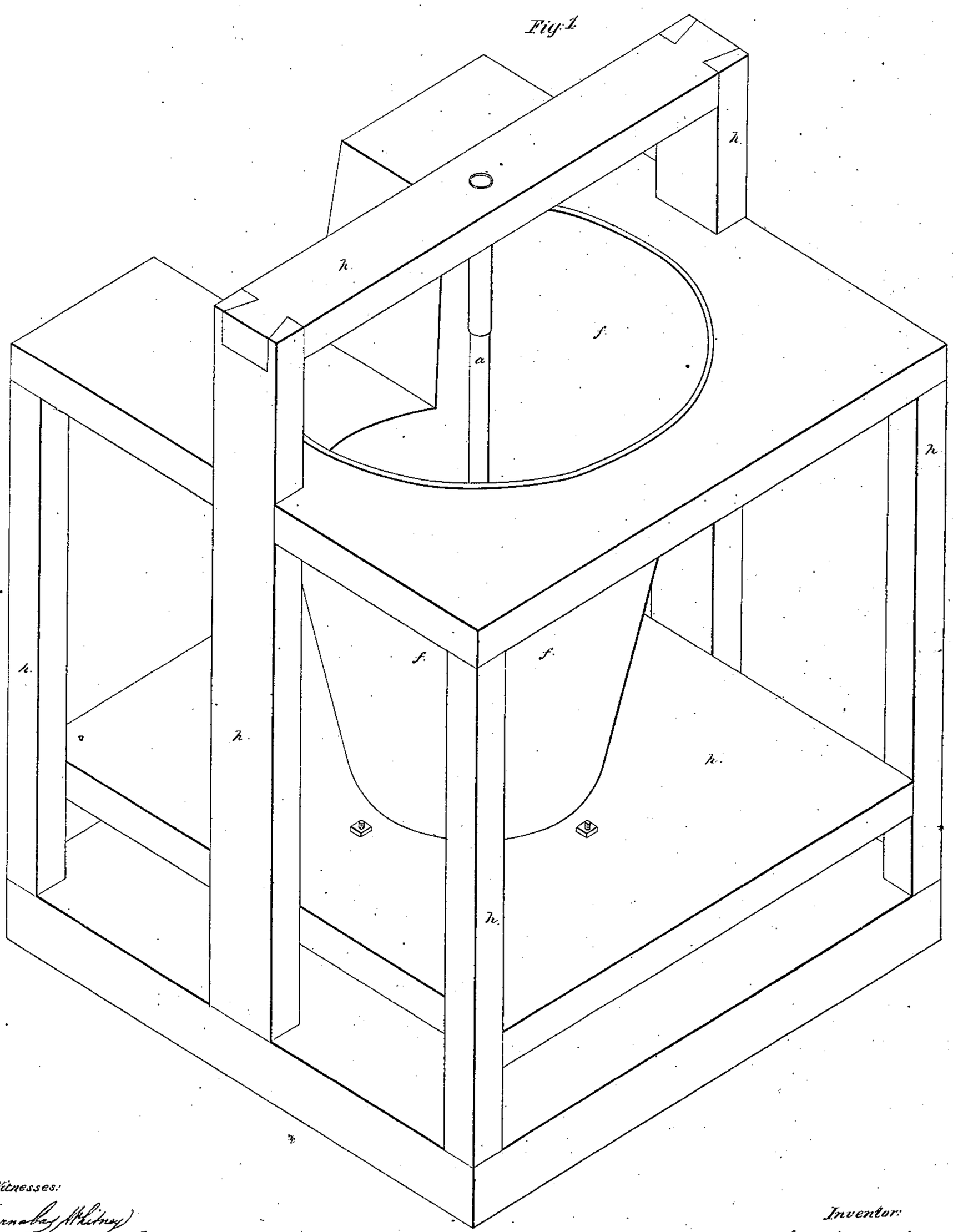
Sheet 1-2 Sheets

U. A. Boyden,

Water Wheel,

No. 5,090. Patented May 1, 1847.

Fig: 1.



Witnesses:
Barnabas Whitney
George Clark

Inventor:
Uriah Atherton Boyden

Sheet 2 - 2 Sheets.

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Water Wheel.

