G. B. DIXWELL.

Pyrometer for Steam-Engines.

No. 160,400. Patented March 2, 1875.

Fig. 1.

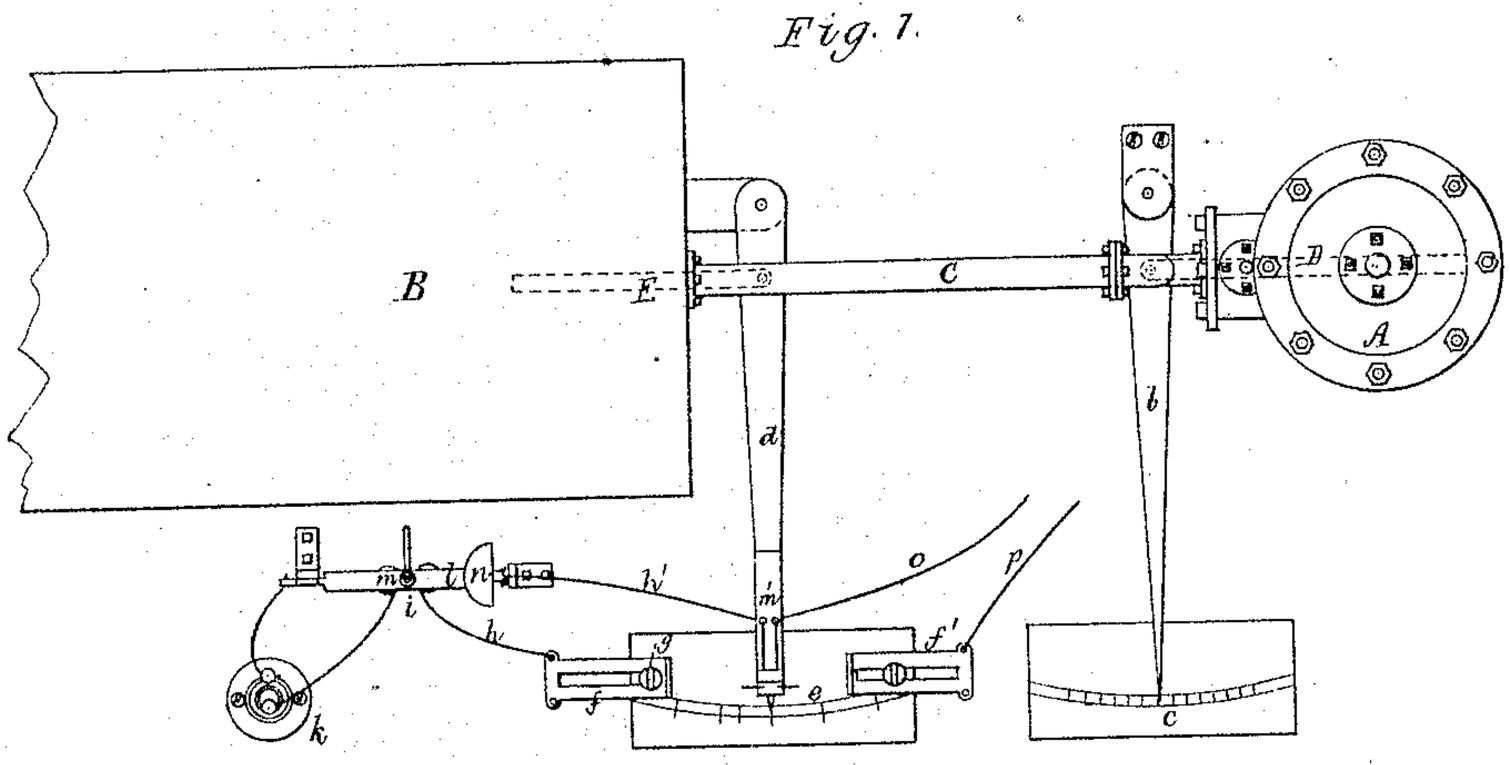


Fig. 2.

