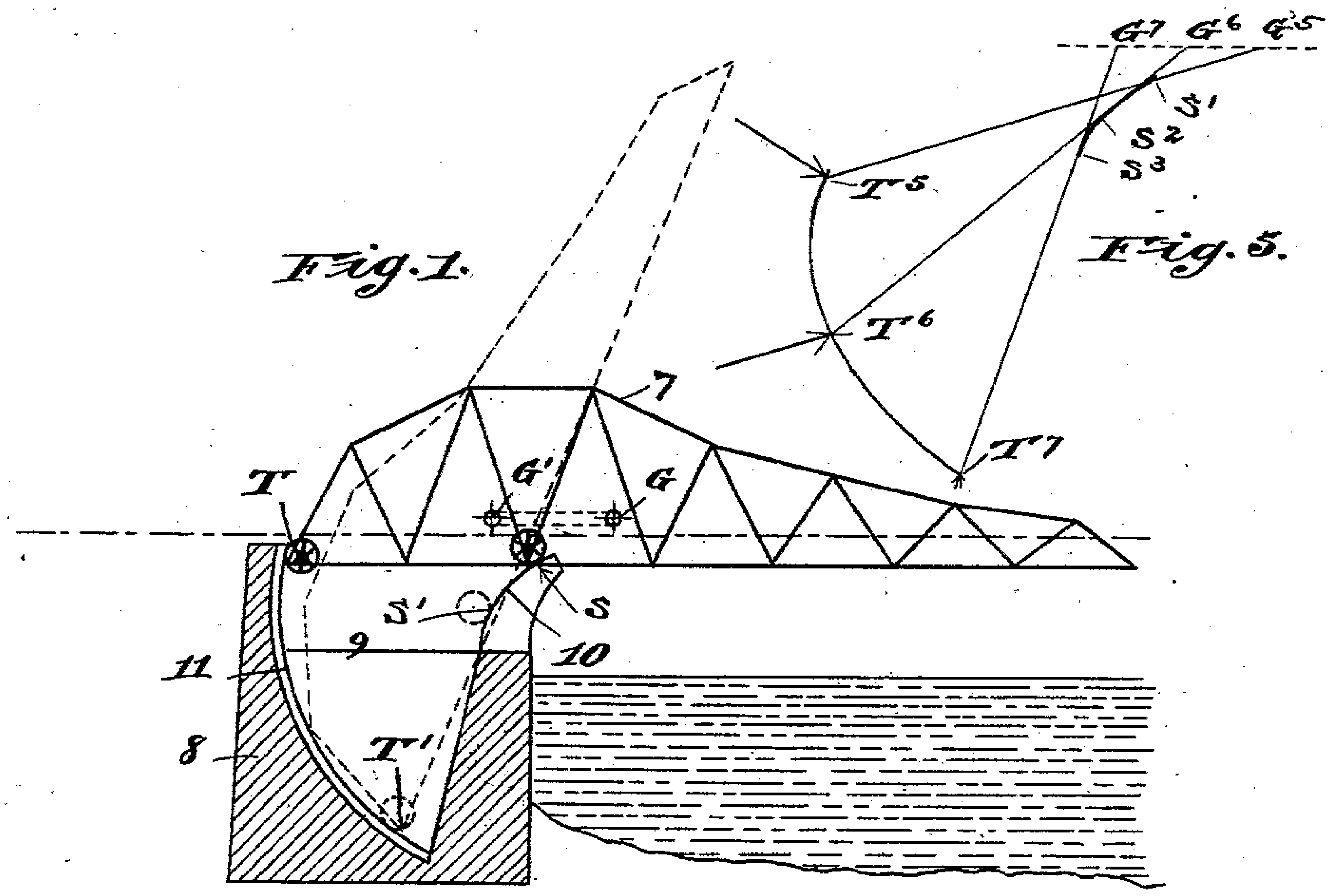
No. 694,744. Patented Mar. 4, 1902.

