(No Model.) 3 Sheets—Sheet 1.

F. M. F. CAZIN.

PERCUSSION WHEEL.

No. 578,813. Patented Mar. 16, 1897.

Fig. 4.

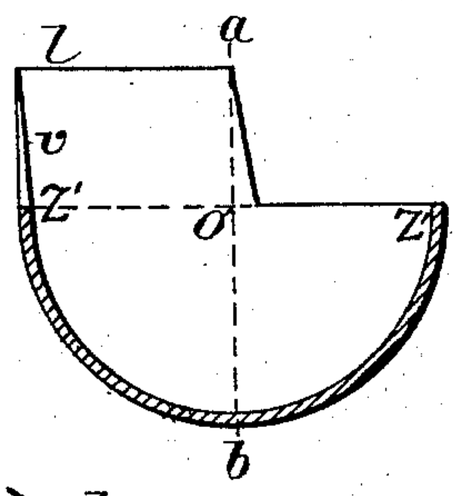


Fig. 3.

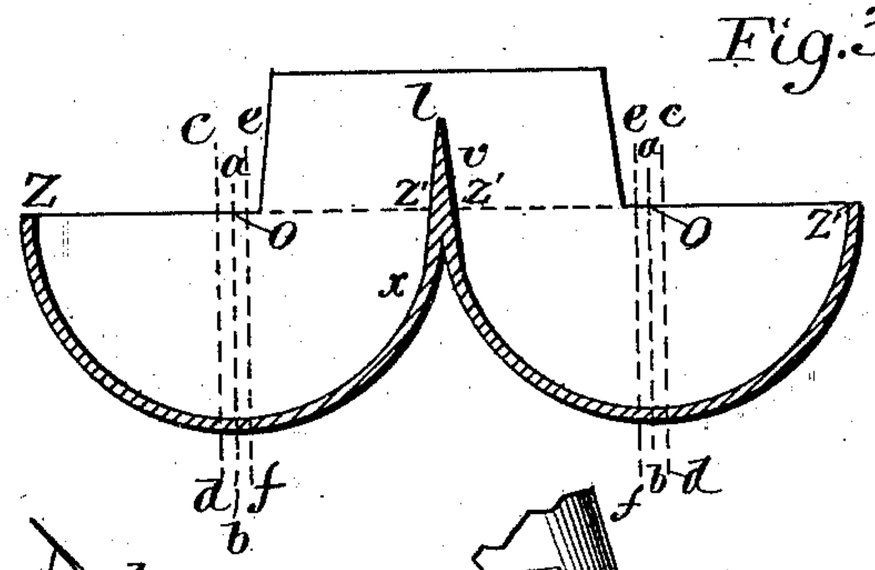
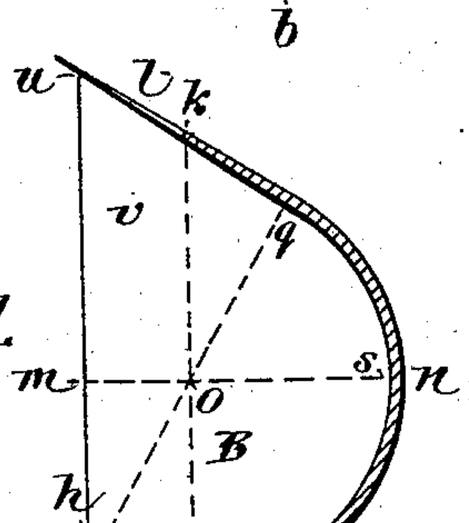


Fig. 1.



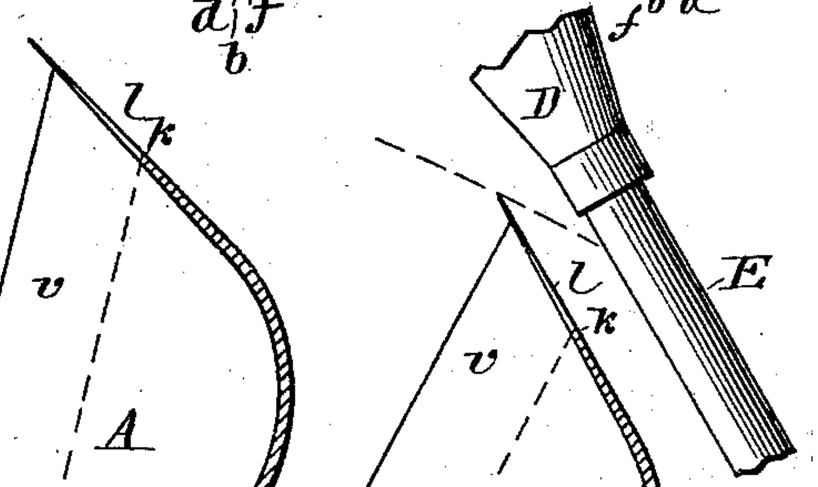


Fig. 5.

