**Specification of Joseph Knowles Broadbent : preventing smoke from furnaces.**

### Contributors

Broadbent, Joseph Knowles.

### Publication/Creation

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A.D. 1867, 3rd JANUARY. N° 19.

# SPECIFICATION

OF

# JOSEPH KNOWLES BROADBENT.

## PREVENTING SMOKE FROM FURNACES.

LONDON:
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# A.D. 1867, 3rd JANUARY. N° 19.

## Preventing Smoke from Furnaces.

**LETTERS PATENT** to Joseph Knowles Broadbent, of the City of Manchester, in the County of Lancaster, for the Invention of "IMPROVEMENTS IN MACHINERY OR APPARATUS FOR THE PREVENTION OF SMOKE FROM FURNACES USED FOR STEAM BOILERS AND OTHER SIMILAR PURPOSES."

Sealed the 28th June 1867, and dated the 3rd January 1867.

**PROVISIONAL SPECIFICATION** left by the said Joseph Knowles Broadbent at the Office of the Commissioners of Patents, with his Petition, on the 3rd January 1867.

I, JOSEPH KNOWLES BROADBENT, of the City of Manchester, in the County of Lancaster, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN MACHINERY OR APPARATUS FOR THE PREVENTION OF SMOKE FROM FURNACES USED FOR STEAM BOILERS AND OTHER SIMILAR PURPOSES," to be as follows:—

This apparatus consists of a self-opening and closing valve for regulating the supply of air to the combustion chamber to suit the fluctuating conditions of the fuel in the furnace, and thereby prevent the formation of smoke and realize economy. Behind the ordinary bridge there is a second bridge, the space between the two forming the combustion chamber, and in an aperture in the front bridge below the fire-bars I place a valve having a shaft working in bearings, and fix to the valve or shaft a lever jointed to a rod which extends to the front of the furnace, and is attached to a long lever connected to a measuring apparatus or meter, which lever is moved one way by a projection on the furnace door when the door is opened, and the other way by the working of the meter, the mechanism of which is as follows:—The long lever

is fixed to a shaft working in bearings in a box or frame, to which shaft is fixed a ratchet or catch wheel, and on the shaft there is a spur wheel which can turn loose on the shaft one way, but the other way turns with the shaft by means of a spring catch in the teeth of the ratchet wheel. The spur wheel gears into a pinion which gives motion to a train of wheels terminating with a crown wheel escapement and balance, and the long lever is also jointed to a bell-crank lever having a weight which acts upon the mechanism and moves the long lever forward at any desired speed according to the weight and leverage. Behind the aperture in the bridge there is a perforated plate, which is attached to the bridge by a hinge, and the air which passes through the aperture also passes through the perforations to the combustion chamber, and this perforated plate may be turned up or opened for the purpose of enabling the ashes or small coals that may have collected to be cleared away through the aperture in the bridge. When the furnace door is opened the long lever connected to the meter is forced back so as to pull the connecting rod and turn the valve in the aperture in the bridge, so that it will be opened to about one-third of its full extent, and the valve is in this position when the furnace door is closed, but the meter is now at work and gradually moves the lever inwards and causes the valve to turn by degrees so that it shall be full open when the largest amount of air is required for combustion, and then gradually closed as the amount of gases diminish, and when the door is opened for another charge of fuel the lever is again forced back and the valve worked as before.

I have only described one arrangement of the working parts of the meter, but it is evident that the movements may be modified in various ways.

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**SPECIFICATION** in pursuance of the conditions of the Letters Patent, filed by the said Joseph Knowles Broadbent in the Great Seal Patent Office on the 2nd July 1867.

**TO ALL TO WHOM THESE PRESENTS SHALL COME,** I, JOSEPH KNOWLES BROADBENT, of the City of Manchester, in the County of Lancaster, send greeting.

