No. 668,766. Patented Feb. 26, 1901.

F. L. BICKEL.

STEAM TRAP.

(Application filed Apr. 5, 1900.)

(No Model.)

FIG. 1.

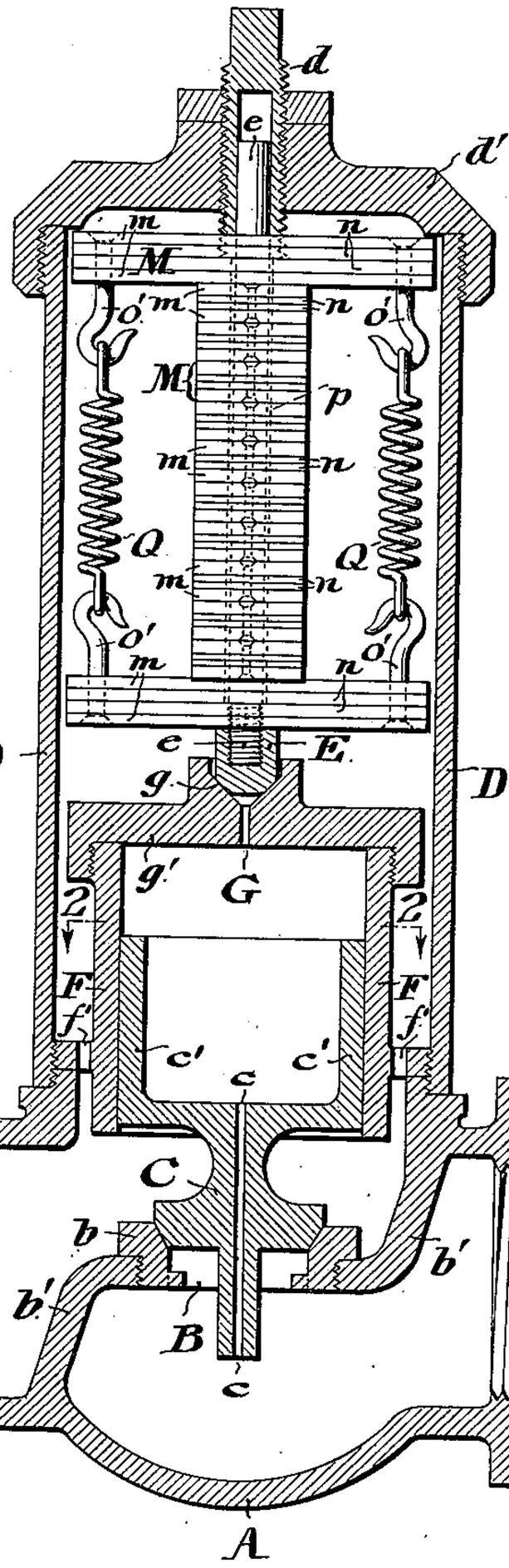


FIG. 2.

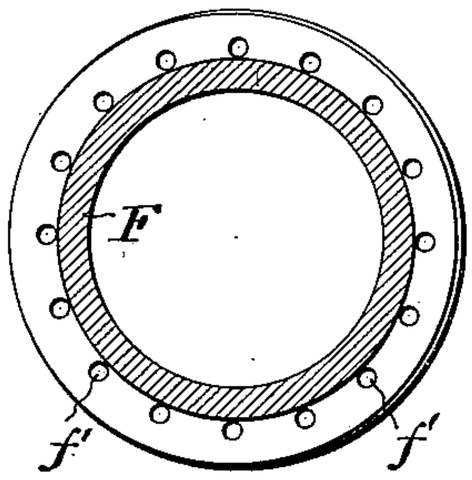


FIG. 3.

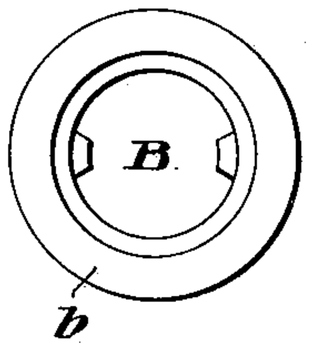


FIG. 4.