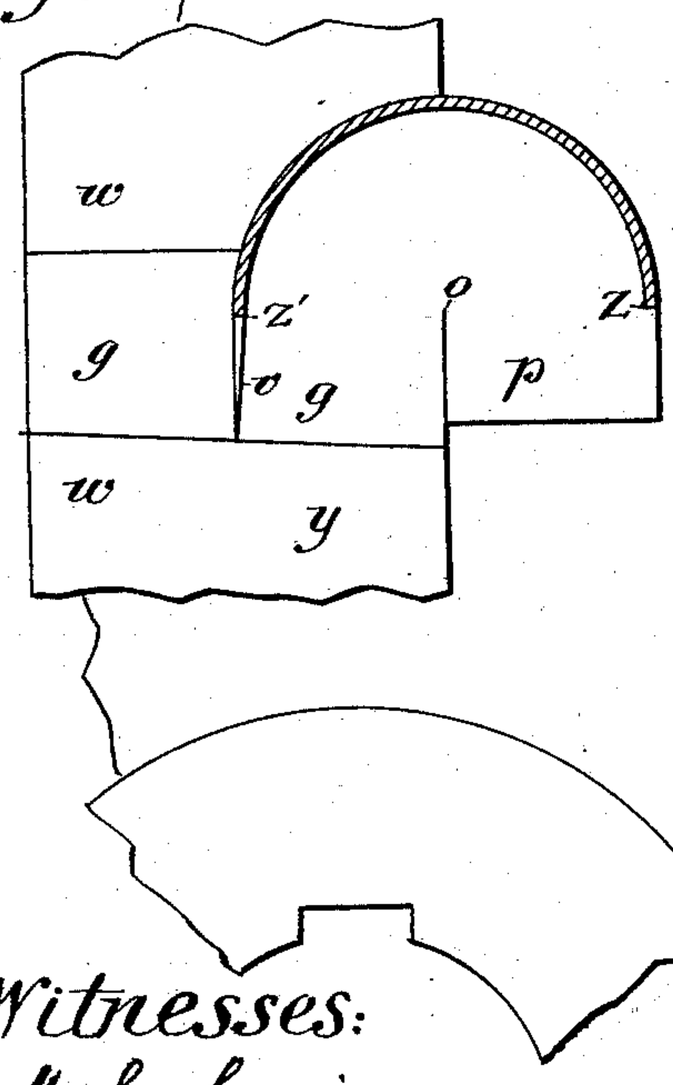
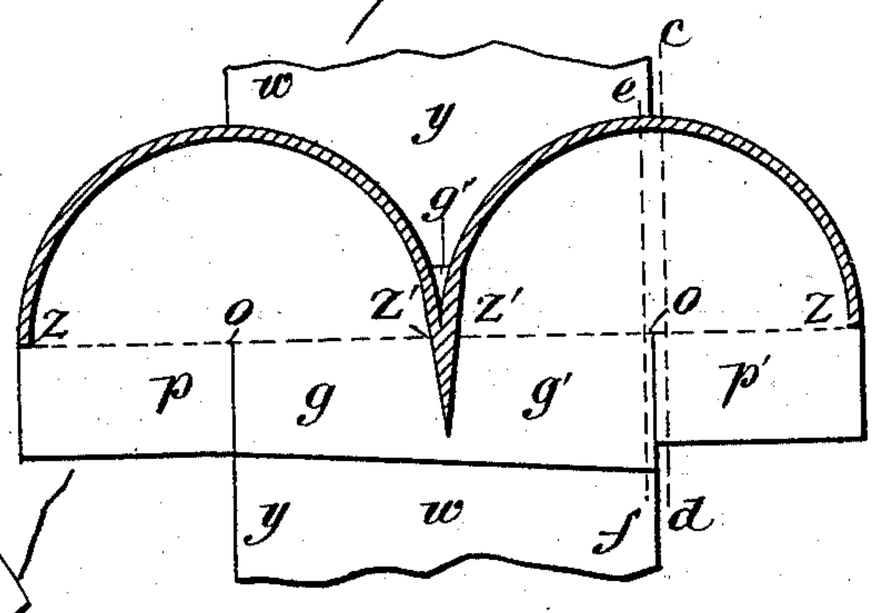


Fig. 2.



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(No Model.) 3 Sheets—Sheet 2.

F. M. F. CAZIN.

PERCUSSION WHEEL.

No. 578,813. Patented Mar. 16, 1897.

Fig. 6.