**WHEREAS** Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Third day of January, in the year of our Lord One thousand eight hundred and sixty-seven, in the thirtieth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Joseph Knowles Broadbent, Her special license that I, the said Joseph

Knowles Broadbent, my executors, administrators, and assigns, or such others as I, the said Joseph Knowles Broadbent, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN MACHINERY OR APPARATUS FOR THE PREVENTION OF SMOKE FROM FURNACES USED FOR STEAM BOILERS AND OTHER SIMILAR PURPOSES," upon the condition (amongst others) that I, the said Joseph Knowles Broadbent, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Joseph Knowles Broadbent, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement (that is to say):—

This Invention consists of a peculiar combination and arrangement of improved machinery or apparatus for admitting a constantly graduated supply of atmospheric air to the flues of the furnaces of steam boilers and other similar furnaces in order to suit the varying requirements of the fuel and the increasing and diminishing supply of the gases generated therefrom, and limiting that supply to the smallest quantity required for the purpose of perfect combustion, and thus prevent the formation of smoke and realize economy in fuel. Behind the ordinary bridge there is a second bridge, the space between the two forming the combustion chamber, and in the ordinary bridge below the fire-bars I build or fix an air box having an aperture fitted with a valve working on centres or pivots. To the valve is fixed an arm or crank jointed to a rod which extends to the front of the boiler, and is jointed at that end to a lever attached by a link to a lever connected with a meter for turning the valve in one direction, and on the furnace door there is an arm or lever for acting on the levers, winding up the meter, and turning the valve in the opposite direction. When the furnace is being closed the valve is turned to the full extent in one direction, and is then open to about one-third of its area, at the same time the meter commences to turn the valve in the opposite direction, and when the valve has travelled about one-third of its course it will be open to the full extent, when it will take about double the time to

travel the remaining portion of the distance towards closing, the time being regulated by the action of the meter. Behind the air box or aperture in the bridge there is jointed a perforated plate, and the air which passes through the aperture also passes through the perforations in the plate to the combustion chamber, and this perforated plate may be turned up and held in that position by means of a quadrant or bent rod attached thereto, for the purpose of enabling the ashes or small coals that may have collected behind the bridge to be cleared away through the aperture.

These improvements will be clearly understood by the following particular description thereof, reference being had to the figures and letters on the accompanying two Sheets of Drawings, in which Fig. 1 is an end elevation, Fig. 2 a longitudinal section, and Fig. 3 a sectional plan of part of a steam boiler having my improved machinery or apparatus connected to it; Figs. 4, 5, and 6 are enlarged views of some of the parts; Figs. 7 and 8 are front and side elevations of the meter drawn about full size; and Figs. 9 and 10 are front and top views of the same, Fig. 9 having a part of the outer casing removed for the purpose of shewing the interior.

In Figs. 1, 2, and 3, *a* represents the shell of the boiler; *b*, the flue; *c*, the fire-bars; *d*, the furnace door; *e*, the ordinary bridge; *f*, the air box; *g*, the valve; *h*, the outer box or case of the meter; and *i* the perforated plate behind the air box, and the parts marked *f*, *g*, and *i* are shewn enlarged in Figs. 4, 5, and 6. The valve *g* placed in the air box *f* turns on the pivots *k*, and to the valve is fixed an arm *l* jointed to the rod *m* which extends to the front of the furnace, and is attached at that end to the lever *n*, *o*, jointed to the framing of the furnace door, the arm *o* being connected by the adjustable link *p* to the lever *q* connected with the meter *h*. To the furnace door *d* is jointed a weighted lever having its arm *r* working in a staple *s*, and when the door is opened for a fresh charge of fuel the arm *r* rides on the curved end of the arm *n* and then falls in front of it, so that when the door is being closed the levers and rods shall be moved to the position shewn by the dotted lines, and one motion given to the valve *g* in the air box *f* and the meter wound up.

The mechanism of the meter consists of a train of wheels and pinions which are placed in a steam and dust tight cast-iron box *h*, and the velocities of the movements are regulated by an escapement or fly wheel. The principal shaft *t*, Figs. 9 and 10, is made long enough for one end to project through the casing *h*, and is attached to the lever *q*, Figs. 7, 8, 9, and 10, by means of a frictional socket *u* on the lever *q*, and the screw and nut *v* which tightens the socket upon the shaft *t* to make the external connection, and at the same time to preserve the interior from injury; or a wedge may be used instead of the