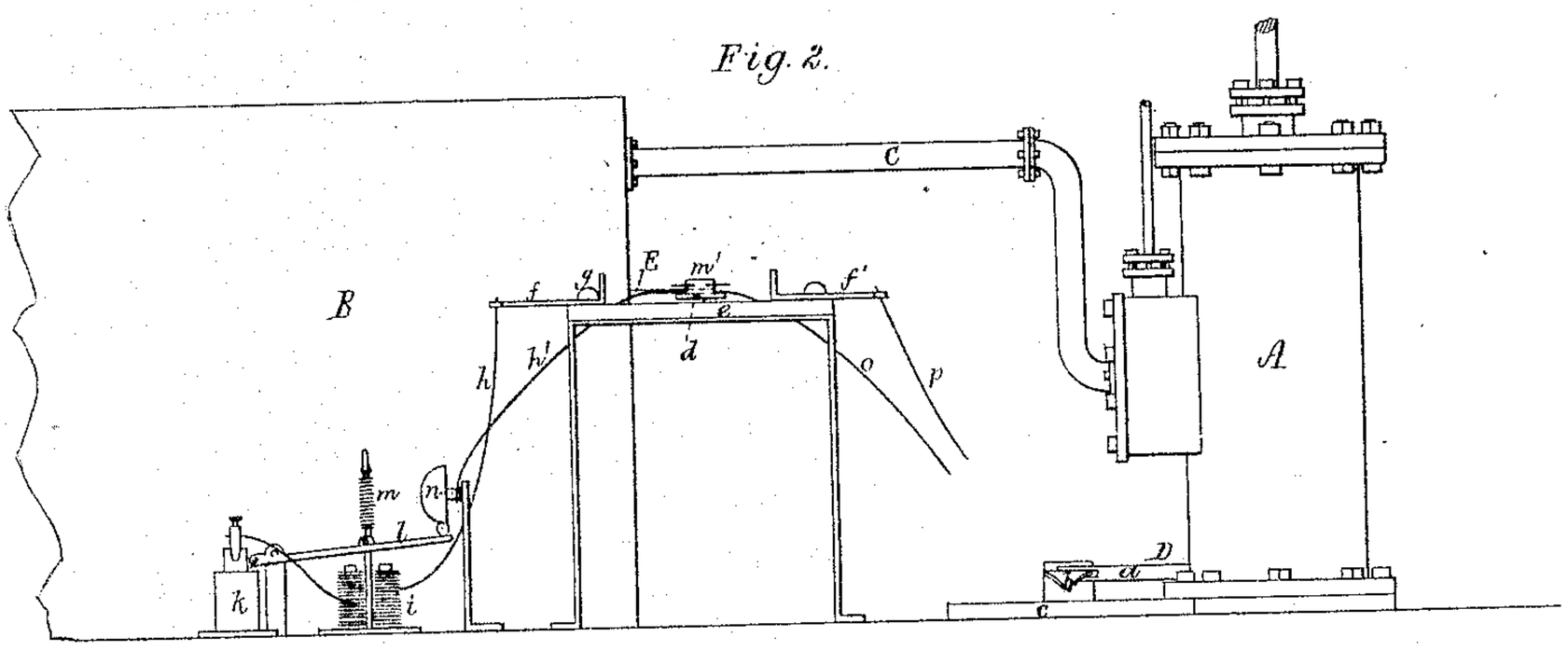
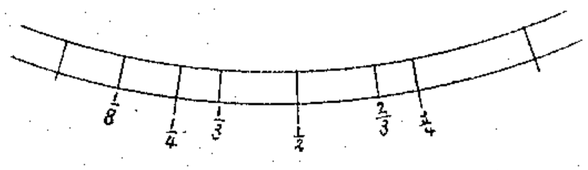


Fig. 3.



Witnesses.
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UNITED STATES PATENT OFFICE.

GEORGE BASIL DIXWELL, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN PYROMETERS FOR STEAM-ENGINES.

Specification forming part of Letters Patent No. **160,400**, dated March 2, 1875; application filed December 19, 1874.

CASE B.

To all whom it may concern:

Be it known that I, GEORGE BASIL DIXWELL, at present a resident of Boston, of the county of Suffolk and State of Massachusetts, have invented a new and useful Improvement in Steam-Engines; and do hereby declare the same to be fully described in the following specification and represented in the accompanying drawings, of which—

Figure 1 is a top view, and Fig. 2 a front elevation, of a steam-boiler and engine-cylinder with my invention applied thereto.