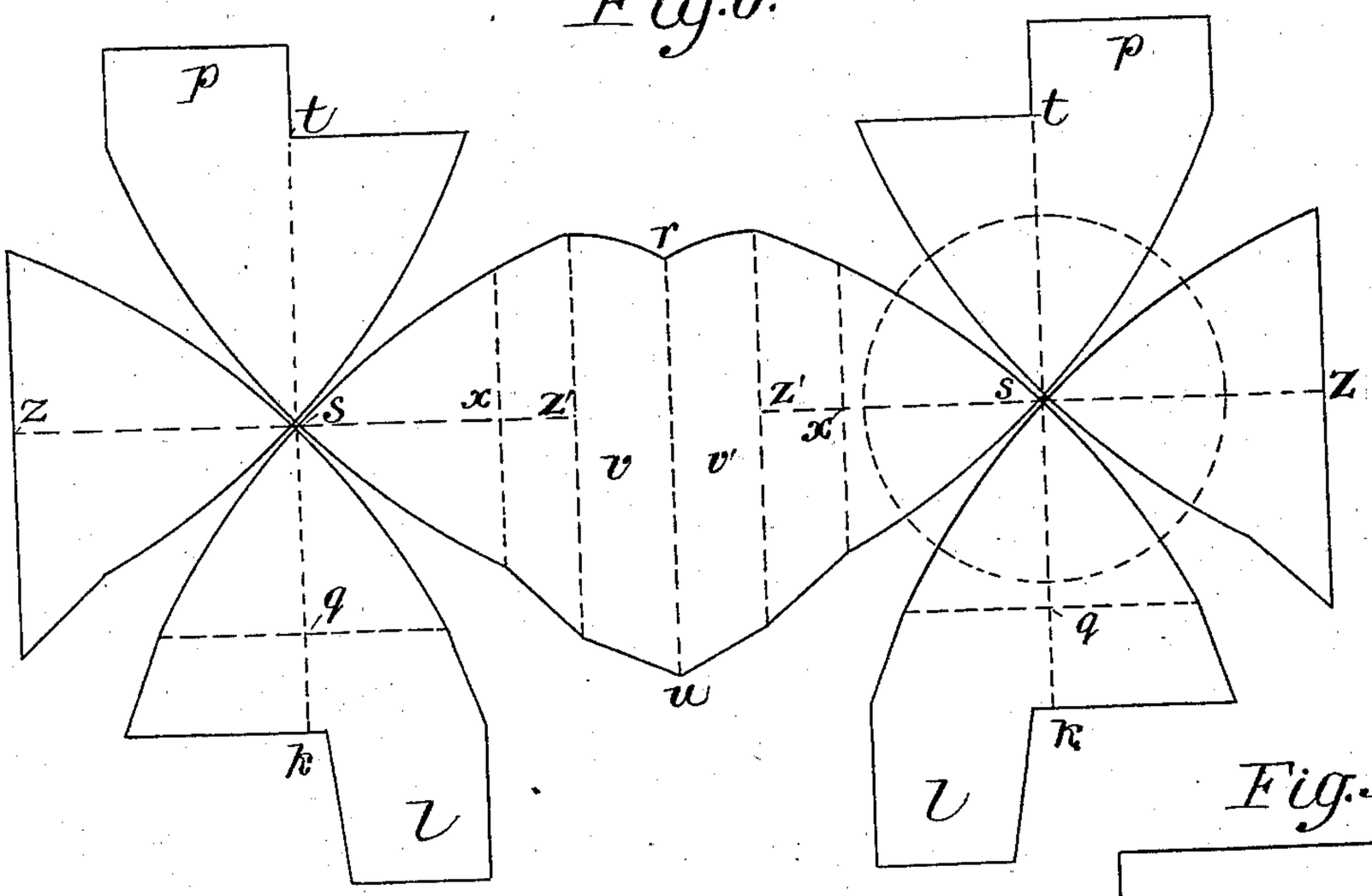


Fig. 9.

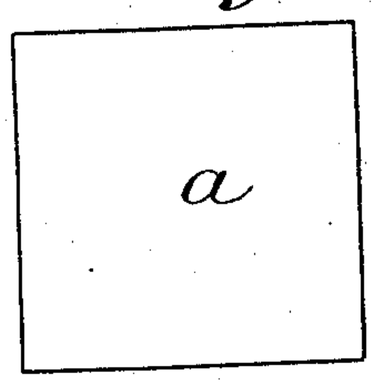
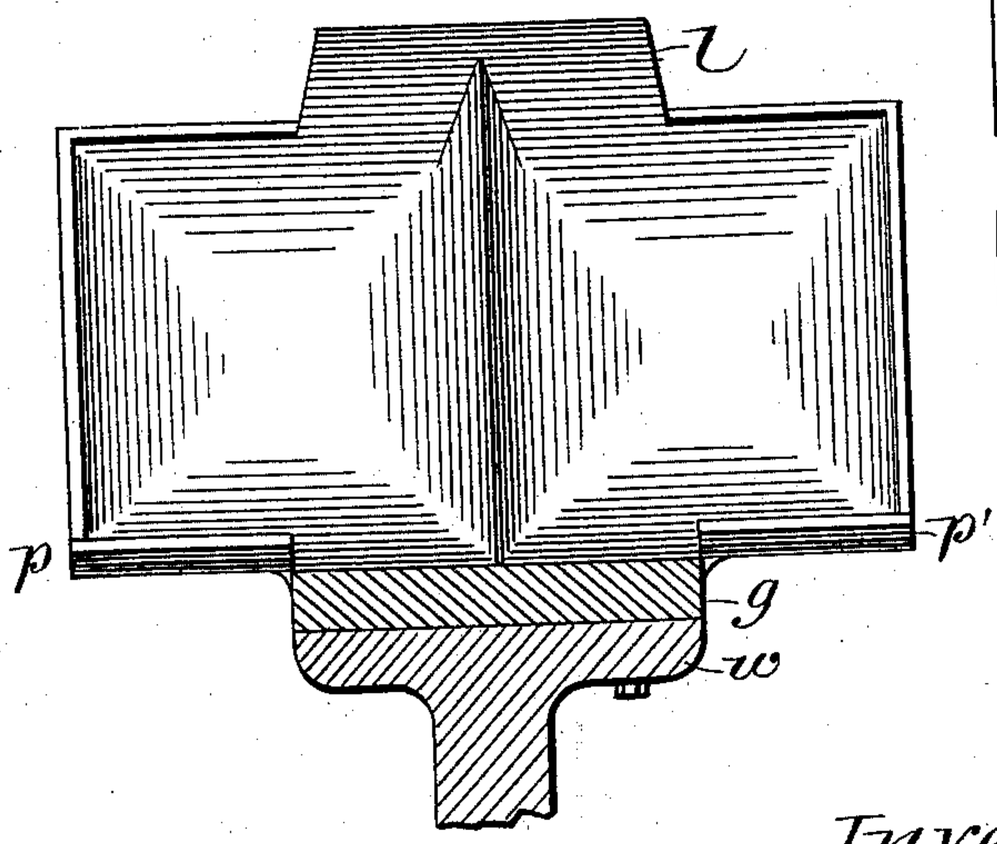
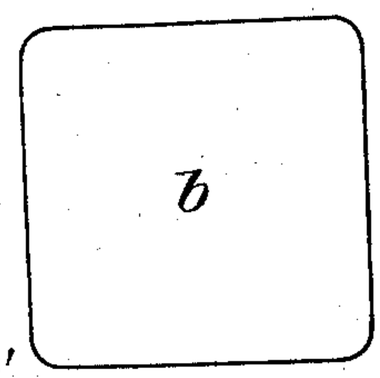


Fig. 7.