screw and nut. To the internal end of the shaft $t$ is attached a ratchet wheel $w$ which turns with the shaft, and loose on the shaft there is a spur wheel $x$ gearing into a pinion $y$, there being a catch or click attached to the spur wheel which allows the shaft and ratchet wheel to turn loose in one direction, but holds them fast to turn the spur wheel in the other direction to drive the other wheels of the train and regulate the time of closing the air valve $g$. To the outside of the meter is attached a bell-crank lever $a^1$ carrying a weight $b^1$, which lever is connected by a link $c^1$ and two screws to the lever $q$ connected by the short link $p$, Fig. 3, to the lever $n$, $o$, on the framing of the door, and by moving the position of this link $p$ the weight will be raised to a greater or lesser extent by the action of the furnace door to suit firing at long or short intervals, or quick or slow combustion, the weight $b^1$ being raised by the closing of the furnace door for enabling it in its descent to work the meter and the valve placed in the aperture in the bridge. The meter may be fixed in any position, and either at the front or bridge end of the boiler, but practically I prefer to fix it on the outside of the boiler or furnace. The perforated plate jointed behind the bridge for enabling the removal of the ashes is shewn at $i$, Figs. 2, 3, 4, 5, and 6, and the quadrant or bent rod at $f^1$, but it is obvious that this perforated plate may be placed in a slide and raised by a lever if required. When the furnace door is opened to supply a fresh charge of fuel the arm $r$ is pushed aside, and then comes in front of the arm $n$ of the lever $n$, $o$, jointed to the framing of the door, and is attached to one end of the long connecting rod $m$ connected to the valve $g$ in the air box. As the door closes the arm $r$ turns the lever $n$, $o$, which pulls the connecting rod $m$ and opens the valve $q$, and as the door is being closed the arm $r$ is again pushed back into its original position by a projecting piece or cam $d^1$, Figs. 1 and 3, fixed to the framing of the furnace door. The meter and its connections will now be disengaged from the arm on the furnace door and regulate the descent of the weight and the motion of the valve, and when the door is opened for another charge of fuel the lever is again forced back and the valve worked as before.

The machinery or apparatus before described may be made of any suitable dimensions, and the arrangement modified to suit the requirements, and although I have only described one arrangement of the working parts of the meter it is evident that the movements may be arranged various ways, and a spring employed instead of a weight. The vacuum or draught guage marked $g^1$ on the front elevation of the boiler, Fig. 1, is for the purpose of indicating when the bars are bare of fuel and the vacuum reduced by the superfluous entry of air.

Having now described the nature of my said Invention, and the manner in which the same is to be performed, I would have it understood that I do not confine myself to the precise details of arrangement of parts; but what I claim for the prevention of smoke and the economy of fuel is,—

First, the general arrangement, construction, and combination of the machinery or apparatus to be attached to steam boilers or other furnaces.

Secondly, the application, use, arrangement, and combination of the meter by which the main shaft is made to turn loose in one direction by the action of the furnace door, and in the opposite direction by a weight acting upon a lever, or by a spring coiled round the shaft driving a train of wheels and pinions regulated by an escapement, fan, or fly wheel.

Thirdly, the application and use of the arm or lever on the furnace door by which the meter is wound up and the valve opened.

Fourthly, the peculiar means of admitting and graduating the supply of air to the combustion chamber or flues of steam boilers and other furnaces.

Fifthly, the frictional socket on the lever placed on the main shaft of the meter, and the modes of tightening the socket in the shaft by means of a screw and nut, or by a wedge.

Sixthly, the peculiar construction and method of attaching the perforated plate to the air box or bridge for enabling it to be raised or turned up.

And, seventhly, the application and use of the quadrant or bent rod by which the perforated plate is raised up, as all such improvements are herein described and illustrated in the accompanying two Sheets of Drawings.

In witness whereof, I, the said Joseph Knowles Broadbent, have hereunto set my hand and seal, this Twenty-seventh day of June, in the year of our Lord One thousand eight hundred and sixty-seven.

JOSEPH KNOWLES BROADBENT. (L.S.)

Signed, sealed, and delivered by the within-named Joseph Knowles Broadbent, in the presence of

E. J. HUGHES,
Patent Agent,
Manchester.

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1867.

A.D. 1867. Jan. 3. N° 19.
BROADBENT'S Specification.

2 SHEETS
SHEET 1.

FIG. 1.

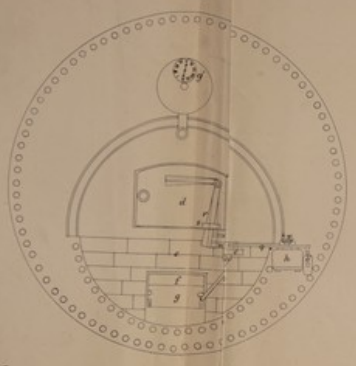

FIG. 2.

