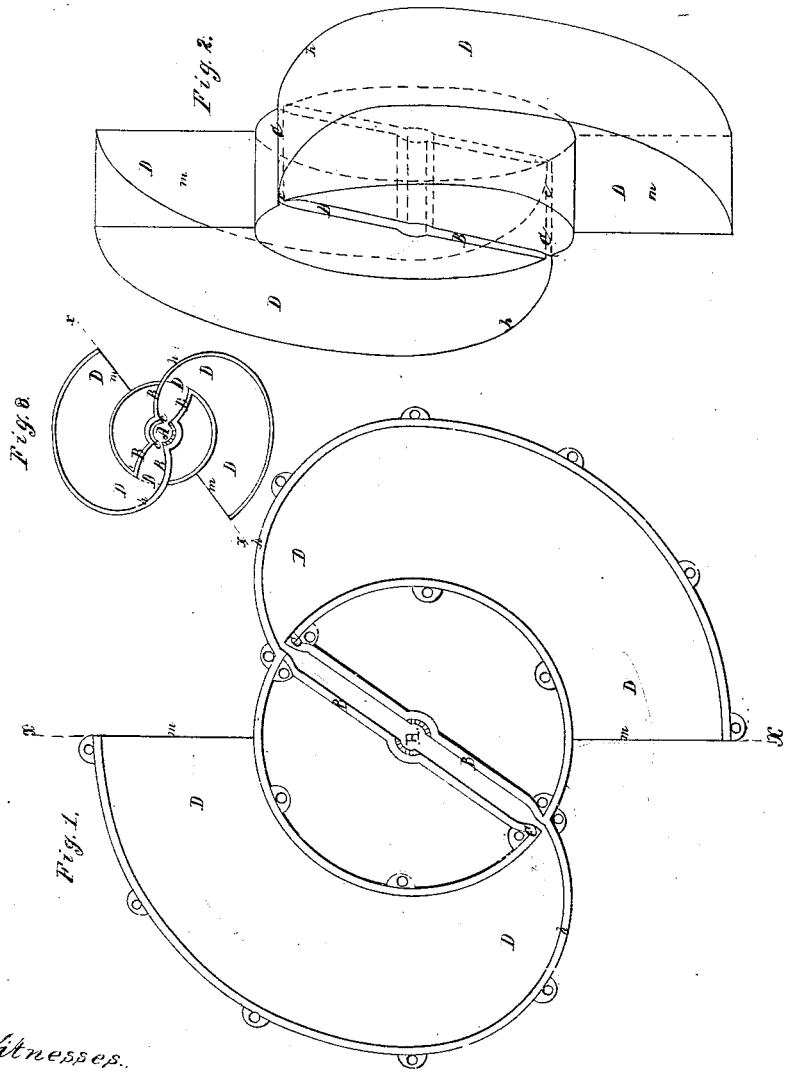
3 Sheets—Sheet 1.

F. E. MILLS.

REACTING ROTARY STEAM ENGINE.

No. 107,078. Patented Sept. 6, 1870.



Witnesses.

Louis Raoul Thiessen
Henry Kline

Inventor.