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(No Model.)

3 Sheets—Sheet 3.

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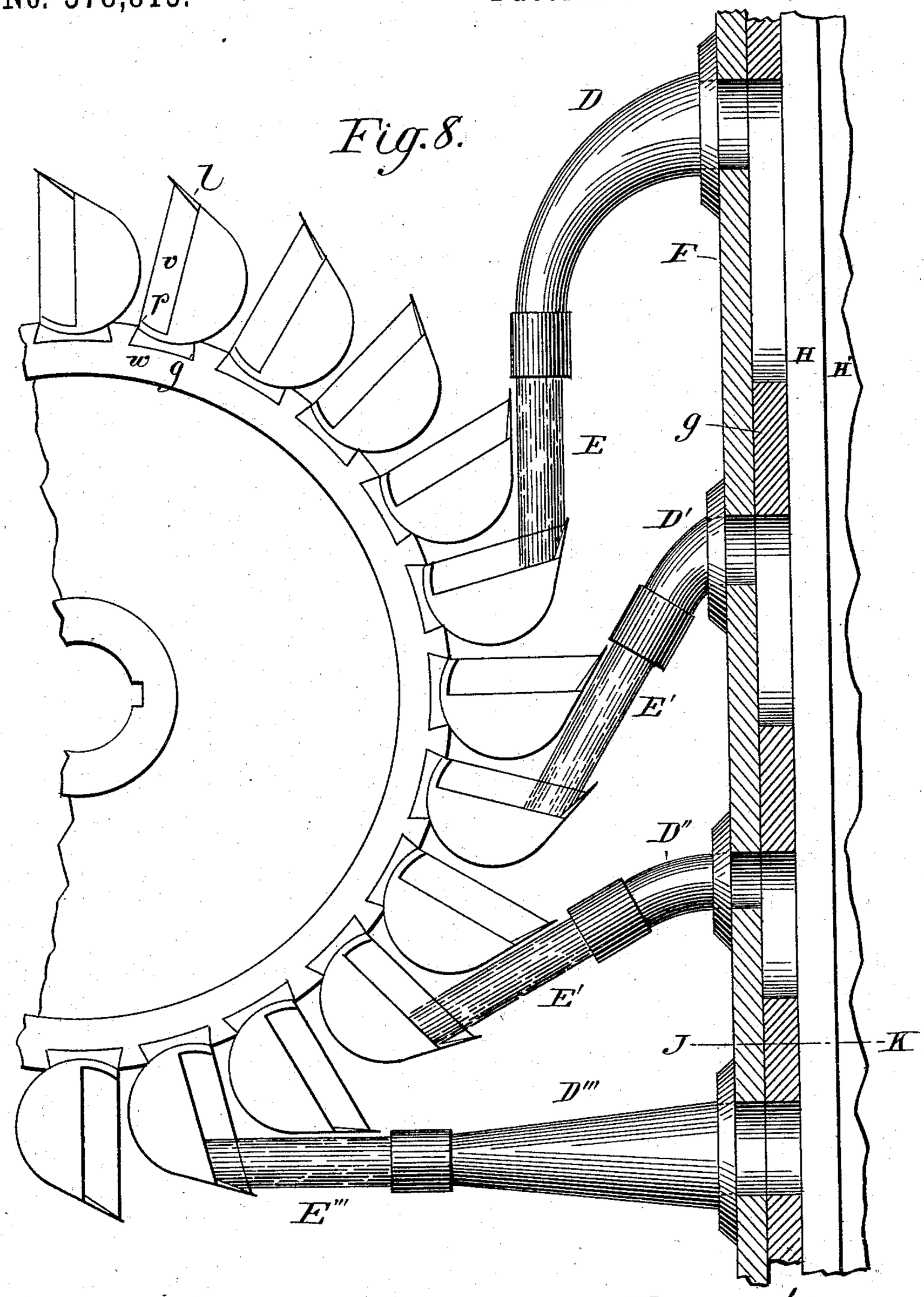
Fig. 8.



Witnesses:
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Henry Erxmeyer.

Inventor:
Francis M. F. Cazin

UNITED STATES PATENT OFFICE.

FRANCIS M. F. CAZIN, OF HOBOKEN, NEW JERSEY.

PERCUSSION-WHEEL.

SPECIFICATION forming part of Letters Patent No. 578,813, dated March 16, 1897.

