July 14, 1925. 1,546,033

H. M. SHARP

AIR LEAKAGE INDICATOR FOR CONDENSERS

Filed March 23, 1923

Fig. 1.

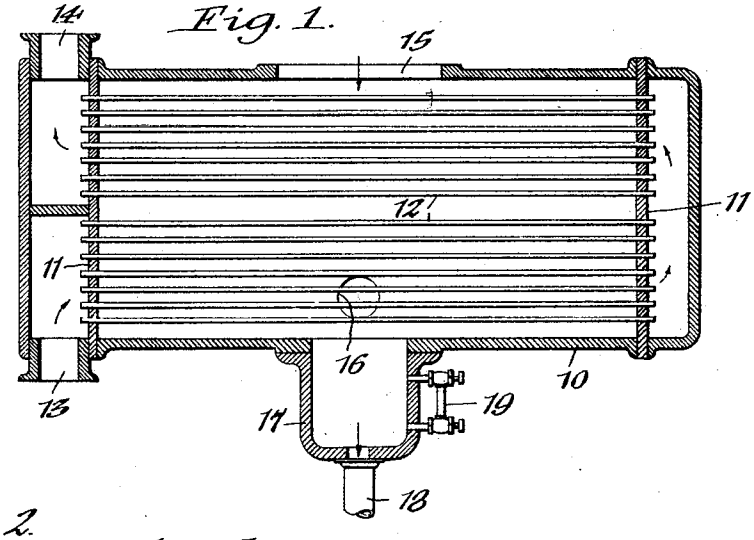


Fig. 2.

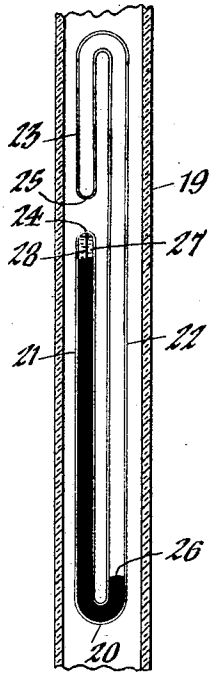


Fig. 3.

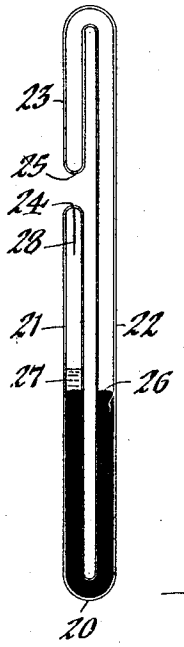


Fig. 5.

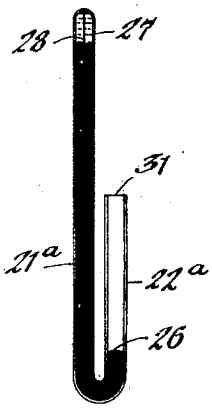


Fig. 6.

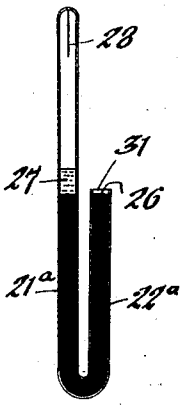
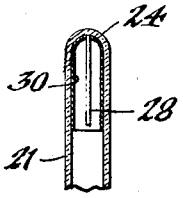


Fig. 4.



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UNITED STATES PATENT OFFICE.

HERBERT M. SHARP, OF BUFFALO, NEW YORK.

AIR-LEAKAGE INDICATOR FOR CONDENSERS.

Application filed March 23, 1923. Serial No. 627,205.

To all whom it may concern:

Be it known that I, HERBERT M. SHARP, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented new and useful Improvements in Air-Leakage Indicators for Condensers, of which the following is a specification.

This invention relates to an air leakage indicator which is more particularly adapted for use with steam condensers and similar apparatus.

In order to maintain a good vacuum in the condensers employed in connection with steam engines or steam turbines and reduce the absolute back pressure in the condenser to the lowest possible point, the air which is non-condensable must be removed. This is usually done by air pumps or ejectors which serve to keep the air pressure in the condenser at the lowest possible point under normal operation.