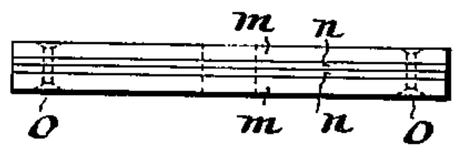
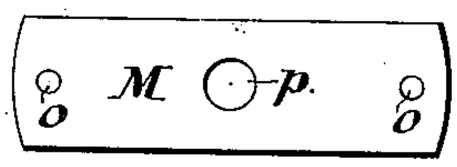


FIG. 5.



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STEAM-TRAP.

SPECIFICATION forming part of Letters Patent No. 668,766, dated February 26, 1901.

Application filed April 5, 1900. Serial No. 11,578. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK L. BICKEL, a citizen of the United States, residing at No. 1348 Palmer street, in the city of Philadelphia, in the State of Pennsylvania, have invented certain new and useful Improvements in Steam-Traps, of which the following is a specification, reference being had to the accompanying drawings.

In the accompanying drawings, Figure 1 represents a vertical central section through the steam-trap. Fig. 2 is a horizontal section through the line 2 2, Fig. 1. Fig. 3 is a horizontal plan of the valve-seat *b*, Fig. 1. Figs. 4 and 5 are respectively an elevation and plan of one pair of thermostatic couples, of which a series is seen in Fig. 1.

A is a short pipe-section which has a valve-aperture B formed in the horizontal valve-seat *b*, which is inserted in the diagonal diaphragm *b'*. Upon this valve-seat rests the valve C. Attached to the pipe-section A and immediately over this valve is a metal dome D, preferably of iron or some other metal less expansible than brass, the center of the dome being directly over the center of the valve. Through the center of the top *d'* of the dome passes an adjusting-screw *d*.

e is a perpendicular valve-stem, the upper end of which is centered by and slides freely within the lower end of the adjusting-screw *d*, which is hollowed out to receive it. The lower end of this valve-stem *e* carries the secondary valve E, which rests within the valve-seat *g*. This valve-seat is formed above the aperture G in the head *g'* of a fixed cylinder F, which is held concentrically within and united to the dome D by the annular web-plate *f*, through which are pierced a number of apertures *f'*. The main valve C has formed upon the top of it a piston *c'*, which slides within the cylinder F. The valve C and piston *c'* are both pierced centrally by the small aperture *c*.

The thermostatic element by which the valve is controlled consists of a series of thermostatic couples united in pairs, a single pair being illustrated in Figs. 4 and 5. Each thermostatic couple consists of an iron and brass plate united together. This may most conveniently be accomplished by taking a larger iron plate, forming a rim around the edge, and heating it sufficiently to melt a quantity of brass placed upon the top of it, which upon melting will diffuse itself over the plate and upon cooling will have become firmly united to it. From this compound plate the thermostatic couples M are cut in the shape seen in Fig. 5. They are then united in pairs, as seen in Fig. 4, by loosely riveting two of them together with rivets *o* near either end. In each such pair the brass sides *m* of the couples are outermost and the iron sides *n* innermost. Through the entire series of couples passes a large aperture *p*, by which the entire series is strung upon the valve-stem *e*. The uppermost couple of the series has a screw-thread cut around the aperture *p*, by which it is attached to the lower end of the adjusting-screw *d*. The lowermost couple of the series has a screw-thread cut in it, by which it is attached to the valve-stem *e* near its lower end. The upper and lower pairs of the series have their lengths at right angles to that of the intermediate pairs of the series, and their rivets *o* are prolonged into hooks *o'*, which are united by the spiral springs Q, the tension of which maintains constantly the valve E at as great a height as the thickness of the series of thermostatic couples will allow. The thermostatic action of this series depends upon the bowing effect, which a comparatively slight rise of temperature has on each couple of the series. The greater expansibility of brass than iron causes each couple under the influence of heat to become concave on the iron side, so that each pair of couples with the iron side innermost takes the shape of a bow-spring. By making the number of these pairs comparatively numerous (twelve being shown in the series strung upon the valve-stem *e*, Fig. 1) the combined action of the bowing of the entire series drives the end of the valve-stem *e*, with the valve E, downward a very substantial distance against the action of the springs Q Q, the exact extent of this depression being adjusted by the adjusting-screw *d*. It is obvious that other thermostatic elements may be used for the purpose of actuating the secondary valve E.