Application filed September 7, 1895. Renewed December 11, 1896. Serial No. 615,419. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS M. F. CAZIN, a citizen of the United States, and a resident of Hoboken, in Hudson county, State of New Jersey, have invented a new and useful Improvement in Percussion-Wheels in general and in the wheel in special as described by me in my application Serial No. 476,406, dated June 2, 1893; and the improvement for which I desire to secure Letters Patent by my present application consists in the following specific additional or modifying features of construction, namely:

(*a*) In a water-wheel bucket having straight front edges forming a right-angled parallelogram and a cavity formed by four faces that are straight in the direction of the front edges and curved in a direction rectangular thereto and having the one of its front edges that stands mainly radially to the wheel-center surmounted on its entire length by a water dividing and directing wedge, blade, or knife, another water dividing and directing wedge, blade, or lip which surmounts the bucket front edge that is most remote from the wheel-center, the part which is nearest to the knife, and which lip and knife adjoin one another at right angles, and either have their sharp front edges in the same plane or the lip projecting beyond the knife, and which lip has the one of its edges facing away from the central plane of rotation free and has its outward side in the same plane with the next adjoining part of the outside of the bucket and also in the same plane with the edge or face of the knife that is most remote from the wheel-center. This outward side or face of the lip is intended to be parallel with the water-jet when the bucket closely approaches the jet, and the inward side or face of the lip, forming with its outward side or face a straight and sharp front edge, is the same as the outer side or face—a straight plane—and is continuous with the adjoining inner face of the bucket-cavity, of which cavity-face a part is a straight plane, the same as the thereto-adjoining inner lip-face, and another part of which cavity-face is curved, and the combined straight plane of lip and part of cavity-face stands to the curved part of the inner cavity-face that adjoins them as a tangential plane. This relation between the inner lip-face and the adjoining straight part of the cavity-face, on the one hand, and the adjacent curved or segmental face of the bucket-cavity face, on the other hand, is best demonstrated in a bucket-section through its deepest point and in the plane of its rotation and the outward side and the inward side of the lip, and in consequence, also, the sharp front edge formed thereby stands at right angles to the plane of rotation, and in the bucket bearing such lip on one of its front edges the two curved and continuous faces that form its cavity, of which faces the one stands rectangular to the other, are both bent on the same radius, the one bent in the plane of rotation, and in so far as the bucket-cavity alone is concerned, being a segment of less than a semicircle, and the other, standing rectangular thereto, being in the main a semicircle; but only in the two sections drawn through the deepest point of the cavity and at right angles to the plane of front edges of the bucket are these curves shown as continuous or as uninterrupted, while in all other sections, drawn parallel with and distant from either the one or the other of these two, these curves appear as interrupted toward the middle by a straight line, to which two parts of the curve form the ends, and the lip is shaped and is placed as hereinabove described for the purpose of causing buckets to enter one after the other into the body of the water-jet without scattering any of the water away from the direction of its most useful and effective action and of reducing to the least the resistance that the jet may offer to the bucket entering the jet's body.

(*b*) A curved or segmental plate or wing, designated as the "apron," which surmounts a part of one of the front edges of the bucket forming a parallelogram, these edges in pairs being of unequal length, the so surmounted edge being one of the shorter pair and the one nearest to the wheel-center, and the so surmounted part thereof being the one diagonally opposite to the lip and the one most remote from the middle plane of rotation of the wheel, in which middle plane the projecting water dividing and directing piece, designated as the "knife," and its sharp front edge ro-

tates, the said apron forming with its inner side a continuous curved face with the adjacent side of the bucket-cavity, the central longitudinal or maximum longitudinal section of which bucket-cavity forms with the longitudinal section of the apron a complete half-circle, thus causing such jet-water as enters the bucket in contact with the lip to be completely inverted in its direction of flow before it leaves the bucket, the apron resting with its inner side edge in part against the base-plate of the bucket, which base-plate being continuous in its upper face with the circular face of the wheel-crown is continuous also with the bucket-cavity face, where the apron leaves the bucket front edge free, all for the purpose of more fully inverting all parts of the water-jet in their direction of flow while they are in contact with the receding buckets.

(*c*) To give to the longitudinal sections of the bucket-cavity, that is, to the curved lines thereof, the same radius as that of the maximum transverse section of the bucket-cavity and to confine such curved section to less than a semicircle by supplementing the segmental line at its end that is most remote from the center of the wheel by a tangential line or plane that is continuous or identical with the line or plane of the inner side of the lip for the purpose of imparting to the jet-water that strikes the lip not only absolutely continuous lines to follow, but lines also on which such water by the most direct possible road is inverted in its direction of flow while in contact with the receding wheel-bucket and for the further purpose of adapting the position of the sides of the lip to the direction of the water-jet, so as to bring about parallelism between the jet and the extreme outside face of the bucket at the time when the bucket arrives in close proximity to the jet, be the lip a plate or a wedge in section.

(*d*) To make the distance-plates an integral part of the wheel-crown and with one side edge longer than the other, so as to make them conical as well as beveled, and with one edge across the crown-face rectangular thereto, namely, the one at the back of the bucket, and only the other diagonal, and to conform the shape of the bucket base-plates therewith for the purpose of securing to the buckets a firm position and a strong hold on the wheel-crown by the use of only one bolt, as a means of higher economy combined with improved technical make-up, the plane of resistance being thereby made square to the direction of the strain.

These improvements, as hereinabove mentioned, are shown in the drawings that are herewith submitted and form a part of this specification. They represent as follows:

Figure 1 is a side view of part of a percussion water-wheel and of one nozzle and water-jet with sections on a plane of rotation of three buckets. Fig. 2 is a view of part of the wheel-crown and a view of the apron and of the base-plate of a pair of buckets, looking toward the center of the wheel, and is a transverse maximum section of a pair of buckets on a plane indicated by *m n* in Fig. 1. Fig. 3 is a transverse maximum section of a pair of buckets on the same plane with the lip in view. Fig. 4 is the same section as shown in Fig. 3, but of one bucket of a pair only. Fig. 5 is the same view and section as shown in Fig. 2, but of one bucket of a pair only. Fig. 6 shows the form of the inner walls of a pair of buckets when these walls are straightened out into a plane with the projecting water-dividing piece, lip and apron included, such form serving as a stencil for cutting buckets in pairs or singly out of sheet metal to be completed by folding, bending, and soldering joints. Fig. 7 is a view of the cavity of a pair of buckets with a section of their base-plate and of the wheel-crown on a radial plane. Fig. 8 is a view of about half of a percussion water-wheel and of four nozzles and water-jets and is a section of such part of a water-compartment through which the water passes under pressure as constitutes the governor sliding valve and as contains the sliding plate, by means of which, when attached to a centrifugal governor, the different nozzles can be closed one after the other. Fig. 9, *a* and *b* represent bucket-cavity sections taken parallel with the plane of bucket-front edges and about half-way down between them and the deepest point in the cavity.