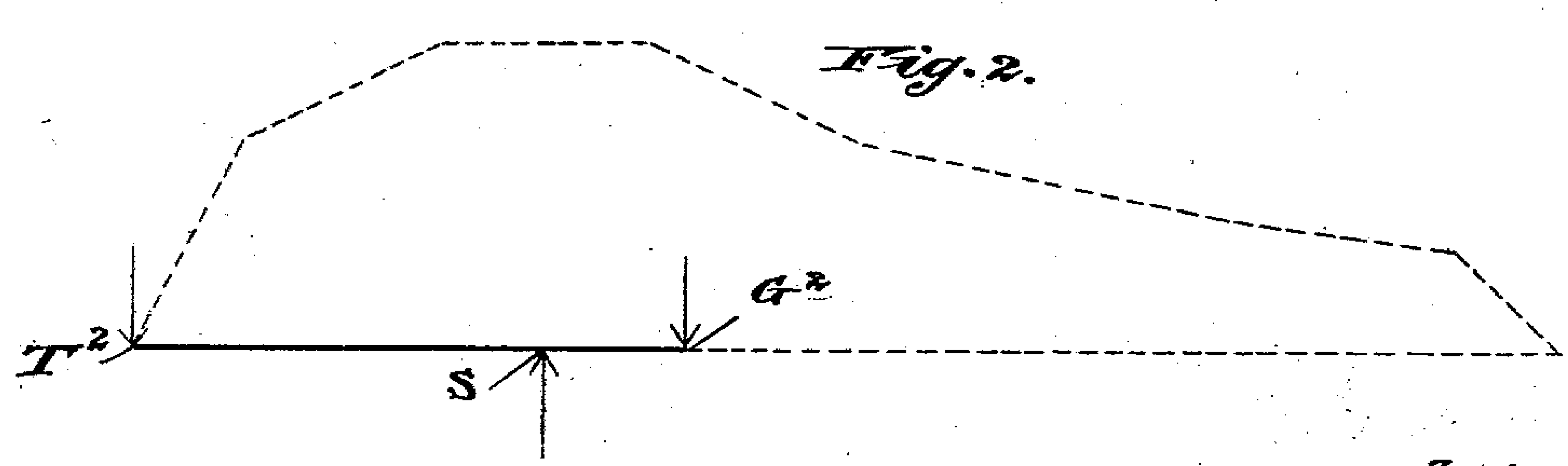
C. F. HALL.

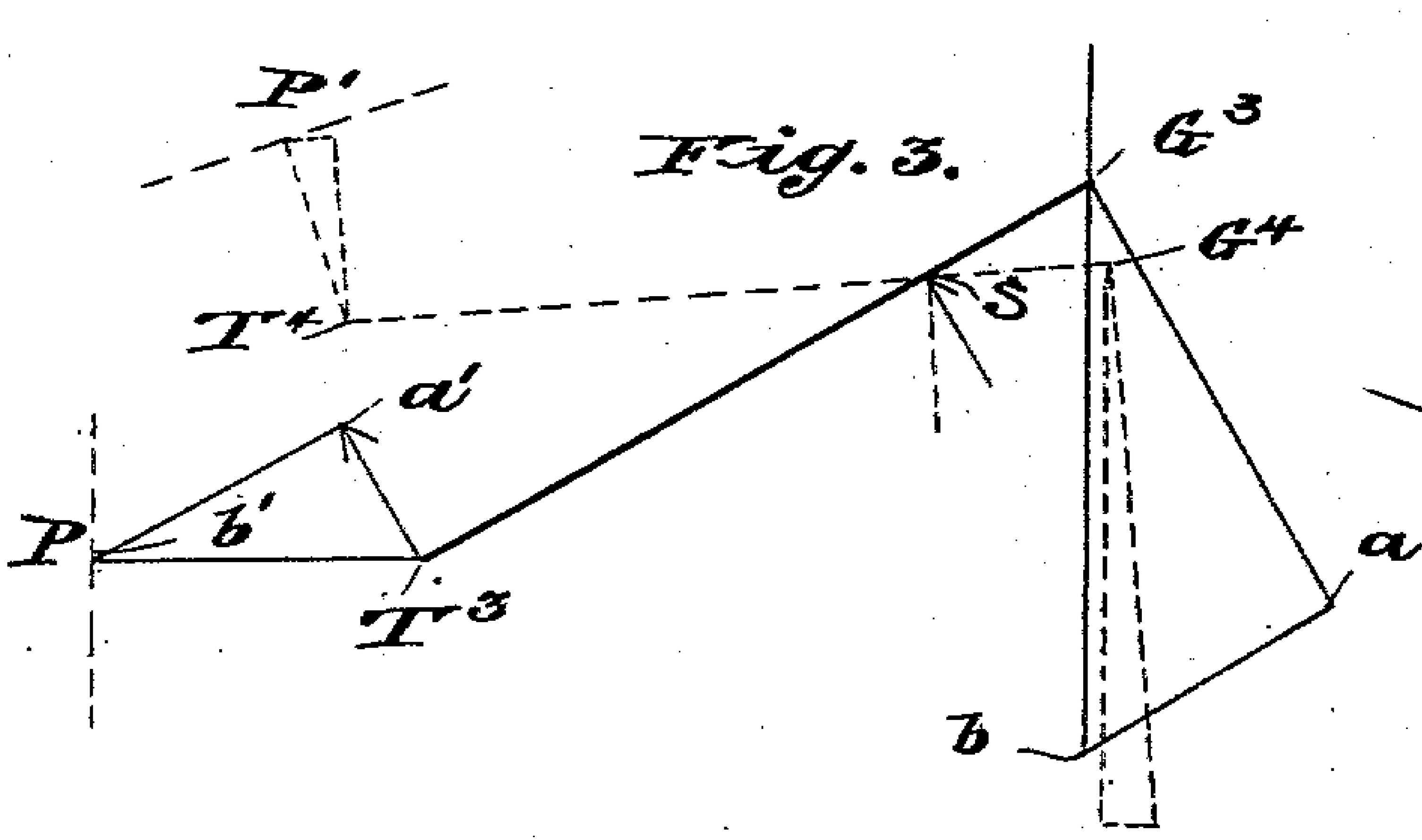
BASCULE BRIDGE.