Frances E. Mills

3 Sheets—Sheet 2.

F. E. MILLS.

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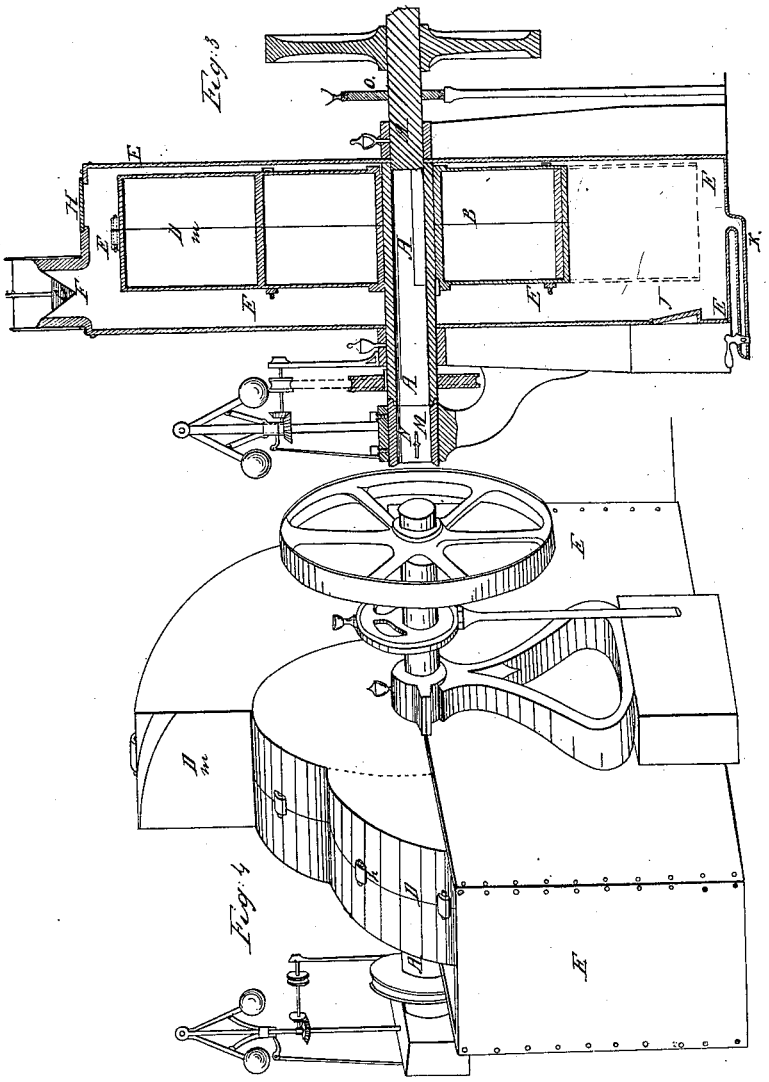

Witnesses.

Louis Raoul Thiessen
Henry Kleine

Inventor.

Francis E. Mills

3 Sheets—Sheet 3.

F. E. MILLS.

REACTING ROTARY STEAM ENGINE.

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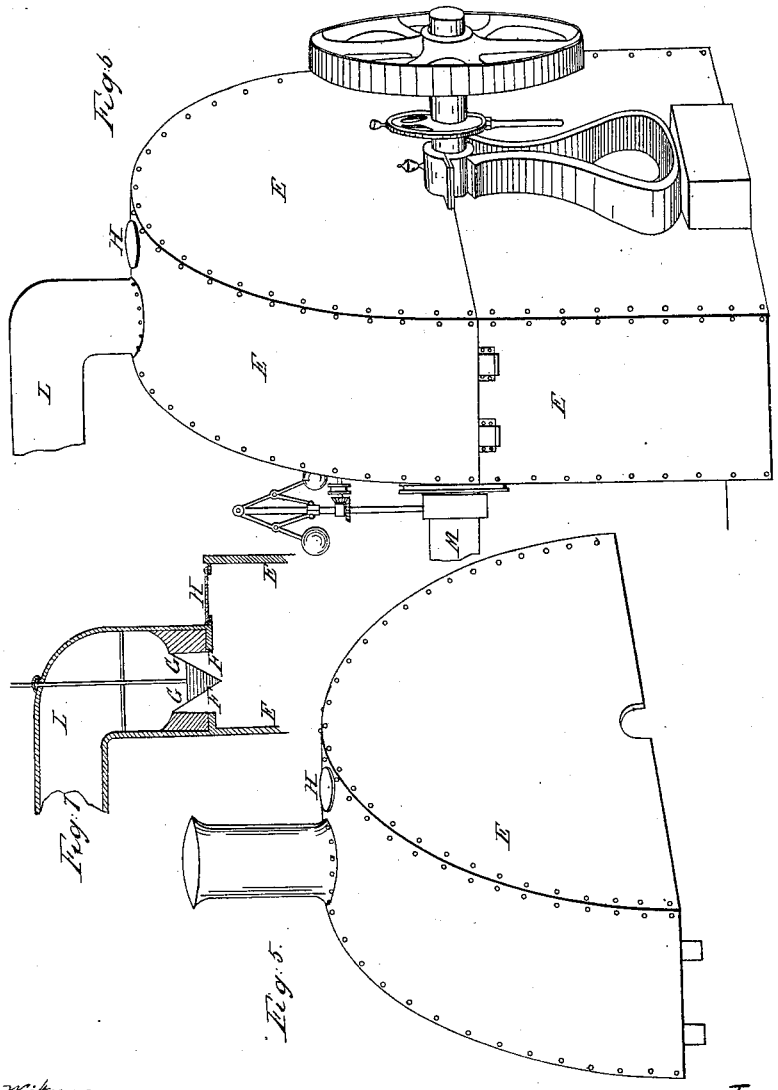