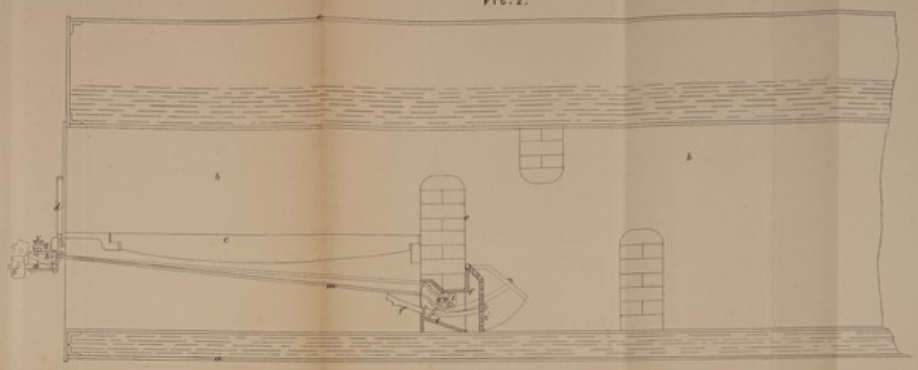

FIG. 4.

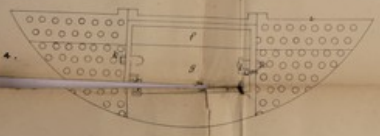

FIG. 3.

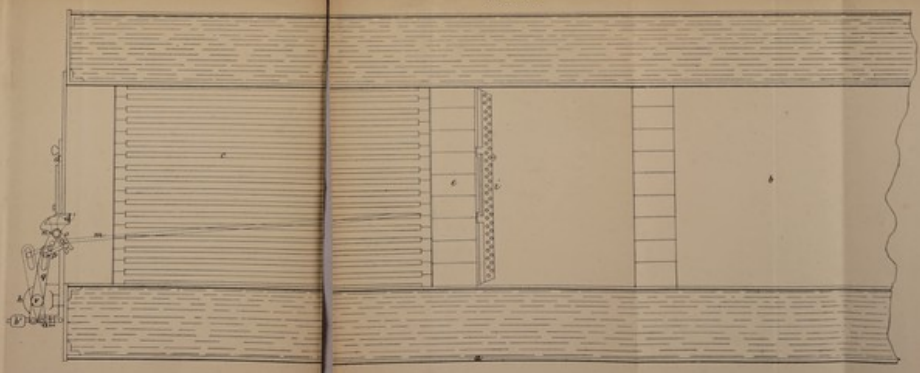

FIG. 5.

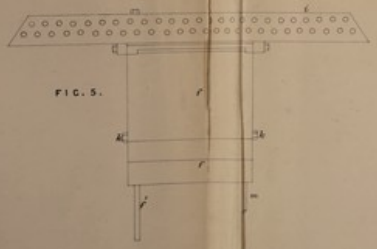

FIG. 6.

*Black drawing is not coloured.*

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FIG. 7.

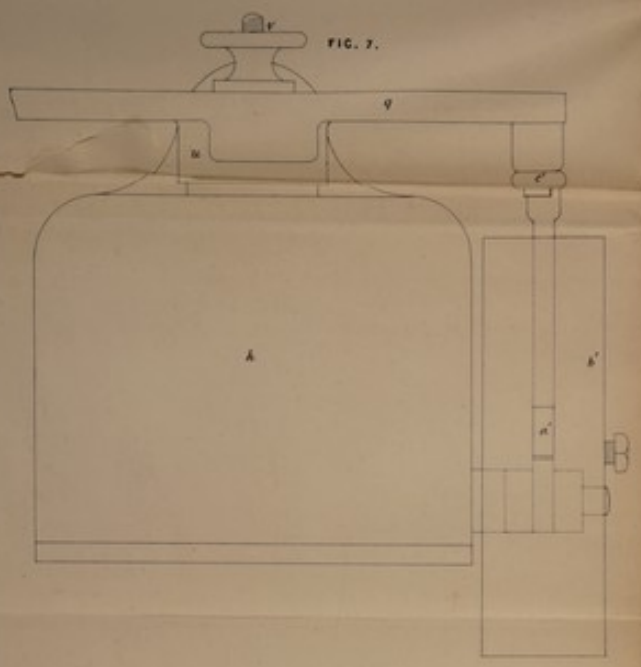



FIG. 8.