(Application filed Dec. 3, 1900. Renewed Aug. 5, 1901.)

(No Model.) 2 Sheets—Sheet 1.







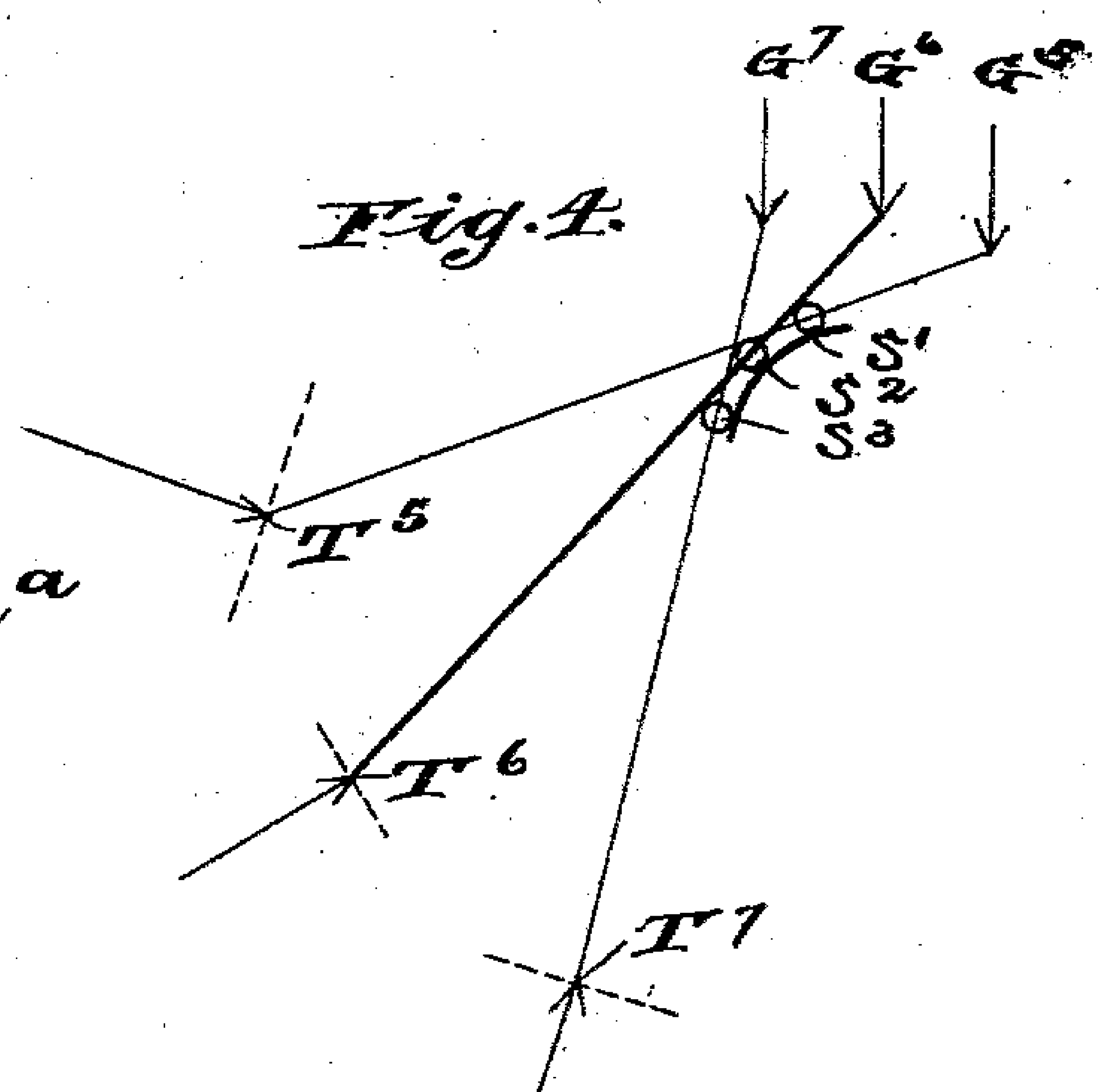