Witnesses
Louis Raoul Fliesser
Henry Kline.

Inventor.
Francis E. Mills

United States Patent Office.

FRANCIS E. MILLS, OF SAN FRANCISCO, CALIFORNIA.

Letters Patent No. 107,078, *dated September* 6, 1870; *antedated August* 26, 1870.

REACTION ROTARY STEAM-ENGINE.

The Schedule referred to in these Letters Patent and making part of the same

To all whom it may concern:

Be it known that I, FRANCIS E. MILLS, of the city and county of San Francisco in the State of California, have invented a new and useful Improvement in Reaction Engines, driven by steam or other elastic gas; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawing and to the letters of reference marked thereon.

The nature of my invention consists—

First, in providing reaction-wheels, driven by a current of steam or other elastic gas issuing against the atmosphere, with two broad expansion chambers, in which the column of hot and high-pressure steam issuing from two narrow throats, expands laterally, while still confined within the wheel, and rushes against the atmosphere or other surrounding medium in a broad volume at low pressure, reacting against an equally broad area of the chamber-head; thus utilizing the power evolved in the expansion of the steam, and enabling the movement of the wheel to be made as slow and powerful as desired.

Second, avoiding the loss of power resulting from the condensation of the issuing steam by contact with the atmosphere, and securing the constant presence of an efficient resisting medium for the steam to act against, by inclosing the working-wheel in a drum or case, furnished with an adjustable gate or port, through which the expanded steam inside is allowed to escape no faster than it is driven out by a pressure a little exceeding that of the atmosphere.

Third, giving such a direction to the current of hot steam, relative to the head of the chamber, as to render effective whatever force there may be in its impact.

Principles and Mode of Operation.

In all reaction steam-wheels known to me, the hot steam leaves the wheel by spouting, with great velocity, against the external atmosphere, through two or more small orifices or tubes.

Now, if we suppose the hot steam issuing from the orifice to have a pressure of forty-five pounds to the square inch, the atmosphere being incapable of offering a resistance exceeding fifteen pounds, two-thirds of the force of the steam is entirely wasted in boring unresisted through the atmosphere, and, in order to render effective the remaining third, the wheel must be driven with such velocity, approaching that of the issuing jet, as to unfit the engine for most work; whereas, if the dense steam, on issuing from the orifice or throat, were permitted to expand laterally in the broad chambers D D while still confined to the wheel, until its pressure should but little exceed that of the atmosphere, and then in its exit blow against a broad transverse section of the external air, and react against a corresponding broad area of the chamber-head, nearly the whole power of the steam would be rendered effective in the propulsion of the wheel, and its movement could be made slow, as desired, by simply increasing the transverse area of the chambers relative to the throats. This presupposes, however, that the force of the steam is not impaired by contact with the external air, before it has done its work. But, the condensation of the steam by such contact produces a constant partial vacuum between the issuing steam and the resisting atmosphere, which greatly abates the elastic energy of the former, and the effective resistance of the latter; and it is to avoid this crippling effect of driving the steam directly against the air, that I substitute a resisting medium of steam for that of the atmosphere. This I do by enclosing the working-wheel in a steam-tight drum, with an adjustable escape-port, so gauged as to keep the same always full of the expanded steam, exerting a resisting pressure equal to one atmosphere.

