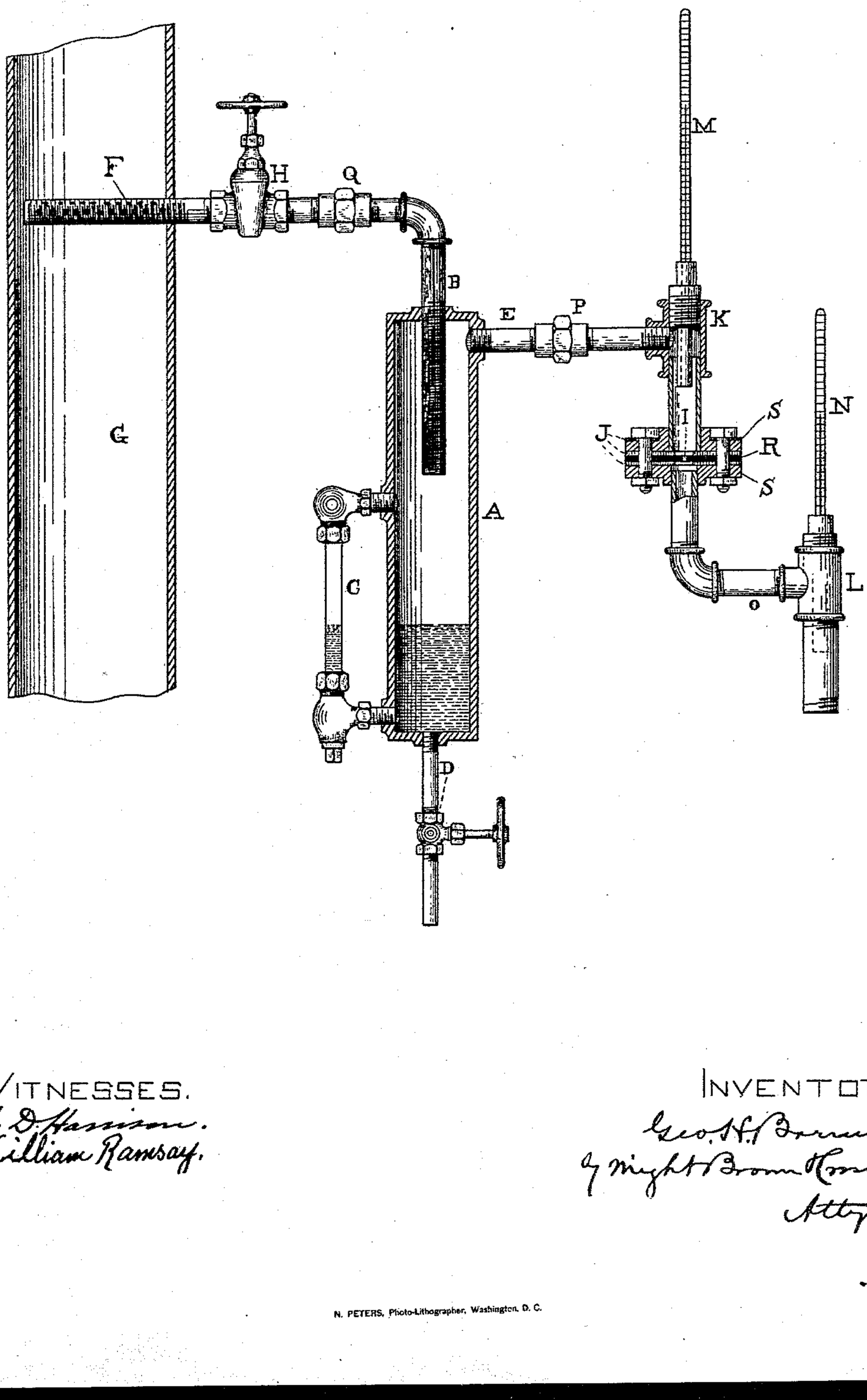
(No Model.)

G. H. BARRUS.

STEAM CALORIMETER.

No. 401,111. Patented Apr. 9, 1889.



WITNESSES.

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UNITED STATES PATENT OFFICE.

GEORGE H. BARRUS, OF READING, MASSACHUSETTS.

STEAM-CALORIMETER.