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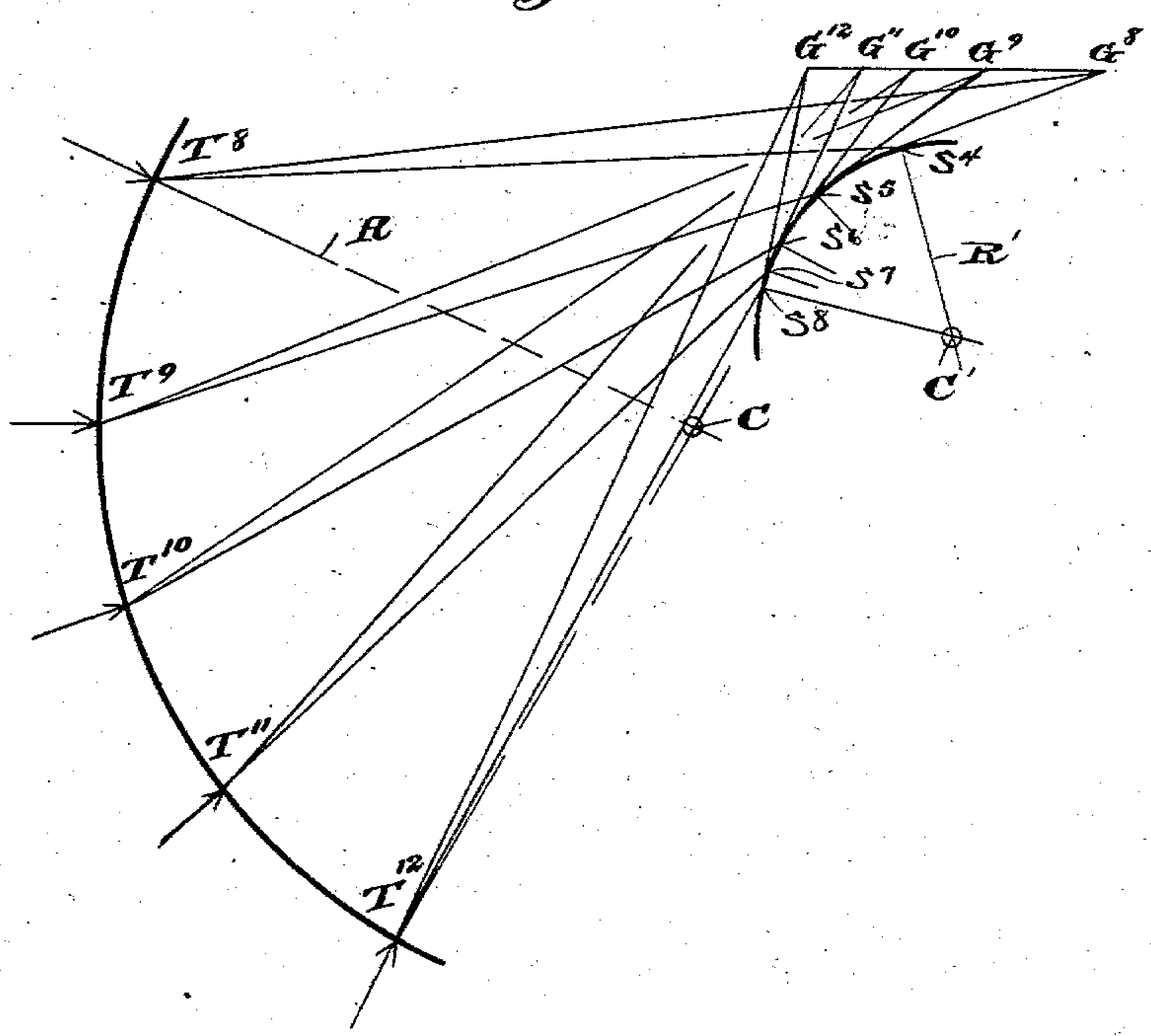
Fig. 6.