The working-steam, then, expanding in the chambers, is resisted by the elastic pressure of the steam in the drum, and reacting against the broad head of the chambers, drives the wheel in the opposite direction. Thus I have steam working expansively against steam under nearly the same conditions as in the modern piston engine, without its great cost and complication, and, I think, without its percentage of waste.

Mode of Construction.

The general form of the invention and of all its parts will be apparent from the accompanying drawing, which is a part of this specification, and in which—

Figure 1 is an inside view of the casting, making one-half of the wheel vertical section, cut at right angles with the shaft.

Figure 2 is a skeleton view of the wheel without the shaft.

Figure 3 is a vertical section of the wheel and pressure-drum, in position, the wheel being taken in the plane of the line X X, fig. 1.

Figure 4 is a perspective elevation of the wheel resting on its bearings in the lower half of the pressure-drum, the upper half of the drum being removed, as shown at fig. 5.

Figure 6 is a perspective elevation of the engine, with the drum closed and ready for work.

Figure 7 is a detail view, showing the gauge-valve.

Figure 8 is a view like fig. 1, showing alternative form of the guide-arms, for a wheel of slow motion, the throats being at the center.

A is the shaft of the wheel, hollow at the port end.

B, the hollow radial arms, leading from the center to the throats.

C, the throats, through which the hot steam enters the expansion chambers.

D, the expansion chambers, *h* the head, and *m* the mouth of chambers.

E, the pressure-drum, inclosing the chambers.

F, the adjustable escape-port, regulating the escape and pressure of the steam in the drum.

G, the gauge-valve, regulating the area of the opening in the port.

H, the indicator-valve, to lift on the pressure exceeding the proper limit.

I, the air-valve, opening inside the drum, to prevent collapse.

K, the water-cock, to draw off the water condensing inside the drum.

L, the waste-pipe, conveying off the escaped steam to heat the feed-water.

M, the main steam-pipe, leading from the boiler to the center of wheel.

N, the throttle-valve, operated by a governor or otherwise.

O, the eccentric, to drive the feed-pump.

Similar letters of reference indicate like parts.

The steam is admitted in one end of the hollow shaft A, and conducted by the two opposite hollow arms or channels B to the two throats C. These throats are simply a narrowing down of the steam-passages in the arms to such small dimensions that only so much steam can pass through them under a given pressure from the boiler, as it is desired to use; and the absolute area of the throats will depend upon what power the engine is designed to yield, and the pressure of steam to be used.

The size of the throats will be, of course, inversely as the pressure of steam, and directly as the power required.

These throats, respectively, open into the head of the expansion chambers D, the general form and position of which are shown in figs. 1, 2, 3, and 4, in the accompanying drawing.

On the size of these chambers, in their transverse section, depends the power with which the wheel will move, as well as its velocity, under a given pressure and quantity of steam, the power being directly, and the velocity inversely to the area of their cross-section at the widest point; precisely what proportions should exist between the areas of the chamber-head and throat, in order to yield the best effect, will depend mainly on the velocity it is intended to give the wheel, and the amount of load to be moved.

With the escape-port properly gauged, I think I can calculate on an effective reacting resistance of at least ten pounds per square inch of chamber-head, and something for the direct impulse of the hot steam as it rushes from the throats; for it will be seen that I give the head of the chamber, *h*, such an angle relative to the radial arms B that whatever force there may be in such impact is made effective in the propulsion of the wheel.

If desired, the throats may be made adjustable by fixing a sliding key in the back of each, in order that the proportions between the areas of the throats and chambers may be varied to suit different requirements of the same engine.

