T. C. HOPPER.

Jet-Photometers

No. 157,471. Patented Dec. 8, 1874.

Fig. 1.

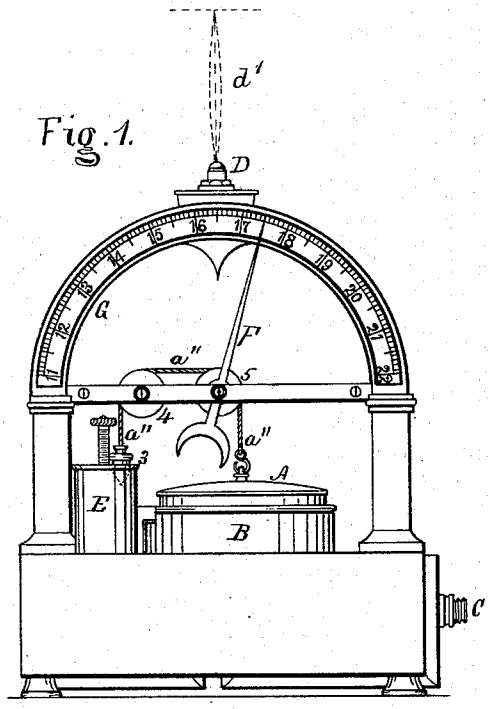
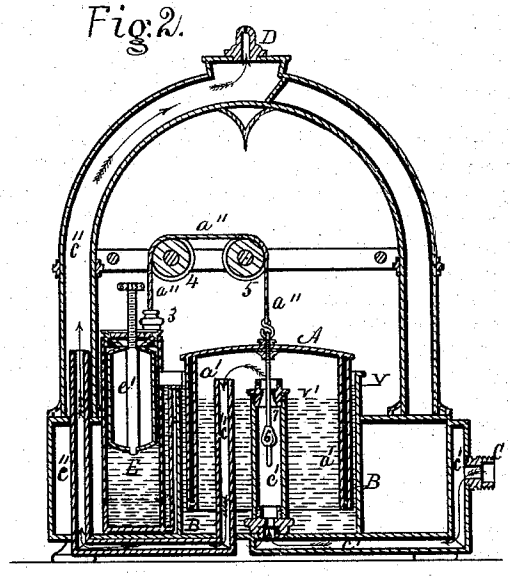


Fig. 2.



Witnesses:

Benj. Morison

Wm. H. Morison.

Inventor:

Thomas C. Hopper.

THE GRAPHIC CO. PHOTO-LITH. 39 & 41 PARK PLACE, N.Y.

UNITED STATES PATENT OFFICE

THOMAS C. HOPPER, OF PHILADELPHIA, PENNSYLVANIA.

IMPROVEMENT IN JET-PHOTOMETERS.

Specification forming part of Letters Patent No. **157,471**, dated December 8, 1874; application filed November 25, 1873.

To all whom it may concern:

Be it known that I, THOMAS C. HOPPER, of the city of Philadelphia, in the State of Pennsylvania, have invented an Improved Photometer, of which the following is a specification:

The jet-photometer, it is well known, is used to determine, approximately, the illuminating value in sperm candles, of coal-gas, and other hydrocarbon gases, by burning the same while being forced through an orifice of specific area by a pressure varying from four-tenths to seven-tenths of an inch, the height of the jet-flame being adjusted exactly to seven inches.

In order to present, in the most clear and unmistakable manner, the nature and objects of my invention, it will be proper, in the first place, to explain briefly the general construction and functions of the jet-photometers now in general use.