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UNITED STATES PATENT OFFICE.

CHARLES F. HALL, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO HALL BASCULE BRIDGE COMPANY, A CORPORATION OF ILLINOIS.

BASCULE-BRIDGE.

SPECIFICATION forming part of Letters Patent No. 694,744, dated March 4, 1902.

Application filed December 3, 1900. Renewed August 5, 1901. Serial No. 70,960. (No model.)

To all whom it may concern:

Be it known that I, CHARLES F. HALL, of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Bascule-Bridges, of which the following is a specification.

My invention relates to that class of lift or draw bridges known as "bascule-bridges," and has for its main object to dispense with the usual counterweight commonly employed in bridges of this class without at the same time increasing the extent of the inner or land portion of the bridge or of the abutment or pier area in which it operates beyond that usually required in bridges of this class.

A further object is to dispense also with the usual supporting-pivots, which in bridges of this type, owing to the enormous weight carried, have to be of great size and provided with costly and cumbrous journals, and even then often disclose structural weaknesses and other defects which make their use mechanically objectionable.

Other objects and advantages of my invention will appear later in the subjoined description.

In carrying out my invention instead of hinging the bridge-span on a fixed pivot or axis of rotation, as is quite commonly done in bridges of this class, I slidingly support the same, at a point somewhat in rear of the vertical plane of its center of gravity, on a downwardly and rearwardly curved convex face of the scarp or curbing of the bridge abutment, whereby the bridge-span constitutes a lever of the first class, and on the opposite side of the dry well I provide a curved track or guide for the heel of the bridge, said last-named curve having a peculiar geometrical relation to the curve of the scarp, by virtue of which when the bridge is raised or lowered the said curve offers a resistance to the force of gravity acting on the opposite side of the fulcrum such that the bridge-span will be in equilibrium at all points of its travel (disregarding external influences, such as windage) and whereby also the center of gravity will be caused to travel in a substantially horizontal line during the opening and closing of the bridge.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation in the nature of a diagram of a bascule-bridge span and its supporting-abutment, the latter being shown in vertical section; and Figs. 2, 3, 4, 5, and 6 are diagrams illustrating the theory of my invention and the geometrical principles on which the same is based as applied to the opposite curved surfaces or walls of the dry well formed in the bridge-abutment and in which the land end of the bridge-span operates.

Referring to Fig. 1, the numeral 7 designates a vertically-operating bridge-span, and 8 is a suitable abutment or support therefor, having formed therein the usual dry well 9. The scarp or curbing of the abutment has an inwardly and downwardly curved convex supporting-surface 10, on which the under side of the bridge is supported and with which it has a sliding engagement during the operation of raising and lowering the bridge. The rear wall of the dry well 9 is formed on a concave curve, which, as will be hereinafter shown, bears a certain peculiar relation to the convex curve of the scarp and on which is formed a groove, track, or other guideway 11, with which the heel of the bridge has a sliding engagement.