The chief object of this invention is to provide a novel indicator for showing at a glance the magnitude of the condenser air leakage.

A further object is to provide an indicator of this character which is simple and inexpensive in construction and which is reliable and efficient in operation.

In the accompanying drawings:

Figure 1 is a sectional view of a condenser showing my invention applied thereto. Figure 2 is an enlarged vertical section taken through the gage glass of the condenser, showing the appearance of the indicator when out of service. Figure 3 is a side elevation of the indicator showing its condition when in service. Figure 4 is a fragmentary view of a modification of the invention. Figures 5 and 6 are further modifications of the invention showing the appearance of the indicator when out of service and in service, respectively.

Similar characters of reference indicate corresponding parts throughout the several views.

The condenser shown in the drawings, by way of example, comprises a shell or cylinder 10 closed at its ends by heads 11 which support the customary water-circulating pipes 12 arranged lengthwise of the cylinder. At one end the latter is provided with the usual water inlet 13 and outlet 14, while in its side it has an exhaust-steam inlet 15 adapted to communicate with the engine or turbine and an air exhaust outlet 16. Attached to the bottom of the cylinder and opening into the same is the usual hot well 17 from which extends a pipe 18 for conducting the condensate to the hot well pump and thence to the boilers. Arranged at the side of the hot well is the customary gage glass tube 19 in which my improved air leakage indicator may be conveniently located.

In the embodiment of the invention shown in Figs. 1–3 inclusive, the same consists of a tube 20, substantially U-shaped, constructed of glass or other transparent material, which may be supported within the gage glass 19 in any appropriate manner. The legs 21, 22 of this tube communicate with each other at their lower ends, the upper end of said leg 22 being bent downwardly upon itself to form an extension 23 substantially in alinement with the other leg 21. The upper end of the latter is sealed or closed, as shown at 24, while the lower end of the leg extension 23 is provided with an opening 25, exposing that end of the tube to the vapor and air pressure present in the gage glass 19. By providing this downward extension, the open leg 22 is prevented from filling with water given off by the wet atmosphere of the condenser.

The sealed leg 21 of the indicator tube is filled with mercury 26, shown in solid black in the drawings, except for a small quantity of evaporable liquid 27, as water, contained in the upper portion of said leg above the column of mercury. Before introducing the water into the tube the air contained therein is first removed. Enough mercury is used to include the bend at the lower end of the tube but not enough to fill its leg 22.

The principle upon which the indicator operates is based on Dalton's law of partial pressures, which states that when several gases and vapors occupy a space in common, each behaves as though the others were absent, and the pressure upon the walls enclosing the space must be the sum of the pressures exerted by all the constituents of the mixture.

The operation of the device is as follows, assuming it to be located within the gage glass 19 or any equivalent part of the condenser.

As the purpose of the condenser is to change the vapor or steam coming from the prime mover back into the water state, it

is obvious that this vapor is wet and cannot be dry or super-heated. This vapor pressure is a function of the temperature, and as the temperature of the sealed end of the U-tube 20 is the same as that of its open end, the vapor pressure from the water in the sealed end is the same as the vapor pressure of the wet atmosphere of the condenser. The vapor pressure in the closed side of the tube therefore neutralizes the vapor pressure on the open side at all times. If no air were present in the condenser, the only pressure on the open end of the tube would be vapor pressure and the mercury levels would be the same in both legs of the U-tube, as shown in Fig. 3.

In addition to the vapor pressure on the open leg of the indicator-tube, there may be air pressure due to air leakage into the condenser; but on the closed leg of said tube there can be no air pressure because the water above the mercury therein is free from any air, as previously described. Any air pressure in the condenser will enter the opening 25 of the leg extension 23 and cause a corresponding change in the mercury levels in the legs 21, 22. This difference in levels would show the magnitude of the air pressure in the condenser. Inasmuch as the efficiency of the prime mover is impaired when the air pressure exceeds its normal value, this indicator is valuable in showing any departure from normal.