Those known as "Lowe's jet-photometers, with Kirkham & Sugg's improvements," are each constructed with a rectangular water-box, which forms a gas-tight supporting-base of the instrument, in which the required water-line surface is produced and maintained by a communicating outside water-tank containing a plunger, having a screw-stem attached, so that the plunger can be operated by hand to raise and lower the surface of the water in said box or base, and finally hold the said surface-line at the required height below the gas-space in said box. The gas to be tested is introduced and regulated in its flow into and through the space above the water-surface by means of a micrometrical cock in the supply-pipe, and passes upward through two hollow columns, and a hollow arch supported thereon, and escapes vertically upward through a burner, having a specific orifice, which is fixed in the crown of the arch, so that when the jet is iguited a slender flame exactly seven inches in length can be readily obtained by adjusting the cock ascendingly. On the face of the semicircular arch there is fixed a pressure-scale, co-extensive in its length with the face of the arch, which scale is spaced and numbered in tenths from 0 at the left to 15 at the right hand ends. Near the midlength of a tie-bar, which connects with and holds the columns and arch steadily and firmly in position upon the base, there is a very small grooved pulley, arranged to rotate as freely as possible, its axis rolling on the perimeters of a pair of large friction-wheels, the axes of which rotate in bearings in the bar which supports them. Fixed to the front end of the axis of the small grooved pulley an index-bar is arranged, the upper end of which reaches and traverses over the face of the said pressure-scale, generally about three-tenths, or from four-tenths or forty-one hundredth to seven-tenths or seventy-one hundredths, according to the divisions on the scale, which is about the extent of range required in the pressure-scale; and hence the spaces and numbers outside of said range are useless. Directly beneath the small pulley which carries the index-bar there is fixed, in a gas-tight manner, through the top of the water-box or base, an open well-tube, the lower end of which extends down perpendicularly through the water nearly to the bottom of the box, and is thus sealed thereby against any escape of gas through the well. Within this well a float rests freely on the water, and is attached to the lower end of a slender cord, which passes in contact with the groove in the index-bar pulley to a small weight attached to that end of the cord, so that as the float is moved up and down by the rise and fall of the water in the well, caused by the varying pressure of the gas upon the surface of the water outside of the said well, the point of the index-bar moves over the spaces between four-tenths and seven-tenths, as marked on the pressure-scale; and, as all the work done by a jet-photometer is between forty-one hundreths and seventy-one hundreths of an inch, to enable the attendant or examiner to find the candle-power from 22 to 11, all the spaces and numbers at each end of the four-tenths and seventy-one hundreths of an inch on the said pressure-scale are superflous.

The operation of said Lowe's photometer as improved by Kirkham & Sugg, just described, is as follows, viz: The gas entering the water-box under a pressure of, say, forty-one hundredths of an inch, indicated on the pressure-

scale, the jet-flame being exactly seven inches high, it will be found, on examining and comparing with a chart, which must be referred to for the purpose, that the candle-power of the gas is equal to twenty-two candles. Now, if the pressure be seventy-one hundredths of an inch, the float in the well will rise three-tenths of an inch higher only, in which case the candle-power will be found to be eleven candles. Now, from the slightest friction (and there must be enough to move the index-bar) the water must first rise around the float in the well a sufficient distance to overcome said friction before the said float can move upward, and so, if it is up sufficiently to indicate seventy-one hundredths pressure on the scale, the slightest friction about the index-bar and its pulley will not allow the float to immediately follow the water as it recedes under a weaker pressure; and hence, if the pressure-scale be largely increased in correspondence with a greatly-lengthened index-bar, there will be always the same erroneous indications of pressure, whether the latter be increased or diminished.

One of the chief objections to Lowe's photometer, as improved by Kirkham and Sugg, just described, consists in the necessity of referring to a separate chart to find the candle-power of the particular pressure on the gas indicated by the pressure-scale; and this objection has been obviated by Mr. Goodwin, of this city, by the combination, with the said pressure-scale, of a candle-power scale, about equal in length to the chord of the usual arched pressure-scale, the candle-powers corresponding with the respective pressures indicated from four-tenths to seventy-one hundredths of an inch on the pressure-scale, being spread out along the whole length of his candle-power scale, and, respectively, indicated by guiding-lines between the two scales. Although this invention is very meritorious, as it dispenses with the objectionable reference to a separate chart, it is objectionable, in that it requires a little delay and close observation in following the particular line connecting the pressure with the candle-power.