My invention and the advantages resulting therefrom are based on the existence of a certain relation between the position and line of travel of the center of gravity of the movable bridge-span and the fixed curved supporting and guiding surfaces for the latter formed in the abutment, whereby the bridge-span may be maintained in substantial equilibrium at any point in its movement without the aid or employment of any counterweights whatever and requiring the application of only a minimum power to actuate the bridge. This result is secured in accordance with my invention by such a relative construction and mode of operation of the movable and stationary parts as that the effective component of the force of gravity (represented by the weight of the span) shall be constantly met and counterbalanced by the effective component of the resistance offered by the rear concave wall of the dry well, which is in engagement with the heel of the bridge. This may be illustrated and demonstrated as follows by reference to the several figures of the drawings.

Fig. 1 shows, in diagrammatic outline, a cantaliver draw-span, the solid line showing its position when closed and the dotted line its position when open. Take G as the position of the center of gravity of the combined weights of the movable portion of the span when the bridge is closed, and G′ as the position of the same center of gravity when the bridge is open. T is the heel or inner end of the land portion of the bridge, showing its position when closed, and T′ its position when open. S and S′ are the supporting-points of the bridge when closed and open, respectively.

The opening of the bridge is accomplished by virtue of a geometrical ratio in the travel of the points S to S′ and T to T′, thereby causing point G to travel in a horizontal straight line to G′. The three lines of travel G G′, S S′, and T T′ are so related that any position of the center of gravity in the horizontal line G G′ will be balanced upon some point in the curve S S′ by the effective component of a force acting normal to a plane tangent to the curve T T′ at the relative geometrical point located in the curve T T′. This force acting normal to the tangent plane is the resistance of a suitable track or other guide, as 11, built upon or in the rear inner wall of the abutment. By reason of this relation between the three mentioned lines of travel, to which points S and T are rigidly held, point G is freely moved in a horizontal line by the application of a minimum amount of power without recourse to counterweights and the bridge is caused to open vertically. This may be demonstrated as follows: Fig. 2 shows the bridge-span resolved into a lever of the first class by the heavy black line. G^2 is the point directly under the center of gravity, S is the fulcrum or point of support, and T^2 the point of application of a balancing force. The force T^2 must have a ratio to the weight of the movable span inversely as the length of its lever-arm T^2 S is to the arm S G^2. Suppose now the lever to be inclined to the position G^3 S T^3 in Fig. 3. Then the weight at G^3 when resolved into its components will act in the direction of and be equal to the lines G^3 *a* and *a b*. The force G^3 *a* acting on the lever exerts a pressure in the opposite direction at T^3 parallel to and in the ratio indicated by the line T^3 *a′*, and *a b* acts parallel with and equal to the line *a′ b′*, the resultant being in the direction and equal to T^3 *b′*. Next draw the plane shown by dotted lines P normal to the direction of this resultant T^3 *b′*. In a similar manner the plane P′ may be found when the lever is in the position shown by dotted lines G^4 S T^4. Now if the point of support S be shifted, as shown in Fig. 4, from S′ to some point, as S^2 or S^3, in the line of a curve, as S′ S^2 S^3, then the resultant of the vertical force G^5, G^6, or G^7 will act at the respective points T^5, T^6, or T^7 in the direction of the arrows shown and normal to the planes shown by dotted lines, and these planes then become tangents at relative points to some curve generated by the points T^5 T^6 T^7 when moving under the influence of the respective points G^5 G^6 G^7 and S′ S^2 S^3, providing these points act in uniform lines, as shown in Fig. 5, where G^5, G^6, and G^7 are located in a horizontal straight line. Then the form of curve T^5 T^6 T^7, Fig. 5, is governed by the form of the curve S′ S^2 S^3, and vice versa. Now if the curve T^8 T^9 T^{10} T^{11} T^{12} in Fig. 6 be an arc of a circle generated by the radius R and G^8, G^9, G^{10}, G^{11}, and G^{12} be a horizontal line any point in this arc will have an equidistant point in the straight line. If these equidistant points be connected by straight lines, as G^8 T^8 G^9 T^9, &c., and upon these lines as bases similar triangles be drawn, then the vertices of these triangles will fall in some curve, as S^4 S^5 S^6 S^7 S^8. Similarly if the curve S^4 S^5 S^6 S^7 S^8 in said figure be an arc of a circle generated by the radius R and G^8 G^9 G^{10} G^{11} G^{12} be a given horizontal line any point in this arc will have an equidistant point in the horizontal line. If these equidistant points be connected by straight lines, as G^8 S^4 G^9 S^5, &c., and upon these lines as bases similar triangles be drawn, then the vertices of these triangles will fall in some curve, as T^8 T^9 T^{10} T^{11} T^{12}. Thus it will be seen that if the straight horizontal line and a curve be given the other curve can be found, and, by graphical analysis, if a weight be applied at the points G^8 G^9 G^{10} G^{11} G^{12} upon a framed structure or lever supported on the curve S^4 S^8 at some equidistant point, as S^4 S^5 S^6 S^7 S^8, respectively, then a track or guide formed in or on the curve T^8 T^9, &c., will offer a resulting resistance to the force applied through the lever or draw span at G^8 G^9, &c., in a direction normal to a plane tangent to the curve at the given point, and thereby cause a balance of forces. If now a force be applied in the direction of these curves or the horizontal line at the points of the respective triangles in Fig. 6 or the lever-arm in Figs. 2, 3, 4, and 5, it will cause a motion of the points G, T, and S of Fig. 1 in the direction of their respective straight line and curves, and thereby cause the bridge to open vertically without the use of counterweights, as shown by Fig. 1.