SPECIFICATION forming part of Letters Patent No. 401,111, dated April 9, 1889.

Application filed November 30, 1888. Serial No. 292,258. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. BARRUS, of Reading, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Steam-Calorimeters, of which the following is a specification.

My invention has for its object to provide a simple, reliable, easily-operated, and inexpensive apparatus for determining the quantity of moisture in wet steam; and it consists in the improvements which I will now proceed to describe.

The construction and the method of operation of my improved apparatus will be understood by reference to the appended drawing, which forms a part of this specification, and represents a sectional view of said apparatus.

The apparatus consists of two parts—one a drip-chamber and the other a heat-measuring device.

In the drawing, G represents the main service-pipe, which conducts steam from the boiler.

F represents a pipe inserted in the service-pipe G, and provided within the latter with numerous small holes, about fifty one-eighth-inch holes being a suitable number. A supply-valve, H, is connected with the pipe F, to prevent the passage of steam therethrough when the apparatus is not in use. The steam passing through the pipe F is conducted by a pipe, B, connected therewith into a drip-chamber, A. The pipe B extends into the drip-chamber below the steam-outlet E, described later, so that the particles of entrained water are thrown to the bottom of the drip-chamber and are there deposited. The water which thus collects is drawn off through valve D into a receptacle, (not shown,) and its quantity is determined by weighing. The level of the water in the chamber A is determined by a glass water-gage, C. The steam is deprived of most of its moisture in the drip-chamber, and passes from the latter through the pipe E to the heat-measurer, which consists of the following elements—viz., first, a chamber, K, connected with the pipe E; secondly, a thermometer, M, the bulb of which is within said chamber; thirdly, the chamber L connected with the chamber K, so as to receive the steam which passes through the latter and having its lower end open to the atmosphere; fourthly, a thermometer, N, in the chamber L; fifthly, a device for wire-drawing the steam between the chambers K and L, said device being here shown as a diaphragm provided with a small orifice, I, about one-eighth of an inch in diameter and clamped between two flanges, S S, on the pipes which connect the chambers K and L, and, lastly, a heat-insulating device to prevent the conduction of heat along the pipes to the point where the steam is reduced to low pressure. The heat-insulating device is here shown as composed of layers J of asbestus or other non-conductor of heat, interposed between the diaphragm and the flanges S S and placed under the heads of the bolts which connect said flanges.

The wire-drawing orifice I may be formed in a movable valve or other suitable body, instead of in a diaphragm. The orifice I by wire-drawing the steam superheats it, because the steam which enters the heat-measurer contains such a small amount of moisture that when it is expanded through said orifice to the atmospheric pressure which exists beneath the moisture is all evaporated and the steam in its state of reduced pressure becomes superheated. The extent to which superheating is produced is shown by the thermometer N. In proportion as the quantity of moisture varies the quantity of superheat varies, and upon this fact depends the operation of the heat-measurer. The insulator J prevents the conduction of heat from the high-pressure steam to the low-pressure steam through the walls of the connecting-pipes. If no insulator were used, the low-pressure steam might be superheated to some extent by means of heat derived from the walls of the main service-pipe G and a result obtained which would not show the true condition of the steam. The particular arrangement of insulator here shown is not essential to the accomplishment of the desired object.

The insulator may be of any form to intercept the conduction of heat along the walls of the pipe and may be placed at any point between the service-main and the orifice. A gage may be used in place of thermometer M; but the thermometer is to be preferred.

The thermometer-chambers are filled with oil or mercury, and the exterior of the appa-

ratus is preferably protected from radiation by a covering of hair, felting, or other non-conducting material.

In operating this calorimeter a sample of the steam to be tested is drawn from the main service-pipe G. The drip-valve D is kept opened sufficiently to maintain the water-level in the drip-chamber at a constant point, the hot water which is drained off being carried by means of a rubber tube into a bucket of cold water resting on scales. The increase in weight which the scales register in any given period of time represents the quantity of moisture deposited in the drip-chamber, and its percentage is found by comparison with the quantity of steam discharged in the same time from the orifice. This last quantity is found either by calculation in accordance with the law concerning the flow of steam through an orifice or by actual determination, the steam being carried for this purpose into a barrel of water resting on scales or into a condenser. This determines a part of the desired result.

