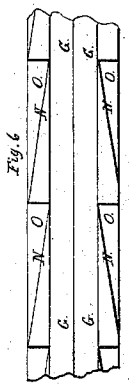
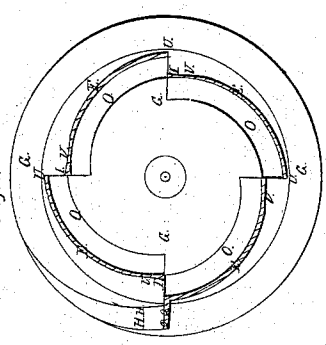
Sheet 1-2 Sheets

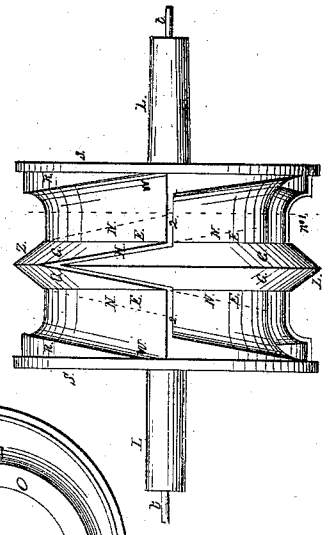
A. Greenleaf,

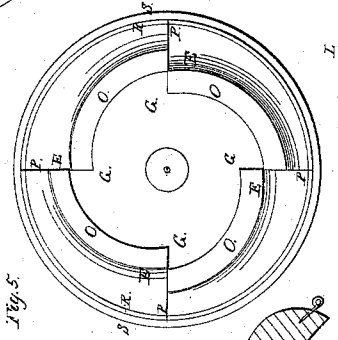
Water Wheel,

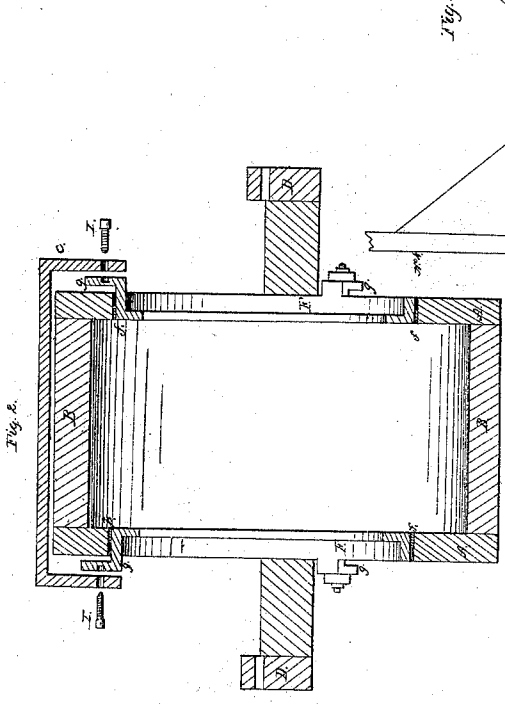
No. 10,916. Patented May 16, 1854.

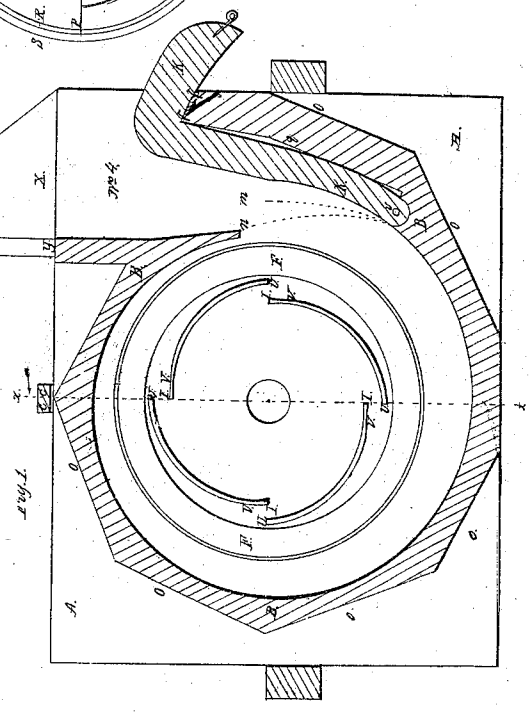












Sheet 2 - 2 Sheets

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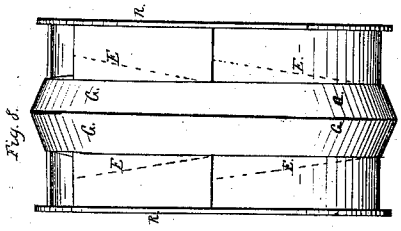