From the foregoing it will be seen that I have constructed a bridge of the bascule type in which the rear or land portion of a vertically-swinging span has a compound inward and downward travel when the bridge is being opened over a pair of curved guiding and supporting surfaces, which are so related to each other and to the line of movement of the center of gravity of the span as that the bridge-span will be in substantial equilibrium at all points of its travel without the necessity of employing the usual heavy counterweights and may be operated by the application of a minimum power sufficient to overcome the inertia and the friction of the movable parts. In order to lessen the latter, it will be readily understood that roller-bearings may be applied to either the movable or fixed member of the engaging parts. The bridge will also be supplied with suitable devices for locking the span in its closed and open positions; but such mechanism is not herein shown and described, as it forms no part of my present invention, any known or approved locking devices being applicable in connection therewith.

I claim—

1. In a bascule-bridge, the combination with a vertically-swinging span of an abutment supporting the same and having a dry well therein to receive the land end of the span, said dry well having a convex scarp and a concave rear wall with which the under side and heel of the span have sliding engagement respectively, said curved walls of the dry well being so related to each other and to the line of movement of the center of gravity of the bridge-span as that said bridge-span shall be in substantial equilibrium at all points of its travel without the employment of counterweights, substantially as described.

2. In a bascule-bridge, the combination with a vertically-swinging span of an abutment supporting the same having a dry well therein to receive the land portion of the span, the said dry well having a curved scarp and an oppositely-curved rear wall with which the under side and heel of the span have sliding engagement respectively, said curves being so related to each other and to the line of movement of the center of gravity of the span as that the effective component of the gravity force acting through the span structure shall be substantially equal to and counterbalanced by the effective component of the resistance offered by the curved inner wall of the dry well at all points of the travel of the span, whereby the latter is at all times in substantial equilibrium without the use of counterweights, and may be operated by the application of a minimum force, substantially as described.

3. In a bascule-bridge, the combination with a vertically-swinging span of an abutment supporting the same and having a dry well therein to receive the land end of the span, the said dry well having a convex scarp on which the under side of the span rests and over which it is adapted to slide, and the rear wall of the dry well engaging the heel of the span and being formed on a curve which is determined by a series of tangents, each of which is normal to a line representing the resultant of the force of gravity acting on the curved face of the scarp, at any corresponding point of the travel of the span, substantially as described.

4. In a bascule-bridge, the combination with a vertically-swinging span of an abutment supporting the same having a dry well therein to receive the land end of the span, the said dry well having a convex scarp on which the under side of the bridge is supported at a point in rear of the plane of its center of gravity and over which it is adapted to slide, and the rear wall of the dry well engaging the heel of the span and being formed on a curve which is determined by a series of tangents, each of which is normal to a line representing the resultant of the force of gravity acting on the curved face of the scarp at any corresponding point of the travel of the span, whereby, when the span is operated, the center of gravity moves back and forth in a horizontal line, and the span is in substantial equilibrium at all points of its travel without the use of counterweights, and may be operated by the application of a minimum power, substantially as described.

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