Such invention has for its object to obtain, with the smallest possible change of the existing form of steam-engines, the total suppression of cylinder condensation, and the greatest amount of further advantage from superheating that is compatible with safety to the working parts. These have been found, by long and carefully-conducted experiments, to be uninjured by a temperature a little above 400° Fahrenheit in the cylinder, but many engines have been ruined by the use of a much higher temperature. I assume, then, that for the present, until better lubricators are introduced, 400° Fahrenheit is the limit for the heat of steam in the cylinder; but 400° Fahrenheit in the cylinder imports a higher temperature in the superheater, because, even at full stroke, the entering steam must counterbalance radiation, and at shorter stroke it must also counterbalance the refrigeration arising out of the work done after the cut-off, and this last increases with each increasing measure of expansion.

Experiments have shown that the heat to counterbalance radiation, and the conversion of heat into power after the cut-off, is taken from the metal of the cylinder, which, in turn, upon the next stroke, absorbs the equivalent from the steam which enters up to the point of cut-off.

If the steam be sufficiently superheated to balance radiation and the work done it will, at the point of cut-off, be in a state of saturation, without any condensation or formation of mist; but in this case the full practicable advantage of superheating will not be obtained. This can only be done by adding to the superheated steam in the heater such further temperature as will raise it at the point of cut-off to 400° Fahrenheit. It is necessary, then, to superheat the steam by the amount of the difference between its temperature at saturation and 400°, and also by the equivalent of radiation, and also by the equivalent of the work done after the cut-off. I say the work done after the cut-off, because the refrigeration caused by the work done up to that point takes place throughout the whole steam existing in boilers, pipes, and cylinder, and the proportion existing in the cylinder is, especially at short cut-off, an insignificant part of the whole.

Theory would lead us to expect this; and in experiments on a large scale, carefully conducted and of long duration, the amount of heat absorbed by the metal from the superheated steam agreed very closely at the different points of cut-off with the sum of radiation and the equivalent of the work done during expansion.

It is evident, then, that to maintain the heat in the cylinder at 400° Fahrenheit requires at each cut-off a different temperature in the superheater; and, in fact, in the experiments above referred to, 400° Fahrenheit in the cylinder, at a cut-off of seventy per cent., required 530° Fahrenheit in the superheater; 400° Fahrenheit in the cylinder, at a cut-off of one-half, required 568° Fahrenheit; and 400° Fahrenheit in the cylinder, at one-third cut-off, required 626° Fahrenheit in the superheater in the engines used. But these differences between the cylinder and superheater temperatures will vary with different engines, because the amount of radiation varies greatly, and we cannot, therefore, rely upon the superheater temperatures to indicate the cylinder temperatures until we have ascertained by experiment the differences which actually exist in each particular engine.

Having thus premised, I now proceed to describe the nature or character of my present invention.

In the accompanying drawings, A denotes the cylinder, and B the boiler and furnace, of an ordinary steam-engine, the boiler being for the production of superheated steam, to be used expansively in the cylinder, which is supposed to be provided with a cut-off. The pipe for conveyance of the steam from the generator to the steam-chest of the cylinder is shown at C. A pyrometer, D, is arranged in the lower part of the cylinder, its stem *a* being to project through the cylinder, and being jointed

to an index-pointer, *b*, to operate with a graduated arc or scale, *c*, to indicate the temperature of the steam in the cylinder. Another such pyrometer, E, is similarly applied to the steam-generator or superheater, and has its index-pointer *d* projected over a wooden scale or platform, *e*.