The object of my invention is, first, to do away with the pressure-scale entirely by constructing and securing in its place a candle-power scale of the same length, spaced and numbered from end to end, or from 11 on the left to 22 on the right hand ends of the scale, thus showing plainly, on the slightest observation of any person, the number and fractions of the candle-power of the gas, pointed to by an index-bar, operated as will hereinafter be described; second, to give motion to the pointing end of the index-bar over the whole face of the candle-scale, or from 11 to 22, and vice versa, in such a manner as to cause it to respond instantly to any variations in the pressure of the gas; and this I accomplish by the construction and arrangement of a gas-holder, in communication with the water in a well, and connected by a weighted cord with an enlarged pulley fixed to the index-bar, as will be more fully described hereinafter.

Referring to the drawings, Figure 1 is a front elevation of my improved photometer; and Fig. 2, a vertical section of the same, illustrative of the interior construction of several parts.

A is the holder or gasometer, with the float a' attached; B, the tank for the holder; C, the inlet for the gas; c' c' c', the conduit-pipes, which discharge the gas into the holder; c'' c'' c'', the pipes which convey the gas to the tip D, from which the seven-inch flame d' starts. (See dotted lines, Fig. 1.) V', the variable water-line of the gasometer, (dotted line.) E is a water-tank, with a movable plunger, e', for supplying and adjusting the water-line V of the tank B. a'' is a cord from which the holder A and a counterweight, 3, are suspended from grooved pulleys 4 and 5, and thereby motion given to the index-bar F, and G is the candle-scale. The float a' is a closed annular space, forming the side wall of the holder A, which latter is closed at top and open at bottom, forming within the inner circumference of the float a' a space, c, the area of the closed upper end of which is about eight times the area of the lower end of the annular float, thus giving an area for the upward pressure of the gas, whereby the lifting-power of the gas will be about eight times that of the area of the bottom of the float a', and hence with every one-tenth of pressure the holder, with the float attached, will rise nearly eight-tenths of an inch, or in other words, the holder will rise two and a quarter inches for every three-tenths of an inch of actual pressure.

The holder and the attached float are made of thin sheet metal, and as the float rises and falls in the water of the tank B the water-line within the holder falls and rises accordingly, under the pressure of the gas, without causing any variation in the water-line outside of said holder and float. For the purpose of preventing the same from rising clear of the water, a conical stopper, 6, is suspended by a cord or its equivalent from the top of the holder so as to hang freely within the vertical part of the gas-pipe c' within the holder, the upper end of the said pipe having within it a conical opening, 7, corresponding with the taper of the stopper 6, and the distance between the said opening 7 and the stopper 6 being adjusted so that the holder will be prevented from rising clear of the water by the stopper entering the conical opening, and thus shutting off the flow of the gas into the said holder.

The proper water-line V in the tank B is obtained by means of a supply-tank, E, which has a spout communicating with the tank B at the proper water-line V, and a plunger, e',

which can be raised and lowered by means of a screw-stem which rotates in a cap on the top of the tank, so that when the plunger *e'* is screwed downward the contained water overflows at the spout into the tank B until the water-line V is obtained, when the plunger *e'* is to be raised and the surplus water allowed to return into the supply-tank E. The gas, entering at C, passes through the pipe *c'* into the holder A, causing the latter to rise or fall in accordance with any variable pressure that may be given. The gas, continuing to flow, passes through the pipe *c''* and out through the tip D, where, being ignited, the desired seven-inch flame is produced and maintained in the usual manner.

Now, as the maintaining of any required candle-power in the gas being produced at the works is of the highest importance to the superintendent and workmen, it is equally important that the said power be readily and quickly seen or known, irrespectively of the pressure.

To afford the means for such information I dispense with the usual pressure-scale and occupy the space therefor, which is a semicircular arch spanning the whole front of the photometer, with a candle-power scale, G, consisting of eleven equal spaces, subdivided each into ten equal spaces, and the eleven first-named spaces numbered from left to right, from 11 to 22 inclusive, as shown in Fig. 1.

The index-bar F being rigidly fixed to the journal of the spirally-grooved pulley 5, and the cord *a''* passing—say, twice—around in the said groove to prevent its slipping, the limited rise and fall of the holder A will carry the point of the index-bar F alternately from one end to the other of the said scale G, and within those two limits of the scale any candle-power of the gas passing through the photometer under a pressure that will support the seven-inch flame *d'* will be clearly and readily seen on the slightest inspection, (see Fig. 1,) thus avoiding both the complications of a pressure-scale with a candle-scale, and the usual resort to a separate chart in order to ascertain the candle-power of the gas passing through the photometer.