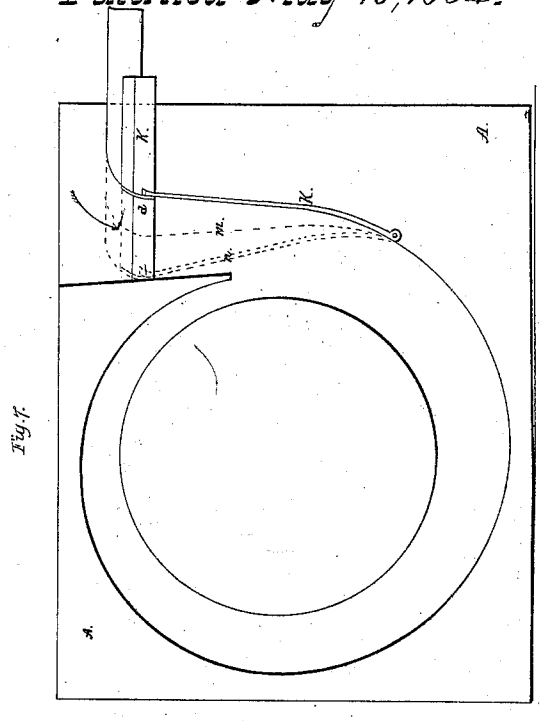

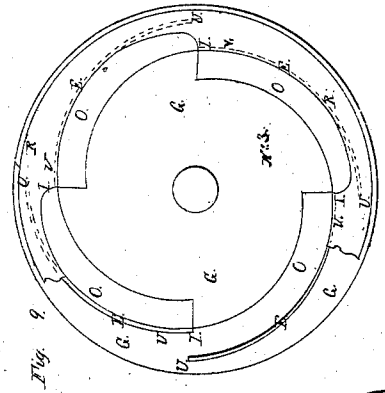

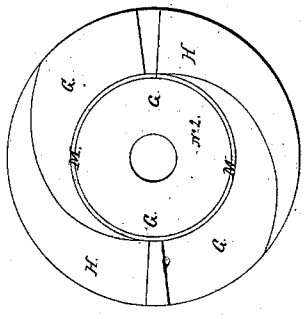

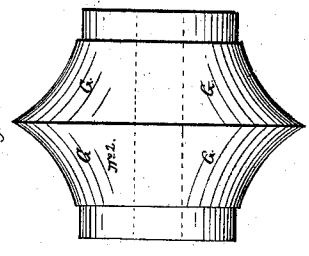

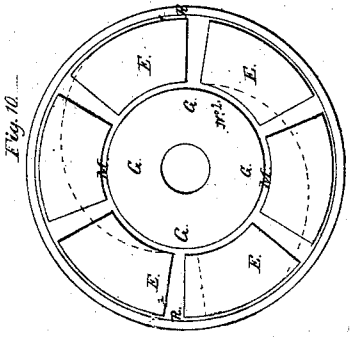

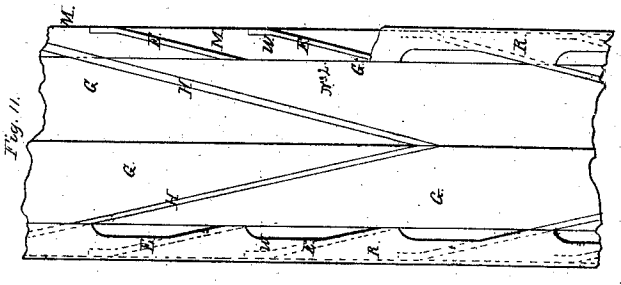

UNITED STATES PATENT OFFICE.

ABEL GREENLEAF, OF KINGSTON, PENNSYLVANIA.

IMPROVED WATER-WHEEL.

Specification forming part of Letters Patent No. **10,916**, dated May 16, 1854.