The remaining quantity of moisture is determined by observing the thermometers M and N. The moisture in the steam passing through this part of the apparatus is represented by the difference between the total heat of the escaping low-pressure steam, which is at atmospheric pressure, and that of dry steam of the high pressure. The total heat of the escaping steam is found by subtracting two hundred and twelve degrees from the indication of the thermometer N and adding the number of thermal units corresponding to the superheating or the difference thus found to eleven hundred and seventy-eight, (the total heat of one pound of dry steam of atmospheric pressure.) For example, suppose thermometer M indicates three hundred and twenty degrees, the pressure above the orifice being about eighty pounds, and thermometer N two hundred and sixty-two degrees. The total heat of one pound of dry steam at three hundred and twenty degrees is twelve hundred and eleven thermal units. The escaping atmospheric steam is superheated $262 - 212 = 50$ degrees, and its total heat is $1{,}178 + (50 \times .475) = 1{,}178 + 23.7 = 1{,}201.7$, (.475 being the specific heat of superheated steam.) The difference between the two total heats is $1{,}211 - 1{,}201.7 = 9.3$ thermal units, and this difference forms a measure, as above indicated, of the quantity of moisture which is present. The percentage of moisture is obtained by dividing this quantity by the latent heat of the high-pressure steam—that is, by 888.1—and multiplying the result by one hundred. Thus: $9.3 \div 888.1 \times 100 = 1.05$. The percentage of moisture thus obtained, added to that found in the drip-chamber, already pointed out, and corrected for a constant loss of heat due to radiation from the apparatus, gives the total quantity of moisture desired.

The complete apparatus in the form thus far described is intended for cases where the amount of moisture is excessive—that is, where (for pressures in the neighborhood of eighty pounds) the percentage exceeds, say, three per cent. If the steam contains less than three per cent. at pressures of about eighty pounds, or if it is practically dry, the drip-chamber may be dispensed with and simply the heat-measurer used.

The apparatus is constructed with two interchangeable unions, P and Q, so that either the complete apparatus or simply the heat-measurer may be attached to the supply-valve H, as desired. When it is desired to make a test, a preliminary trial is first made, using simply the heat-measurer. If the thermometer N indicates a temperature considerably above 212°, this part of the apparatus will answer all requirements. If, on the other hand, the temperature is 212° or only slightly in excess of 212°, either continuously or intermittently, the complete apparatus must be called into use.

While the insulating device is a very desirable part of the apparatus, as above stated, I do not desire to limit myself to its use in all cases, as a comparatively useful apparatus can be made without said device.

I claim as my invention—

1. In a steam-calorimeter, a drip-chamber for the deposit and measurement of most of the entrained water contained in the wet steam tested, combined with a heat-measurer in which the balance of the moisture is measured, in the manner ard for the purposes set forth.

2. In a steam-calorimeter, the combination of two thermometer-chambers with their respective thermometers, one subjected to the steam of initial pressure, the other to the escaping steam of atmospheric pressure, the second chamber being open to the atmosphere, and means for wire-drawing the steam interposed between the two thermometer-chambers, in the manner and for the purposes set forth.

3. In a steam-calorimeter, the combination of two thermometer-chambers with their respective thermometers, one subjected to the steam of initial pressure, the other to the escaping steam of atmospheric pressure, the second chamber being open to the atmosphere, means for wire-drawing the steam interposed between the two thermometer-chambers, and an insulating device for intercepting the transfer of heat along the walls of the pipe to the wire-drawn steam, in the manner and for the purposes set forth.

4. In a steam-calorimeter, the combination of means for wire-drawing the steam and a thermometer-chamber (which is open to the atmosphere) with its thermometer for showing the temperature of the escaping steam, in the manner and for the purposes set forth.

5. In a steam-calorimeter, the combination of means for wire-drawing the steam, a ther-

mometer-chamber (which is open to the atmosphere) with its thermometer for showing the temperature of the escaping steam, and an insulating device for intercepting the transfer of heat along the walls of the pipe to the wire-drawn steam, in the manner and for the purposes set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 22d day of November, A. D. 1888.

GEORGE H. BARRUS.

Witnesses:
C. F. BROWN,
A. D. HARRISON.