These figures are more specifically described hereinbelow, similar letters referring to similar parts in all figures, that represent them in view or in section.

In Fig. 1 the hub, disk, and crown of the wheel are shown in side view, but of the buckets the one in the middle, marked A, is shown in section on the plane marked *e f* in Figs. 2 and 3, and the two other buckets, marked B and C, are shown in section on the plane marked *c d* in Figs. 2 and 3. The section A therefore shows slightly less than one-half of the cavity of one bucket of a pair and one side of the knife (the water-dividing piece *v*) in view, as well as one edge of the lip, and the section proper shows the wall of the bucket and the base-plate *g*, but not the apron, because the section on the line *e f* does not take in the apron *p'*, and this section shows that the lower or inner edge of the buckets is sunk into the base-plate *g* for the purpose of making them in one piece, thereby making the cavity-wall and the outer face of the base-plate in part or near the knife continuous for the purpose of causing the part of the jet possibly taking its course over the inner part of the most central edge to pass along the face of the wheel-crown and laterally out, thus obviating all possibility of any jet part opposing the other in its course.

The section B shows slightly more than one-half the cavity of one bucket of a pair with one side of the water-dividing piece *v* and one edge of the lip *l* in view, while the section proper shows the bucket-wall and the

apron p', but not the base-plate, because a section on the plane marked $c\,d$ does not take in the base-plate g, but takes in the apron p', which is resting with its base against the bucket edge nearest to the wheel-center, and which with one side is adjacent in part to a side of the base-plate, and such section proper shows that the inner face of the apron and the adjoining cavity-face are continuous, being both in the curved face, as indicated by the central longitudinal or maximum longitudinal section of each bucket, all for the purpose of causing the jet part that enters the bucket through striking the lip to pass out of the bucket on the curved diagonal lines leading over the apron, and thus to describe a full half-circle on the radius $o\,q$, $o\,s$, $o\,t$, or $o\,r$, while the line $o\,k$ is longer than such radius, because the continuous face of the extreme part of the bucket-cavity and of the inner side of the lip, as marked by the letters $q\,k\,u$, are in a plane that is tangential to the curved mainly semicircular face of the bucket-cavity, as indicated by the line $q\,s\,t\,r$, the line $k\,o\,t$ indicating the plane in which the parallelograms of front edges of all buckets are situate and $m\,n$ indicating the plane on which the sections shown in Figs. 2, 3, 4, and 5 are taken.

In Fig. 1 the distance-plates $y\,y$ are shown as integral with the wheel-crown w, and the bucket base-plates $g\,g$ are shown to conform therewith and to be fastened by one bolt only, because on account of their dovetailing and of their conical shape, as shown in Figs. 2 and 5, one bolt is sufficient for maintaining the bucket immovably in its proper position, and the same Fig. 1 also shows the relative positions of the outward plane or side of the lip l and the jet E at the moment when the bucket approaches the jet and the continuity in the same plane with the said outward side of the adjoining outside of the bucket.

In Figs. 2 and 5 the width of the wheel-crown w is shown to be only about half that of a pair of buckets and to leave room laterally on either side for an apron p or p' to each bucket, and it is also shown that the apron projects as a whole beyond the plane of the parallelogram of bucket front edges, which is indicated in Fig. 1^B by the dotted line $k\,t$ and in Fig. 2 by the dotted lines $z\,o\,z'\,z'\,o\,z$, and these Figs. 2 and 5 also show the lines on which the distance-plates y and base-plates g join on the face of the wheel-crown w, the one behind the bucket being transverse to the plane of rotation and to the jet direction and the one in front of the bucket being diagonal for the stated purpose of offering a square resistance to the strain and of giving the plates the form of wedges mutually adapted within the space of the crown-face aside from their dovetailing together, and it is further shown by these same figures that the base-plates g occupy only so much of the bucket edge nearest to the wheel-center as is left free by the apron, and that it extends across the full crown-face, even though each member of a pair of buckets has its own and separate base-plate.

In Figs. 3 and 4 the inner side of the lip is shown in view and to project beyond the plane of the parallelogram of bucket front edges (indicated by the lines $z\,o\,z'$ and $z'\,o\,z$) and to occupy only the under part of the front edge; and these figures, as well as Figs. 2 and 5, show the radius of the two curved faces that form the bucket-cavity standing rectangular to one another to have the same length, and with the centers of the two curved faces to be in the point o of the two lines $k\,t$ and $z\,z'$, which stand rectangular to one another, crossing at the point o.

In Fig. 6 all the bucket parts, as well as the accessory parts, namely, the projecting pieces for first division of water, of which the one marked v is called the "knife" and the other marked l the "lip," as well as the "apron," marked p, over which part of the water is discharged, are shown as stretched out on a plane. A piece of sheet metal cut into the form shown and bent in its different parts into the curves and folds, as shown in the other figures, and the adjacent edges solidly joined will make a pair of buckets of the form invented by me.