To all whom it may concern:

Be it known that I, ABEL GREENLEAF, of Kingston township, in the county of Luzerne and State of Pennsylvania, have invented certain new and useful Improvements in Gravity and Percussion Water-Power Machines; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, making part of this specification, and to the letters of reference marked thereon, in which—

Figure 1 is a longitudinal section of the machine, in which is shown a sketch of the center part of the hub or main body of the wheel and the inner or central part of the main buckets. Fig. 2 is a cross-section of Fig. 1 in the line *x x* and viewed in the direction of the dart, the wheel not being shown. Fig. 3 is a side view of the wheel and shaft removed from its place in the machine. Fig. 4 is a section of Fig. 3 in the line *x x* and viewed in the direction of the dart. Fig. 5 is an end view of Fig. 3. Fig. 6 is a portion of the hub or main body of the wheel with the buckets and rims removed. Figs. 7, 8, 9, 10, 11, 12, 13, 14, and 15 are all auxiliary drawings, showing some of the principles of this machine developed in different forms, Fig. 7 being a sectional side view of a portion of the machine, showing one of the forms of arranging the gate and throat to the same. Fig. 8 is a side view of the wheel in one of its forms. Fig. 9 is an end view of the same with part of the rim removed. Fig. 10 is an end view of the wheel in another of its forms. Fig. 11 is a sectional side view of Fig. 10 developed, having a portion of the rims R R removed. Fig. 12 is an end view of the center hub of the same, with the spiral floats or buckets H H attached. Fig. 13 is a side view of the center hub of the same. Fig. 15 is a side view of the wheel in another different form. Fig. 14 is an end view of the same, with a portion of the rim R R removed.

In describing my improvements in detail the same letters refer to the same parts of the machine in all the figures, excepting the letters *o*, which refer to different parts in the different figures.

A A represent the main body or sides of the machine forming a part of the water-guide around the wheel.

B B B is the main part of the scroll or water-guide around the wheel.

C C is a crooked lever or yoke, which connects the rings F F together and holds them in contact with the ends of the wheels.

D D are the pillow-blocks on which the wheel and shaft rest and turn.

E E E E are the main buckets of the wheel.

F F are rings for the ends of the wheels to run against.

G G G G is the main body or hub of the wheel. H H are spiral floats attached to the center part of the hub between the main buckets. L L is the shaft of the wheel.

K K is the gate combined with a portion of the scroll which surrounds the wheel.

X represents one of the water-guides to direct the water into the throat, one not being shown.

In order to enable others to make and use my invention, I now proceed to describe its construction and operation.

I make the sides A A of the machine of plank of suitable thickness, dressed true upon their inner sides and edges, and fasten them together by putting screw-bolts through them near their ends from top to bottom. The holes in which the rings F F are placed I make a little larger than the rings, so as to receive strips of leather around the rings, as shown at *f f f f*, Fig. 2, the outer edges of which are nailed fast in the openings around the rings. The inner edges act as valves to prevent the escape of water between the rings and the sides A A, and at the same time the rings are left free to move as required in adjusting them to the ends of the wheel. The rings F F, I usually make of cast-iron, in the form shown in the drawings, the use of which is to prevent a waste of the water between the ends of the wheel and the sides A A of the case. The crooked lever C C I make of wood or iron in the form shown, having the set-screws I I, passing through the ends of it into the opposite countersinks in the ears *g g* of the rings, by which means the rings are brought to and kept adjusted with and to the ends of the wheel. Any suitable number of these crooked levers I use for this purpose, although I have shown but one in the drawings. I have another method of connecting the rings F F together and adjusting them to the ends of the wheel, (not shown in

the drawings,) namely, by extending the ears *g g* of the rings long enough outward to allow long screw-bolts to pass outside of the staves B B B from one to the other and through the ears of both.

The gate K K, Fig. 1, I commonly make of wood in the form shown, the front side of the upper portion of it forming a part of the throat and the lower portion forming a part of the scroll. It is hung upon a long bolt passing through it at *v* and through the sides A A, between which it works. The upper portion of the gate is nicely fitted to the sides A A to prevent leakage of water between them. To prevent the escapement of water under the upper part of the gate, I nail a strip of leather through its edges to the stave immediately under the gate, as shown at *r r*. A recess shown at *s* is cut (and over which the leather is placed) with the openings shown at *l* leading into it, to allow water to pass from the penstock up under the leather and press it against the gate with sufficient force to prevent any water from passing between them. The lower portion of the gate I make a little narrower than the space in which it works to allow water to pass into the chamber behind it, (shown at *q*,) in order to neutralize the pressure of the water upon the front side of it, and thereby allowing it to work easily in opening and shutting, which is effected by a lever connected with the eye-bolt, as shown at *p*, and with the lever or arm of an ordinary roller or otherwise.