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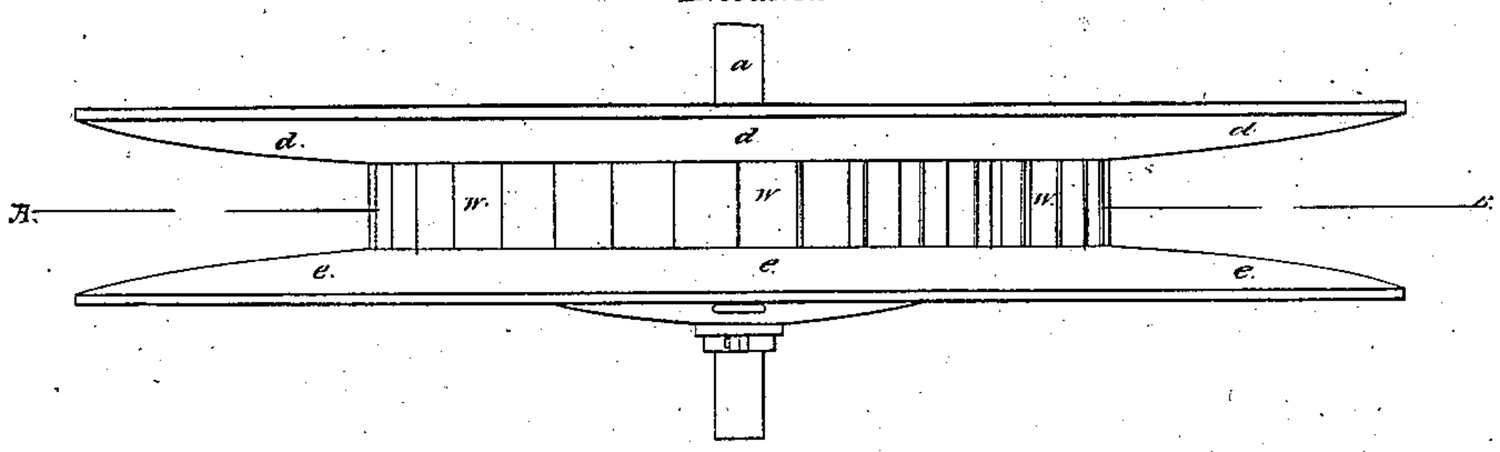
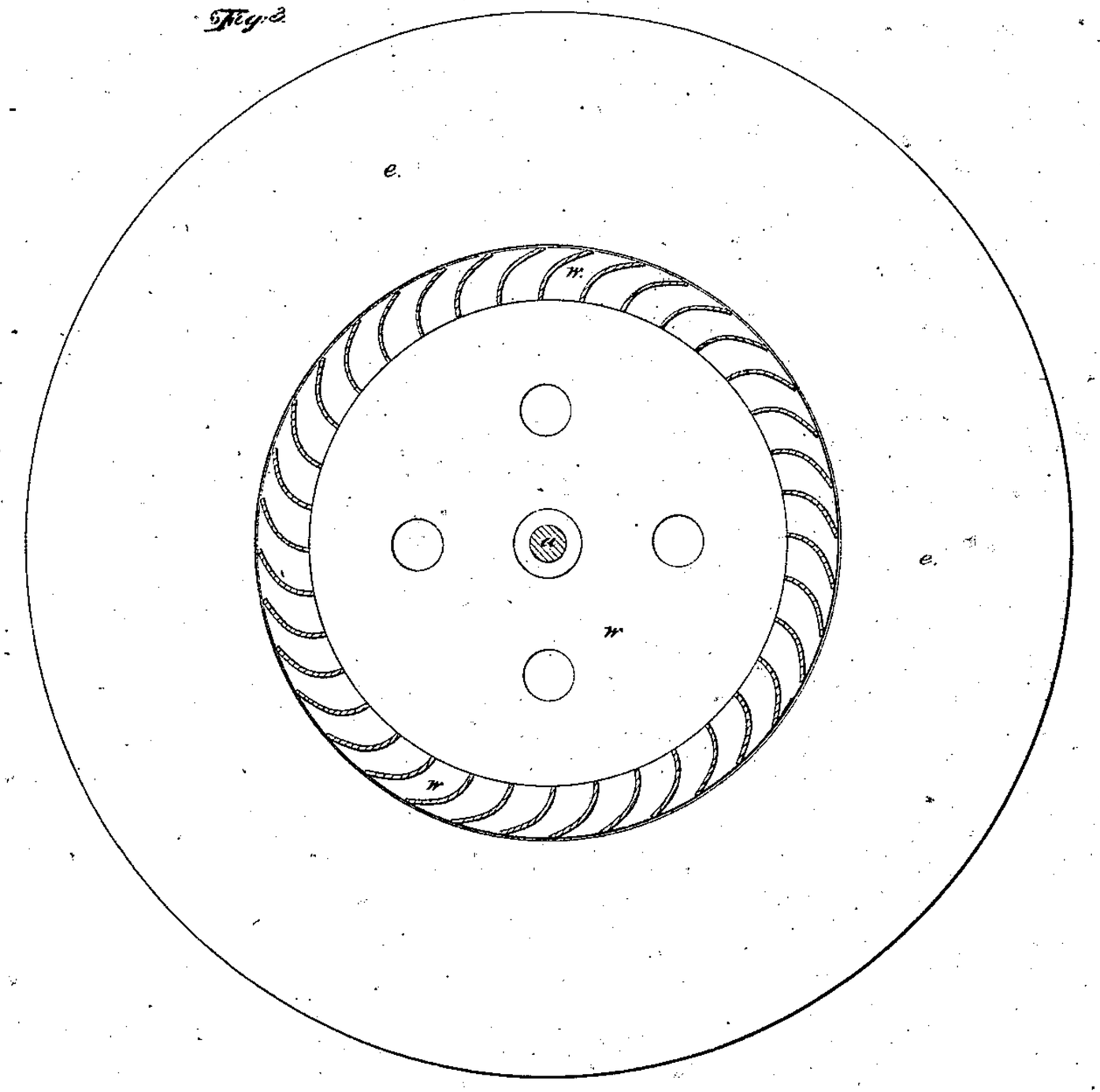
Fig: 2.
Elevation