Fig. 7 has been sufficiently described.

Fig. 8 is intended to show an arrangement of buckets on the wheel-crown by which a given number of these buckets, alternately with an equal number thereof, take an identical position relative to an equal number of water-jets, by which arrangement it becomes feasible to obtain the required space between valve-apertures under my method of regulating the ejected quantity of water without reducing the number of buckets below a desirable number and without abandoning for each bucket the most advantageous position of the jet when approaching the same, namely, a position where the outward face of the lip is parallel to the jet that is to be intersected; and in this Fig. 8 there is shown all that is essential to a water-compartment, through which the water passes under pressure, namely, its position relative to the wheel and the nozzle arrangement fed therefrom, and the governor slide-valve that is common to all nozzle-outlets. It is there shown that with the sliding plate G, assumed as attached with its top end to a centrifugal governor of common construction, the successive raising of the sliding plate G acts in this way, that first one outlet of the four leading to the nozzle-tips is acted upon exclusively without affecting any of the three others and that only when the outlet of this one, D‴, is closed, the solid part of the sliding plate passes in front of the second outlet D″ and closes the same, and so on, one outlet being closed only subsequent to the preceding ones in the order of succession, and that this is achieved by adding to the length, measured in the sliding direction, of each aperture in

the sliding plate corresponding to the outlet, the total length of all preceding apertures in the order of succession.

Fig. 9, *a* and *b* represent each the section of the inner bucket-face parallel with the parallelogram of front edges and half-way between such rectangular and sharp-edged parallelogram of front edges and the deepest point of the bucket-cavity and on a line where the sides of the inner or lower parallelogram has so been reduced that they have become equal, the one figure illustrating the case where the corners in the bucket-cavity have been left rectangular and sharp and the other figure illustrating the case where the corners away from the front edges have been rounded off, the effect of such eventual modification on the flow of the water-jet being not essentially deteriorating with rounded corners, while sharp corners as long as practicable in execution are in more correct adaptation to the rational requirements of the case.

It is to be understood that the main and chief merit of my improvements as herein disclosed is the constructive lines of resisting-faces of the vanes or buckets in a free-jet percussion-wheel, by means of which lines and faces the direction in which the free jets of liquid or fluid matter are ejected under pressure or head is fully inversed in parallel direction and is so inversed not only when the resisting-vane is in one certain position while revolving relative to the jet, but is so inversed in all positions that the vane occupies while receding by the force of the jet or jets. This improvement is absolutely independent of the cause that produces the head or pressure in the jet itself, as long as my primary assumption be fulfilled, that the jet have some percutient force. I therefore do not limit my invention by using water in its liquid form exclusively or by using such water exclusively when its force of percussion is derived from falling, but I propose to make use of my improved vanes or buckets conjointly with force-jets of all or any description, be the force obtained from fall, from mechanical or other phases of force, such as heat and consequent expansion into vapors of water, or oil, or naphtha, or air, or gases; but I do not claim as my invention the use of other than water-jets and not their use in connection with any other form of vanes or buckets except those herein described.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a percussion-wheel a bucket, the front edges of which, as well as all lines drawn on the face of the cavity at uniform distances from such front edges, form right-angled parallelograms, the parallelogram of the front edges having right-angled and sharp corners, the dimensions of parallelograms decreasing toward the deepest point in the cavity, the parallelogram of front edges having two short and two long edges comparatively, of which the longer pair until to about half the depth of the bucket decreases in length at a greater rate than the shorter pair decreases, the four lines of the parallelogram becoming equal at about such half depth and then remaining equal, until the deepest point in the bucket-cavity is reached, such deepest point not being in the center of the cavity but being nearer to the center of the wheel than is the center of the parallelogram of front edges, and the longitudinal maximum section of which bucket is formed by a segment of a circle, less than half a circle, and of a tangent to the outer end of the segment, the radius of segment in the central longitudinal or maximum longitudinal section and the radius of the half-circle in the central transverse or maximum transverse section of the bucket-cavity being of equal length, as and for the purpose set forth.

2. The combination with a percussion-wheel, a bucket, and a water dividing and directing knife, that surmounts one front edge of the bucket and revolves with this front edge in a plane, that divides the water-jets into two parts, of a straight lip, which surmounts the one of the four bucket front edges, forming are ctangular parallelogram, that is most remote from the center of the wheel, and surmounts of this edge only the part, which is nearest to the knife, the said lip resting with one of its edges against one side of the knife, and against such side along the edge of the knife, that is most remote from the center of the wheel, the lip and the knife having their sharp front edges in suitable proximity, and the said lip having its outward side in the same plane with the next adjoining part of the outside face of the bucket and also in the same plane with the edge or face of the knife, that is most remote from the wheel-center, and parallel with the water-jet, when the bucket approaches the jet, and the said lip having an inward side, that forms a sharp front edge with its outward side, and a continuous face with the next adjoining part of the bucket-cavity face, and the said lip, having its inner side continuous with part of the adjoining bucket-cavity, forming with such next adjoining part a straight plane which stands at right angles to the plane of rotation of wheel and bucket, and having such inner side or face jointly with the adjoining straight part of the cavity-face in the position of a tangential plane relative to the adjacent curved part of the same cavity-face, as and for the purpose set forth.