I make the entire wheel, including the radial arms B, the throats C, and the expansion chambers D, of cast iron, casting it in two corresponding parts, cut transversely to the axis, the walls of the steam passages being raised or projected from the side plates in the form of flanges, as shown in fig. 1.

The edges of these flanges having been brought to one true plane, the two corresponding parts are bolted strongly together, and made steam-tight.

Pressure Drum.

In most cases where steam is used as the motor, I make the pressure-drum in the form of a separate case, inclosing the entire wheel, the shaft of the wheel passing through it, as shown at E E, figs. 3, 4, and 6. It is cut horizontally, in two equal parts, the lower half being made strong and heavy, sustains the horizontal shaft of the wheel, the upper half may be made of thick sheet iron, and should be covered with felt.

This upper half may be hung on strong hinges, so as to be readily opened and closed, or it may be made to lift off entirely, and when closed fastened with hooks or clamps.

The corresponding edges of the two parts should be lined with soft leather, or other packing, to make the joint tight.

In the top of this drum I cut an opening, large enough to allow all the steam which may be driven through the throats of the wheel to escape under a pressure slightly exceeding one atmosphere, allowance being made for leakage, and the condensation and liquifaction of a portion of the steam by cooling, &c.

To this escape-port I attach a valve, by which its size may be always so adjusted and limited that no air can enter to condense the steam, and the steam be allowed to escape no faster than just sufficient to prevent the pressure inside from much exceeding that assigned limit.

If the pressure of hot steam passing through the throats of the wheel were always unform, and the temperature of the atmosphere surrounding the drum always uniform, the size of this escape-port could be calculated, and then remain fixed; but owing to the variations in these conditions, it should be made adjustable, for if too small steam will accumulate in the drum, and escape at too high a pressure, occasioning a loss of power as well as endangering the bursting of the drum; if too large, the vacuum of condensation will diminish the elastic resistance inside.

This escape-port may be adjusted by hand, on the state of the pressure being made known by an indicator-valve, H, and the air-valve I, but it is better to make it self-regulating by the funnel-shaped gauge-valve G, shown in figs. 3 and 7; this gauge-valve being so lightly weighted, and guided by a spindle, as to open on the pressure slightly exceeding the surrounding atmosphere, but opening only so much as necessary to allow all the steam to escape under that pressure.

I make an opening in one side of the pressure-drum, covered with a flap-valve, hinged on its upper edge, and opening inside, I, fig. 3. This air-valve is to prevent a collapse of the drum from the condensation, when the engine is stopped, as well as to assist in ascertaining the state of the pressure inside.

In the bottom of the pressure-drum I make an aperture, closed with a stop-cock, K, for drawing off the water which may collect in the drum, from the condensation of the steam.

The expanded steam, escaping through the port, may be conducted off through the waste-pipe L, fig. 6, and used to heat the feed-water for the boiler.

In the main steam pipe, *m*, leading from the boiler to the center of the wheel I construct a valve, N, similar to the throttle-valve of the ordinary piston-engine, to regulate the supply of steam to the wheel,

and equalize its movement, this valve being operated by the ordinary governor, or its equivalent.

Alternative Form of the Arms and Throats.

In cases where the motion of the wheel is desired to be quite slow, I place the throats at or near the center of the wheel, and allow the arms, while still retaining their radial position, to open from the throats into the reaction heads of the chambers, substantially in the form shown at B, fig. 8.

Claims.

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

1. In a reaction-wheel, driven by steam or other elastic gas, rushing against the atmosphere or other surrounding medium, the expansion-chambers D D, in combination with the throats C, substantially as and for the purpose described.

2. In combination with a reaction-wheel, driven by steam or other elastic gas, the pressure-drum E E, with the adjustable escape-port F, and the water-cock K, substantially as and for the purposes described.

FRANCIS E. MILLS.

Witnesses:

LOUIS RAOUL THIESSEN,

HENRY KLEINE.