Attached to the sealed end of the tube-leg 21 is a wire 28 of sufficient length to extend into the column of mercury when the condenser is out of service, as shown in Fig. 2. The purpose of this wire is to overcome difficulties resulting from the intermolecular forces in the mercury and water. In practice, it has been found that without this wire, the contents of the tube will fail to respond to the vacuum drawn on it by the condenser, the reason being that attractional forces exist among the water and mercury molecules which tend to hold them together as long as the space between them is sufficiently small. By having this wire dip into the mercury, a sufficient separation of these molecules is effected to overcome the molecular forces, thus facilitating the formation of the first bubble of vapor and permitting the indicator to respond to the vacuum in the condenser.

To obtain the best results, it is desirable to provide the sealed end of the tube on its inner side with a coating 30 of a waxy substance, such as paraffin, as shown in Fig. 4. The attractive forces between the molecules of water and the molecules constituting the interior coating of the tube become negligible as soon as the distance between molecules becomes more than a few hundred millionths of an inch. As the water does not tend to wet the waxy coating as it does the glass, it follows that the distance between the molecules of wax and water is great enough to break down the attractional forces, thereby allowing the indicator to respond to the vacuum in the condenser.

In the modification of the indicator tube shown in Figs. 5 and 6, the leg-extension 23 is dispensed with and the leg 22^a is shorter than the leg 21^a, the former being open at its upper end, as shown at 31. In this construction, while just as efficient as the others, the open leg of the tube is liable in some cases to fill up with water, in which case a correction in calibration must be made for the extra water column in said open leg.

Although in the example of the invention herein shown the indicator is arranged within the gage glass 19, it may obviously be otherwise located, so long as it is visibly exposed to the atmosphere of the condenser.

With this improved indicator, any air leakage in a condenser can be checked by direct observation of the columns of mercury in the U-tube. In connection with its use, no calculations of any kind are necessary. Furthermore, periodic checking with the dry vacuum pump and gasometer is eliminated, as well as the method involving simultaneous observations of vacuum temperature, vacuum gage and barometer.

While this invention is shown in connection with a condenser, it may obviously be used in connection with feed water heaters and other apparatus where a relatively small amount of air is mixed with a condensable vapor.

I claim as my invention:

1. An air leakage indicator for condensers and the like, comprising a U-tube having communicating legs, one leg being open and the other closed, the upper portion of the open leg being turned downwardly, the upper portion of the closed leg containing a quantity of water and its remaining portion being filled with mercury.

2. An air leakage indicator for condensers and the like, comprising a U-tube having communicating legs, one leg being open and the other closed, the closed leg being filled partly with an evaporable liquid and partly with a liquid heavier than said evaporable liquid, and means in the end of said closed leg for overcoming the intermolecular forces in said liquids.

3. An air leakage indicator for condensers and the like, comprising a U-tube having communicating legs, one leg being open and the other closed, the closed leg being filled partly with an evaporable liquid and partly with a liquid heavier than said evaporable liquid, and a wire arranged in the end of said closed leg and normally extending into the heavier liquid therein.

4. An air leakage indicator for condensers and the like, comprising a U-tube having

communicating legs, one leg being open and the other closed, the closed leg being filled partly with an evaporable liquid and partly with a liquid heavier than said evaporable liquid, a wire arranged in the end of said closed leg and normally extending into the heavier liquid therein, and a lining of waxy material applied to said closed leg.

5. The combination with a condenser or the like, of an air leakage indicator consisting of a U-tube having an open leg and a closed leg, the closed leg being filled partly with an evaporable liquid and partly with a liquid heavier than said evaporable liquid, the ends of both legs being exposed to the atmosphere of the condenser, whereby, in the absence of air leakage into the condenser, the levels of the heavier liquid are the same in both legs, while when there is air leakage, such levels are different.

6. The combination with a condenser or the like having a gage glass attached thereto and communicating therewith, of an air leakage indicator sustained within said gage glass and consisting of a U-tube having an open leg and a closed leg, the closed leg being filled partly with an evaporable liquid and partly with a liquid heavier than said evaporable liquid, and the ends of both legs being exposed to the atmosphere of the condenser.

HERBERT M. SHARP.