Horizontal Section on A B.

Fig: 3.



Witnesses:
Barnabas Whitney
George Stark

Inventor.
Uriah Atherton Boyden

UNITED STATES PATENT OFFICE.

URIAH ATHERTON BOYDEN, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN DIFFUSERS FOR WATER-WHEELS.

Specification forming part of Letters Patent No. **5,090,** dated May 1, 1847.

To all whom it may concern:

Be it known that I, URIAH ATHERTON BOYDEN, of Boston, in the county of Suffolk and State of Massachusetts, have invented a new and Improved Mode of Increasing the Efficiency of Water in Moving Wheels by Using a Diffuser; and I do hereby declare that the following is a full and exact description thereof.

The nature of my invention consists in causing the stream or streams of water from a water-wheel to diverge gradually, or in causing the water which is ejected from a water-wheel to be diffused gradually, whereby the momentum which the water has on leaving the water-wheel is expended in diminishing the pressure of the water or air on the parts of the wheel which the water last leaves, which is effected by applying a diverging or flaring passage or passages to the exits of the wheel, which passage or passages the water necessarily passes through after leaving the wheel, which causes the stream or streams of water to expand or spread gradually or to be gradually diffused, and hence I call this adjunct to the wheel which I have invented a "diffuser."

To enable others skilled in the art to make and use my invention, I will proceed to describe its construction and operation, beginning by describing the annexed drawings, which make a part of this specification, in which—

Figure 1 is an isometrical projection of the flume, a part of the water-wheel shaft, and the frame which supports them. In this view the water-wheel and the diffuser are hid by the parts above them. Fig. 2 is an elevation of the water-wheel, a part of its shaft, and the diffuser. Fig. 3 is a horizontal section of the water-wheel and its shaft, in which figure the lower part of the diffuser is shown as it appears when looking down perpendicularly upon it. Fig. 1 is on a smaller scale than the other figures.

The same small letters in all the figures refer to the same parts.

h h, &c., Fig. 1, is the frame which supports the flume, shaft, wheel, and diffuser.

f is the flume.

w w w, Figs. 2 and 3, is the water-wheel.

Water-wheels of the form represented by the drawings are called "turbines," or, rather, a wheel of this form is a part of a hydraulic machine called "turbine," and a wheel of this kind has a disk within it which sustains the water in the flume, and there is an annular gate in the wheel, which gate rests on the said disk when it is not necessary to have the wheel in operation. The effects of the diffuser, which is the part or adjunct claimed, do not depend on the said disk or gate, nor is it connected with either. Therefore I do not represent these in the drawings.

Descriptions and drawings of turbines may be found in my applications for patents for improvements in turbines, filed in the Patent Office at Washington at the same time with the application for a patent for this diffuser.

a is the axle or shaft of the water-wheel.

d d d e e e is the diffuser which encompasses the water-wheel.

I construct my wheels, whether reacting-wheels or turbine-wheels, so that when they are horizontal the water passes into their central parts by either ascending or descending, or by both, and out at their circumference, whether their circumference represent the form of a zone of a sphere, the frustum of a cone, or be cylindrical, or of any other form.