That part of the machine represented at B B B and extending from Y around to *s*, I make of staves of any suitable size for the purpose intended. Tenons (not shown) are made on both ends, corresponding in shape with the inner sides of them, which are made in such shape as to form the parts here represented when put in their places. The tenons upon the staves are inserted into corresponding grooves or mortises cut in the side pieces A A for the purpose. I put long screw-bolts (not shown) through holes in A A, Fig. 1, as represented by *o o o o o o o*, passing entirely through both of the sides A A, by which means the staves are held firmly in their places between them. The pillow-blocks D D I make of wood, in the form shown.

The wheel of this machine, as represented in Figs. 3, 4, 5, and 6, and which contains all the principles which are developed in the several different forms represented in the other accompanying drawings, I construct in the following manner: The shaft L L, I make of wood or iron, in the form shown or otherwise, of sufficient strength and size for the purpose intended, and provide it with gudgeons upon which it turns. The hub G G G G, I usually make of a solid piece of wood, through which the shaft passes and to which it is secured. The center part of the hub is in its section of a conical form, as represented at Z Z. The floats or flanges H H, I make broad at their outer ends and taper them nearly to a point at their inner ends, as represented in the drawings. They are fastened to the hub by screws or pins. They are made winding like the thread of a screw to suit the angular position in which they are placed upon the hub. The portions of the hub on which the buckets E E E E are attached are made in a spiral or wedge-like form, as shown at N N N N, by cutting away portions of the hub, as shown at *o o o o*, Figs. 4, 5, and 6. The buckets E E E E, I make in the form shown, they being cast separate, each with a section of the rims R R attached to it, the ends of which come together, as shown at P P P P. I make the outer surface of the inner edge of the buckets the arc of a circle, or nearly so, as shown at section in Fig. 4, from the ends at U U U U to V V V V, where the circular form suddenly stops or unites with the straight line which is represented at V I, V I, V I, and V I. This change of curvature and angles of the buckets I extend outward the entire breadth of them, varying in form as it passes through their concave parts until it reaches the outer edge of the buckets, where the plane or straight parts run parallel to and unite with the rims R R, as shown at W W, Fig. 3. The flanges Q Q, Figs. 3 and 4, are cast solid with the main buckets and form a part of them. The buckets E are fastened to the hub, which is made to fit their inner sides by screws, pins, or otherwise. Two pairs of the spiral floats H H are generally used, placed opposite each other upon the hub, and a corresponding number of flanges upon the main buckets to unite with them, as represented, although but one pair of each is shown in the drawings. The bands S S are made of wrought-iron, put on hot to hold the ends of the wheel firmly together and to form a surface to run against the rings F F, their outer sides being set true for the purpose.

In constructing the wheels I sometimes form the portion V I of a form slightly curved.

The wheels represented in Figs. 8, 9, 10, 11, 12, 13, 14, and 15 are various modifications of Figs. 3, 4, 5, and 6, but based upon the same general principles.

Fig. 7 is a modification of the combined gate, as shown in Fig. 1.

In attaching this machine to a penstock or flume I so place it as to cause the breast of the throat to come even with the bulk-head planking, as shown at Y, Fig. 1. The water-guides X, I make of plank, in the form shown, and fasten them to the planks Y and also to the sides A A of the machine, by nailing or otherwise. I use two of these guides—one on each side of the throat—although there is but one shown in the drawings. They serve to cause the water to enter the throat in a smooth solid stream from the penstock above it.

In constructing the wheels of this machine in the forms represented in Figs. 3, 8, and 15, it is my intention in some cases to dispense with

the broad hub and substitute in its place thin flanges connected with the inner sides of the buckets E E E E in their centers, which are in this case connected together in the center of the wheel. These flanges have others connected with the inner edge of them in such form and manner as to form a suitable hub to support the wheel upon the shaft, and in which case I intend sometimes to attach spiral wedge-like pieces to the sides of the flanges and the insides of the buckets, which are intended to act as substitutes for the spiral or angular surfaces (shown at *o o o o*, Figs. 4, 5, and 6) in facilitating the passing out of the water from the wheel, as hereinafter more fully explained.