I work the engine at a given cut-off, say, (for instance,) one-third, and note the temperature indicated by the pyrometer in the cylinder, noting, also, at the same time, the temperature in the superheater. If I find the temperature in the cylinder to be 400° Fahrenheit, while that of the superheater is, say, 600° Fahrenheit, I make upon the pyrometer scale-board of the superheater, against 600° Fahrenheit, the words "one-third cut off." I next work the engine at another cut-off, (say, for instance, one-half,) and if I find that with 400° Fahrenheit in the cylinder the pyrometer of the superheater shows, say, 560° Fahrenheit, I mark against 560° Fahrenheit of the pyrometer-scale of the superheater the words "one-half cut off." And so I proceed until the pyrometer of the superheater is, so to speak, graduated for the different cut-offs. I next, if disposed, withdraw from the cylinder the pyrometer placed in it, and rely thereafter upon the pyrometer of the superheater, graduated as described.

Fig. 3 denotes the pyrometer-scale, provided with the divisions for temperatures, and the marks to indicate the cylinder temperatures for different cut-offs, as set forth.

In order to audibly indicate the temperature of the superheater I apply to the scale of the pyrometer an adjustable metallic slide, *f*, fixed to the scale by a clamp-screw, *g*, going through a slot in the slide. To the said slide *f* I attach a wire, *h*, of an electro-magnetic current, whose electro-magnet is shown at *i* and battery at *k*. The armature *l* has an elevating-spring, *m*, and is, in effect, a hammer to strike a bell, *n*, arranged over it, as shown. From the bell a circuit-wire, *h'*, extends to and through an electro non-conductor, *m'*, fixed upon the index-pointer of the pyrometer of the superheater, and thence is turned toward the slide *f*.

When the index-pointer may arrive at the position for which the slide is to be touched by the end of the current-wire carried by the said index-pointer, a galvanic circuit will be completed, and the alarm-bell will be rung. When the engine may have been set to work at a particular cut-off, the adjustable slide *f* is to be arranged so that before the circuit may be completed the index-pointer may have passed a little beyond the indicating division of the cut-off, and whenever this point is reached the electric bell will give the alarm and the temperature of the superheater will be easily diminished by partly closing the damper, or by diminishing the fire, or by opening the door of th efurnace, or any other of the usual means.

There is also applied to the pyrometer-scale another such adjustable slide, *f'*, arranged as shown. Its purpose may be thus explained: To this auxiliary slide *f'*, and to the non-conductor *m'* of the index-pointer, circuit-wires *o p* are attached, and arranged as shown, they leading to the electro-magnetic alarm apparatus, or another such having a bell of a tone differing from that of the other bell.

When it may be desired to have an alarm indicate that the heat in the superheater has descended below the equivalent of a previously-selected minimum, (say, for instance, 370° Fahrenheit,) the auxiliary slide *f'* is to be adjusted properly to the scale, so that when the degree of temperature may have been reached the wire of the index-pointer may be brought into contact with the auxiliary slide, and thus create closure of the circuit and the sounding of an alarm.

My invention is based upon four facts, which I have discovered from experiments. The first is that superheated steam, unlike the gases, gives up its heat to metallic surfaces, and receives heat from them with great rapidity. The second is that the metallic surfaces of the cylinder and piston take up with immense rapidity the excess of heat existing in superheated steam brought near them, and by their great weight convert a high temperature of steam into a much lower temperature of metal. If we suppose the temperature of the entering steam to exceed the temperature of the cylinder by, say, 200° Fahrenheit, a very thin film of the cylinder and piston will suffice to reduce this excess from 200° Fahrenheit to 20° Fahrenheit over the original temperature of the internal surfaces. The third is that the said metallic surfaces give back to the expanding steam the heat previously absorbed, in such a manner as to supply the heat which is converted into work, and the heat withdrawn by radiation. The fourth is that different quantities of heat are thus absorbed and given out with different measures of expansion, so that the steam must, and safely may, be superheated to temperatures proportioned to the said measures of expansion plus the heat withdrawn by radiation.

I claim as my invention as follows, viz:

1. The combination of the two pyrometers D E with the superheater B and the engine-cylinder A, to be operated by such, as and for the purpose specified.

2. In combination with the two pyrometers D E, superheater B, and the engine-cylinder A, applied as described, one or more adjustable slides, *f f'*, and one or more electro-magnetic alarms, applied thereto, and to the pyrometer of the superheater, all substantially as and for the object and purposes as explained and represented.

GEO. BASIL DIXWELL.

Witnesses:

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