My diffuser consists principally of two annular parts, which, for convenience in describing, I will call "platforms." The upper one *d d d* encompasses the upper part of the water-wheel, and the lower platform *e e e* encompasses the lower part of the water-wheel. The upper surface of the lower platform next the wheel is at the same height as the bottoms of the apertures of the wheel through which the water escapes, or a very little lower than the bottoms of these apertures; and this part of the platform fits the wheel as closely as it is practicable to keep it without the wheel rubbing it so as to produce any considerable friction. This is made to fit closely about the lower rim of the wheel to prevent any considerable quantity of water from ascending between it and the wheel. The lower surface of the upper platform next the wheel is of the same height as the tops of the outlets of the wheel, or a very little higher than the tops of these outlets, and this part of the platform fits the upper rim, or the circumference of the upper ring of the wheel closely, to prevent the descent of the water between it and the wheel, but is not made to touch the wheel, so

as to produce any considerable friction. The upper surface of the lower platform is curved downward, the commencement of the curve next the wheel having the same direction as the lower part of the stream or streams where the water passes out of the wheel—that is, the direction of the lower part of the stream where it first touches the upper surface of the lower platform is a tangent to this surface, or the commencement of this surface next the wheel inclines downward so as to diverge a little from the said direction of the stream or streams in the direction from the wheel. The lower surface of the upper platform is curved upward, the commencement of the curve next the wheel having the same direction as the upper part of the stream or streams where the water passes out of the wheel; or the commencement of this surface next the wheel inclines upward so as to diverge a little from the direction of the said upper part of the stream or streams in the direction from the wheel. All parts of these two surfaces may be of the same curvature.

The diameter of the diffuser is about double the diameter of the wheel, and the space between the outer edges of the two platforms is about twice as wide as the space between their inner edges next the wheel. With wheels as usually constructed the parts of the curved surfaces of the two platforms next the water-wheel may diverge a little—that is, the first element of the curve next the water-wheel of the upper platform may diverge a little from the first element of the curve next the water-wheel of the lower platform in the direction from the wheel. This angle of divergence may be about six degrees. The circumference or outer extremity of the lower surface of the upper platform should be as low or lower than the surface of the water about the wheel which has passed through the wheel or which is below the fall—that is, the outer extremity of the lower surface of the upper platform should be so low as to be always immersed in the tail-water when the wheel is working.

I have above described the particular form of my diffuser, which I think is best for the majority of cases; but some modifications of this form will answer better and be more conveniently applied in some cases, and there are some other modifications which will answer nearly as well as the form above described. Instead of the lower platform being fitted very closely to the lower periphery of the water-wheel to prevent the ascent of water between the platform and the wheel, this may in some cases be conveniently effected, when there is a suitable floor or partition under the wheel, by closing all passages between the lower platform and the floor or partition, so as to form a water-tight joint between them; and the descent of water or air between the upper platform and the water-wheel may be prevented by closing all passages between the upper platform and flume.

The surfaces of the diffuser which confine the stream or streams may be somewhat different from what I have above described and the diffuser still operate according to the same principle. Thus these surfaces may be curved differently, or they may be plain, or one may be plain and the other curved; but it is essential that they be such, or that the passage or passages formed by the diffuser be such, as to cause the stream or streams to expand or spread in one direction at least, and that this expansion or diffusion be gradual or by successive degrees. If the passage or passages be made to widen or diverge irregularly, or be made to widen or diverge by small steps or offsets, the diffuser thus formed may cause the stream or streams to expand, and it will still operate, though imperfectly, excepting when these irregularities, steps, or offsets are very small, so as to approximate to a gradual flaring or enlargement. Props may be placed between the two platforms to prevent their being pressed toward each other when neither of the platforms is to be movable, and when this object cannot conveniently be effected by other means. These props should be thin and so placed as to obstruct the flow of the water as little as practicable. One or both platforms, more particularly the upper one, may be movable, so that the width of space between them may be varied and the quantity of water which passes through the wheel thus regulated.

This diffuser may be applied to vertical or inclining reacting-wheels and vertical or inclining turbine wheels.