The holder is so constructed, after the manner hereinbefore described, that it will not lift until four-tenths pressure is acting under it. It then rises, say to forty-one hundredths of an inch, and shows twenty-two candles. The pressure being then increased, say to seventy-one hundredths of an inch, the index-bar will show eleven candles, and all numbers of candles between 11 and 22 will be so shown. At a pressure of seventy-two hundredths the stopper 6 closes the opening 7 and shuts off the gas. The holder acts also as a governor, and the usual two dry-governors heretofore used in connection with a photometer can be dispensed with by the use of one ordinary cock and one micrometrical cock, if the same be desired. (These cocks not shown.)

The accuracy of the whole instrument must be determined by the jet-flame *d'* being exactly seven inches high. Now, if the flame be too high, the micrometrical cock must be slightly closed to reduce the pressure, and in doing so the holder A falls and causes the index-bar to point to the candle-power. On the other hand, if the jet-flame is too low, the micrometrical cock must be opened a little to admit more gas, or to increase the pressure, and immediately the holder will rise and the index-bar point to the candle-power on the scale G. This immediate action is due to the fact that the gas which supports the seven-inch jet-flame is taken directly from under the holder A, which is effected instantly by the slightest variation in the pressure, and, consequently, the index-bar answers at once, and, being lengthy, affords the wide spaces between the divisions and subdivisions on the scale G, whereby the precise candle-power of the gas can at any moment be distinctly seen.

The mode of filling, to obtain the true water-line in the tank, is somewhat different from the ordinary mode, as in this photometer the holder A does not begin to move until a pressure of four-tenths is under it, which causes the water between the holder A and the tank B to rise four-tenths of an inch, and immediately after this rise of the water the holder commences to rise; and hence it is necessary to regulate the water-line V just at the time the said holder begins to rise, and this is quickly and accurately done by means of the plunger *e'* in the water-tank E, as before described herein.

It being a very nice operation to get the two cylinders which form the float *a'* of the holder A exactly to size, and on which so much depends (in this photometer) the range of the holder, I contemplate changing the size of either the inlet or the outlet pipes, so as to increase or decrease the rise and fall of the holder A under any desired pressure, instead of the more difficult adjustment of the relative sizes of the said two cylinders of the float.

It will be understood that as the holder rises the water inside of the same falls to fill the space vacated by the float, and that, therefore, the proportions of the area of water-surface and float-surface have an intimate relationship to each other; and, hence, the larger the pipes in the water the less will be the actual water-surface, and, therefore, the water must recede farther in order to fill up the space previously occupied by the float. The consequence is, the holder does not rise quite so high for the same pressure, and, therefore, a shorter range is obtained, and by lessening the size of the said pipes a longer or more extended range is obtained.

As a modification of the float, in its connection with the holder, the former may be a closed hollow cylinder, fixed vertically in the center of the under side of the top of the holder, thus leaving the side walls of the holder to be only of a single thickness of the sheet metal, the relative proportions of their area being the same as in the mode of construction first shown and described; but, as this latter mode interferes somewhat with the position of the central tube or pipe for the inlet of the gas, I prefer the mode of construction first set forth herein.

In regard to the proportions hereinbefore named of the areas of the top of the holder and the bottom of the float in relation to each other, I do not intend to confine them strictly to said proportions—*i. e.*, 8 to 1—because they may be varied indefinitely, as the range desired may require.

I claim as my invention—

1. The combination, in a jet-photometer, substantially as described, of a well or tank, B, and holder A, constructed substantially as described, with the enlarged pulley 5 of the index-bar F, for the purposes specified.

2. In a jet-photometer, the combination consisting of the tank B and holder A, the gas-jet D, the index-bar F, and the arched candle-power scale G, the said devices being constructed and arranged to co-operate in the manner and for the purpose hereinbefore set forth and described.

THOMAS C. HOPPER.

Witnesses:

BENJ. MORISON,
WM. H. MORISON.