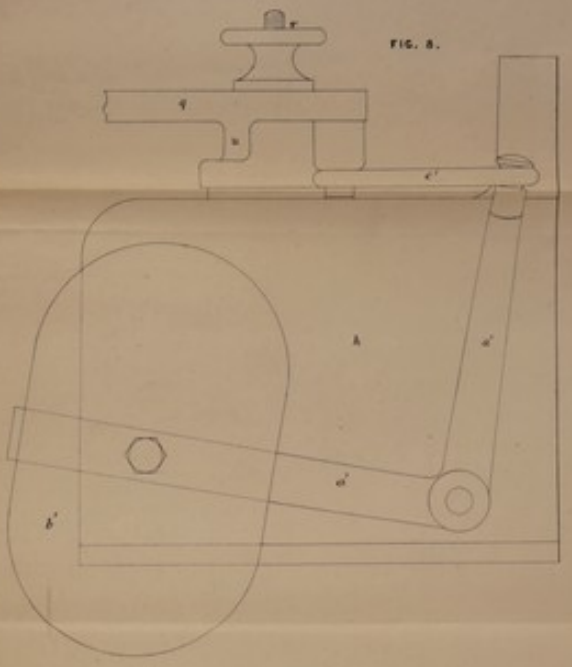



FIG. 9.

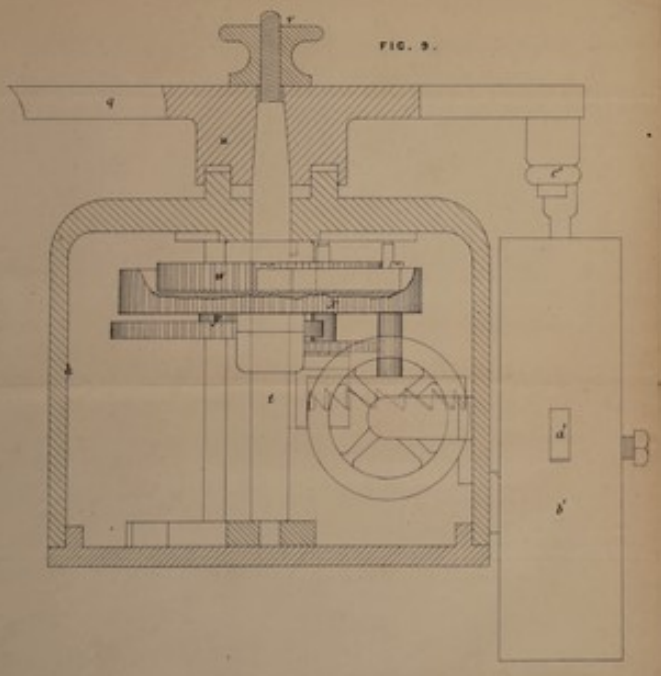
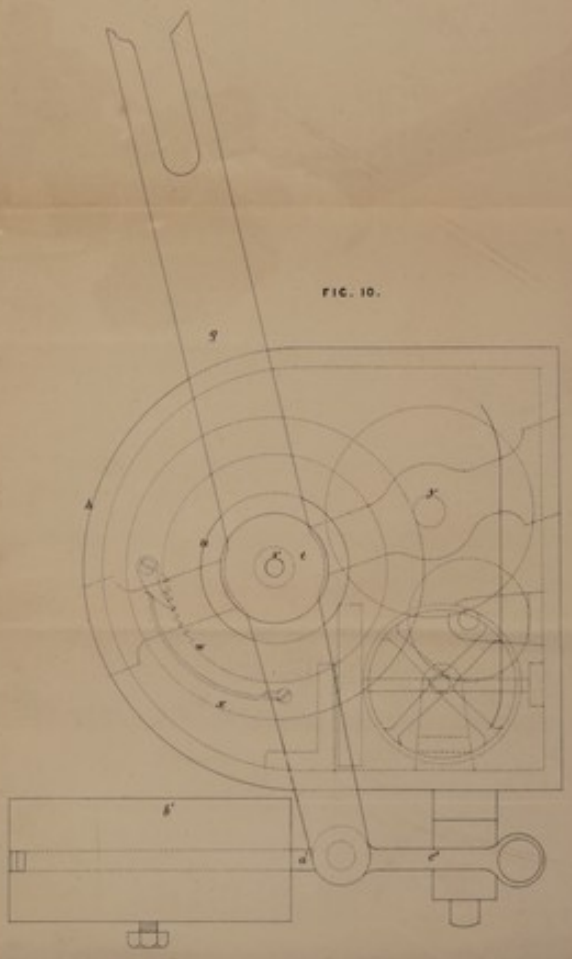



FIG. 10.




*The filed drawing is not colored*

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