3. The combination with a percussion-wheel and a bucket, the front edges of which bucket form a parallelogram, and with a water dividing and directing piece, blade or knife, that surmounts the front edge of the bucket and revolves in a plane, that divides the water-jet into two parts, of a curved or segmental plate or wing or apron, which surmounts part of the front edge of the bucket, that is nearest to the wheel-center, and the so surmounted part thereof being the one

most remote from the knife, the said apron forming with its inner side a continuous curved face with the adjacent side of the bucket-cavity and with the curved part of the central longitudinal or maximum longitudinal section of the bucket-cavity a half-circle mainly, the said apron resting in part with its inner side edge against the base-plate of the bucket, the upper face of the base-plate of the bucket and the inner face of the bucket proper being made continuous, where the apron leaves the bucket edge free, as and for the purpose set forth.

4. In combination with a percussion-wheel and bucket, distance-plates on the face of the wheel-crown, being integral with the crown, filling the width of the crown and the space between the base-plates of buckets and having undercut edges across the crown-face, of which one is rectangular to the crown edges and the other diagonal thereto, as and for the purpose set forth.

5. The combination with a percussion-wheel and with a pair of buckets and with a water dividing and directing piece, blade or knife, that surmounts two adjacent front edges of the pair of buckets and revolves with these adjacent front edges in a plane, that divides the water-jet into two parts, of a straight plate, wing, wedge or lip to each bucket of the pair, which lip surmounts of the bucket front edges the one, that is most remote from the center of the wheel, and of this edge the part nearest to the knife only, the two lips resting on opposite sides against the extreme edge of the knife, and having their sharp front edges in suitable proximity to the sharp front edge of the knife, and the two lips having their outward sides in the same plane, the one with the other, and also in the same plane with the next adjoining part of the outside of the pair of buckets and also in the same plane with the edge or face of the knife, that is most remote from the wheel-center and parallel with the water-jet, when the pair of buckets approaches the jet, and the said lips having their inward sides in one and the same plane and forming thereby a sharp front edge with their outward sides, which inward sides also are in the same plane and continuous with the next adjoining parts of the cavity-faces of buckets, and tangential to the curve or segment of the central longitudinal or maximum sections of the bucket-cavities, as and for the purpose set forth.

6. The combination with a percussion-wheel and a pair of buckets, the front edges of which form two parallelograms, and with a water dividing and directing knife, that surmounts two adjacent front edges of the pair of buckets and revolves with these adjacent front edges in the plane, that divides the water-jet into two parts, of a curved or segmental apron to each bucket, which apron surmounts a part of the front edge of each bucket, that is nearest to the wheel-center, the said part thereof being the part, that is most remote from the knife, the said aprons forming with their inner side a continuous curved face with the adjacent side of the bucket-cavities, and forming with the segment of the central longitudinal or maximum longitudinal section of each bucket-cavity a half-circle mainly, each apron resting with its inner side edge on opposite sides against the base-plate of the pair of buckets, as and for the purpose set forth.

7. The combination with a percussion-wheel a bucket and a water dividing and directing blade or knife, that surmounts one front edge of the bucket, and with such front edge revolves in a plane, that divides the water-jet into two parts, of a straight plate, wing wedge or lip, which surmounts the bucket front edge, that is most remote from the center of the wheel, but of this front edge only the part, which is nearest to the knife, the said lip resting with one side edge against the extreme end of one side of the knife, the sharp front edges of lip and knife being in suitable proximity, the said lip having its outward side in the same plane with the next adjoining part of the outside face of the bucket and also in the same plane with the edge or face of the knife, that is most remote from the wheel-center and parallel with the water-jet, when the bucket approaches the jet, and the two sides of the lip forming a sharp front edge, that stands rectangular to the sharp front edge of the knife, and inward side of the lip forming a continuous plane with the next adjoining part of the bucket-cavity face, such plane being to the curve or segment of the central longitudinal or maximum longitudinal section of the bucket-cavity a tangential plane, and of a curved or segmental plate, wing or apron, that surmounts part of the bucket front edge, nearest to the wheel-center, and of such front edge the part, which is most remote from the knife, the said apron forming with its inner face or side a continuous curved face with one side of the bucket-cavity, and a complete half-circle with the segmental part of the central longitudinal or maximum longitudinal section of the bucket-cavity, as and for the purpose set forth.

8. The combination with a percussion-wheel and with a pair of buckets, all front edges of which are in one plane, and with a water dividing and directing knife, which surmounts one front edge of each bucket of the pair and revolves with these adjacent front edges in a plane, that divides the water-jet into two parts, of a straight lip in each bucket of the pair, each lip surmounting a part of the bucket front edge that is most remote from the center of the wheel, namely the part nearest to the knife, and each lip resting with one edge against the extreme end of one side of the knife, with the sharp front edges of the two lips forming a straight line, standing at right angles to the front edge of the knife and in suitable proximity thereto, both lips having their outward sides in the same plane with

the extreme small edge or face of the knife and also with the next adjoining part of the outside face of the buckets and with one another, such plane standing at right angles to the plane of rctation of wheel and bucket and parallel with the water-jet, when the pair of buckets approaches the jet, and which lips have their inward sides in the same straight plane with the next adjoining part of the bucket-cavity face and with one another, the said straight plane being in a tangential position to the adjoining curved or segmental part of the cavity-face, and the inner and outer sides of the lips forming one sharp, straight front edge, and of a curved or segmental apron to each bucket of the pair, which apron surmounts part of the bucket front edge, that is nearest to the wheel center, and the part thereof, that is most remote from the knife, each apron by its inner face forming a continuous face and curve with the adjoining bucket-cavity face, and complementing the segmental cavity-curve to a semicircular curved face, as and for the purpose set forth.

FRANCIS M. F. CAZIN.

Witnesses:
WM. BREMERMAN,
ADELE CAZIN,
M. E. CAZIN.