The operation of my valve is as follows: At normal temperature the series of thermostatic couples M, strung upon the valve-stem *e*, permits the springs Q to raise the secondary

valve E quite free of its seat *g*. Under these circumstances any water passing through the pipe-section A is free by its own pressure to unseat the valve C and flow through the section. If any water, instead of passing through the valve-opening B, passes up through the small aperture *c* into the cylinder F, it finds opportunity for escape through the aperture G in the head of the cylinder, which is equal to or larger than the aperture *c*, and after escaping through the valve E the water can freely flow down around the outside of the cylinder and through the apertures *f'*, and thus pass through the pipe-section. If, however, steam instead of water begins to pass through the pipe-section, some of it will immediately rise to the top of the dome D either by way of apertures *c* and *g* or by way of the apertures *f'*. At the temperature of steam the thermostatic series near the top of the valve immediately expands sufficiently to drive the valve-stem *e*, and with it the secondary valve E, firmly down upon its seat *g*, thus closing the aperture G. As soon as this occurs the steam passing through the aperture *c*, finding an avenue of escape from the cylinder F, drives the piston *c* down, so as to force the main valve C firmly down upon its seat *d*, this action taking place by reason of the fact that the interior diameter of the cylinder F is greater than that of the aperture B of the valve, so that the pressure above the valve C, forcing it downward, is necessarily greater than the pressure below forcing it up. As long as steam is present this closure of the valve will continue; but as soon as nothing but water is present the steam in the dome will condense and by its cooling contract the thermostatic series sufficiently to open the valve E and allow the water to unseat the valve C and pass freely through.

Having thus described my invention, I claim—

1. In a steam-trap, the combination of the main valve; a piston connected therewith sliding in a fixed cylinder of larger internal diameter than the aperture of the main valve; a secondary-valve aperture in the cylinder; a secondary thermostatically-operated valve controlling this latter aperture and closing it at the temperature of steam; and a constantly free connection not substantially larger than the secondary-valve aperture between the interior of the cylinder and the pressure side of the main valve, substantially as described.

2. In a steam-trap, the combination of the main valve; a piston connected therewith sliding in a fixed cylinder of larger internal diameter than the aperture of the main valve; a secondary-valve aperture in the cylinder; a secondary thermostatically-operated valve controlling this latter aperture and closing it at the temperature of steam; and a constantly free aperture passing through the main valve and piston into the cylinder and not substantially larger than the secondary-valve aperture, substantially as described.

3. In a steam-trap, a thermostatic valve consisting of a valve aperture; the valve; and thermostatic means for controlling the action of the valve, said means consisting of a valve-stem which depresses, against the opposition of a spring, the valve into its seat by the expansion at steam heat of a coördinated series of expansible metallic couples strung upon the valve-stem, each couple consisting of two metallic plates loosely united at their extremities and each plate consisting of two metals of differing coefficients of expansion united at their proximate surfaces, substantially as described.

4. In a steam-trap, the combination of the main valve; a piston connected therewith sliding in a fixed cylinder of larger internal diameter than the aperture of the main valve; a secondary-valve aperture in this cylinder controlled by a valve; means for seating and unseating this secondary valve, consisting of one or more thermostatic couples each of which consists of two bimetallic plates loosely united at their extremities, each of said plates consisting of two metals of differing coefficients of expansion united at their proximate surfaces; and a constantly free connection not substantially larger than the secondary-valve aperture between the interior of the cylinder and the pressure of the main valve, substantially as described.

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