When this machine is in operation, the water passes from the penstock through the throat into the scroll in the direction given to it by the throat in front of the gate until it reaches the wheel and presses against the angular surfaces of the buckets exposed to its direct action and causes the wheel to run in the same direction as the water with a velocity and power in proportion to the head of water acting above. The water, after having done its execution upon the wheel, passes through the openings between the buckets toward the shaft and passes out at the ends of the wheel.

In order to prevent as far as possible the objection arising from the reaction of the water escaping through the wheel upon the inner surfaces of the buckets by its centrifugal force, the ends of the wheel are enlarged, as shown in Figs. 3, 5, 14, and 15, by which means the water has a far more free and direct discharge than it would have if the enlargement was not made and the face sides of the buckets made to run parallel with the shaft their entire breadth.

The spiral or wedge form given to the portions of the hub (represented at *o o o o* in Figs. 4, 5, 6, 9, and 14) is intended and does serve to prevent in a considerable degree the reaction of the water upon the inner surfaces of the buckets by covering a portion of the same, and thereby preventing the water from coming in contact with it, and also by crowding against and urging the water out of the wheel. These preventations of reaction are very beneficial in starting the wheel from a state of rest when heavily loaded, in which case the tendency of the escaping water to react upon this kind of wheels is far greater than when they are in motion, as it takes a rapid circular backward motion through the wheel when in a state of rest. This tendency to reaction is greatest in cases where the head of water used is moderate, and the volume of water applied to the wheel large, and the wheel broad in proportion to its diameter.

The peculiar shape given to the portions of the main buckets, as represented at V I, V I, V I, V I, Figs. 4, 9, and 14, and also shown at W W, Figs. 3 and 11, is designed to and does cause an increase of pressure of water at and near those points, and by means of which the maximum velocity and power of the wheel is considerably increased, and which tends also to arrest more perfectly the forward motion of the water while acting directly upon the wheel, which otherwise would by its centrifugal force cause considerable reaction upon it to diminish its velocity while passing through and out of it.

The combined gate (represented at K K and hereinabove explained) serves to cause the water to flow in a solid smooth stream to the wheel, when the gate is but partially drawn as well as when it is entirely opened, and thereby preventing the formation of an eddy below the gate, as is usually the case where gates of the ordinary construction are used and only opened a part of the way, and which is of frequent occurrence in using these and similar machines.

The dotted line at *n* shows the position of the front side of the gate when shut. The one at *m* shows it when it is half-way drawn.

The operation of the spiral floats or flanges H H, combined with the conical form of the hub, is to receive the first action of the water striking against the center of the width of the wheel at its periphery before coming in contact with the buckets E E, whereby the force of the water is used to more advantage than when the spiral floats are used with a cylindrical hub, as by this form and combination no dead-water is carried round by that portion of the wheel. The rings F F, by being connected or yoked together by crooked levers and set-screws, as represented at *c c*, Figs. 1 and 2, (and above described,) independent of any fastening to the sides A A of the case are allowed to move freely with the wheel to suit themselves to any new position it may assume and thereby heavy friction and consequent loss of water between the rings and the ends of the wheel is in a great measure prevented. The connecting or yoking the rings together by means of long screw-bolts passing through the ears of both of them, as hereinabove set forth, is intended also to make the rings self-adjusting to the position of the ends of the wheel after being brought to their places and properly adjusted, and which in some cases produces about as favorable results in preventing friction and loss of water between the wheel and rings, as by using the crooked bars for the same purpose.

Having thus fully described the above machine for the purpose of illustration, I would have it expressly understood that I do not claim it in whole or in part as my original invention, excepting and reserving what is contained in the following claims, to which I limit myself; but

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

1. The combination of the gate with the scroll, substantially in the manner described, and for the purposes specified.

2. The recess *s* and the apertures *l*, leading thereto, in combination with the leather at *r r*, or its equivalent, substantially as described, and for the purpose specified.

3. The spiral or wedge like form given to the portions of the wheel, as represented at *o*, in combination with the buckets thereof, substantially as described, and for the purposes specified.

4. The tapering form given to the floats H, in combination with the double cone-like shape given to the portion of the hub to which they are attached, substantially as described, and for the purposes specified.

5. The change of curvature in the buckets at or near their ends, as shown at V I, arranged so that their ends shall not be overlapped by the ends of adjoining buckets, substantially as described, and for the purposes specified.

ABEL GREENLEAF.

Witnesses:
A. C. CHURCH,
JOHN JACKSON.