In some cases the wheel of a turbine has one or more diaphragms between the upper and lower rings of the wheel which the floats are fastened to. These diaphragms are annular and of about the same width and diameter as the width and diameter of the rings of the wheel which the upper and lower edges of the floats are attached to, or the diaphragm is composed of pieces fixed between the floats, which pieces collectively form an annular partition in the wheel, as is well known to people conversant with this kind of water-wheels. For a turbine wheel which has a diaphragm there should be, in addition to the diffuser, as above described, an annular partition between the platforms of about the same diameter as that of the platforms. This annular partition should be at the height of the diaphragm in the wheel, and it should encompass and fit as closely to the diaphragm as it can without touching it so as to produce any considerable friction. The inner part of this partition next the diaphragm should have the same thickness or be a very little thinner than the circumferential parts of the diaphragm next it. The circumferential parts of the partition should be as thin as they can be and have sufficient strength and stiffness to resist the pressure of the water. If this partition have not the same thickness at its circumference and at its inner part next the dia-

phragm, the change of thickness should be gradual.

When there is more than one diaphragm in a wheel, there should be as many annular partitions between the platforms as there are diaphragms, one partition to encompass each diaphragm, as above described for the case when there is only one.

Though it is best to have the diffuser so shaped that the expanding or diffusing of the stream or streams will commence at the exit or exits of the water-wheel, it will operate when it is so shaped that the expanding or diffusing is produced only at a considerable distance from the wheel, as when the parts of the passage or passages which are at a considerable distance from the wheel are diverging or flaring and the other parts of the passage or passages which are near the wheel not diverging or flaring.

Where my diffuser is used, it is best to construct the turbines a little different from what they otherwise should be, as follows: Increase the length of the radii of the leading curves a little through their whole length, so that while their inner ends next the axle of the wheel remain unaltered their outer ends have their directions changed three degrees. As the ends of the leading curves should be at the same distance from the axis of the wheel after the change which they were before the change, their length must be diminished a little when this change of curvature is made. Take so much from the outer extremity of each float as forms three degrees of the curvature of each float, letting the outer ends of the remaining parts of each of the floats have the same directions which these parts had before the outer parts were removed. Diminish the curvature of all parts of the remaining parts of each float in the same ratio, so as to change the directions of the inner ends of the floats five degrees each. Hence the whole deflection of each float will be diminished by eight degrees. The inner ends of the floats should remain at the same distance from the axis of the wheel which they were before the alteration, and as this diminution of the curvature of the floats moves their inner ends a little toward or from the axis of the wheel, according to the directions which these ends had before the alterations, the length of the floats will be diminished more or less than by the whole quantity taken from their outer extremities, according to the directions which the inner ends of the floats had before the alterations; but the whole diminution of curvature of each float should be eight degrees, as above stated. When the length of the floats is so diminished by taking off their outer parts, it is best to diminish the width of the rings of the wheel which the edges of the floats are fastened to by taking some from their outer edges—that is, to diminish the diameter of the wheel a little, so that it may conform to the extremities of the floats so altered. It may be perceived that these alterations in the curvatures of the leading curves and floats are such that the last elements of the leading curves next the floats make with the first elements of the floats next the leading curves an angle which differs only two degrees from the angle which these parts made before the alteration. When a turbine is so modified and used with my diffuser, its wheel should revolve in about ninety-six hundredths of the time which would be required when at work without the diffuser and before being so modified.

As some parts of the passages of the water, especially the exits of the wheel, are widened a little by this modification, their liability to being choked is diminished a little. This is of some importance with very small turbines in places where they are liable to be choked. When my diffuser is used where the wheels are very liable to be choked, it may be well to increase the widths of the exits of the wheels twice as much as above mentioned by altering the leading curves and floats in the same way as above described, but about twice as much.

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

My diffuser, as described above, as adapted and applied to all turbines, reacting and all other water-wheels to which the same is applicable—viz., those which receive the water between their peripheries and axis and discharge the water at their outer or circumferential parts, whether these parts be cylindrical, conical, convex, concave, or of whatever other form.

I do not confine my claim to the precise forms of my diffuser described above; but I extend it to all forms which are essentially the same in which the parts are so shaped as to form a gradually diverging or spreading passage or passages or in which the passage or passages spread, diverge, or enlarge from the wheel by degrees or by small steps or offsets, so as to cause the stream or streams of water on or after leaving the wheel to expand, spread, or be diffused gradually or by small steps or degrees, so as to expend a considerable portion of the momentum which the water has on leaving the wheel in diminishing the pressure of the water or atmosphere on the circumference of the wheel or parts of the wheel from which the water is ejected.

URIAH ATHERTON BOYDEN.

Witnesses:
BARNABAS WHITNEY,
GEORGE STARK.