(No Model.)

5 Sheets—Sheet 1.

C. C. WORTHINGTON.

SURFACE CONDENSER.

No. 447,396. Patented Mar. 3, 1891.

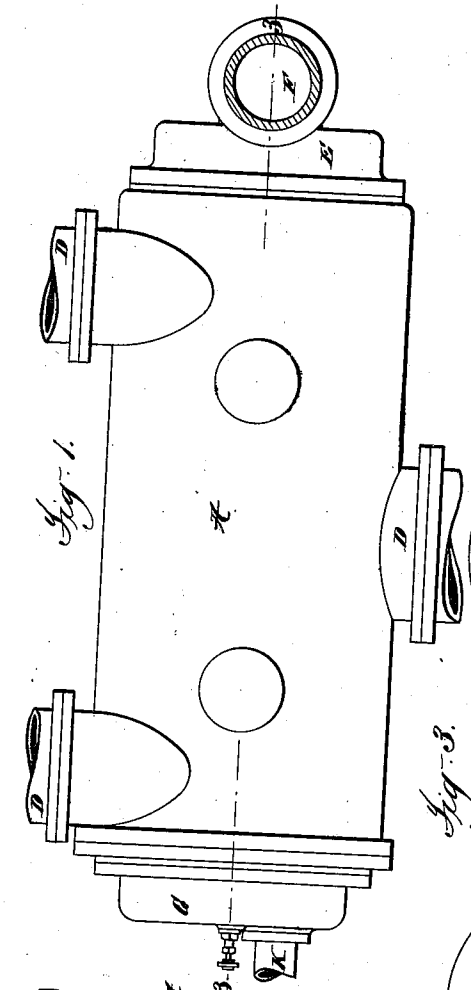


Fig. 1.

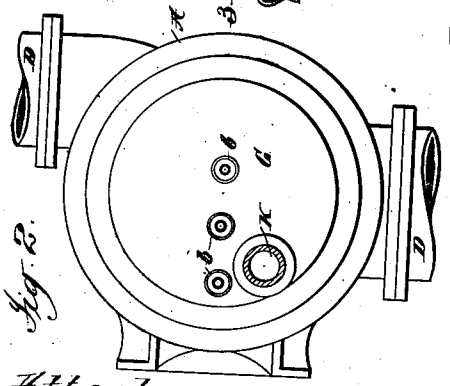


Fig. 2.

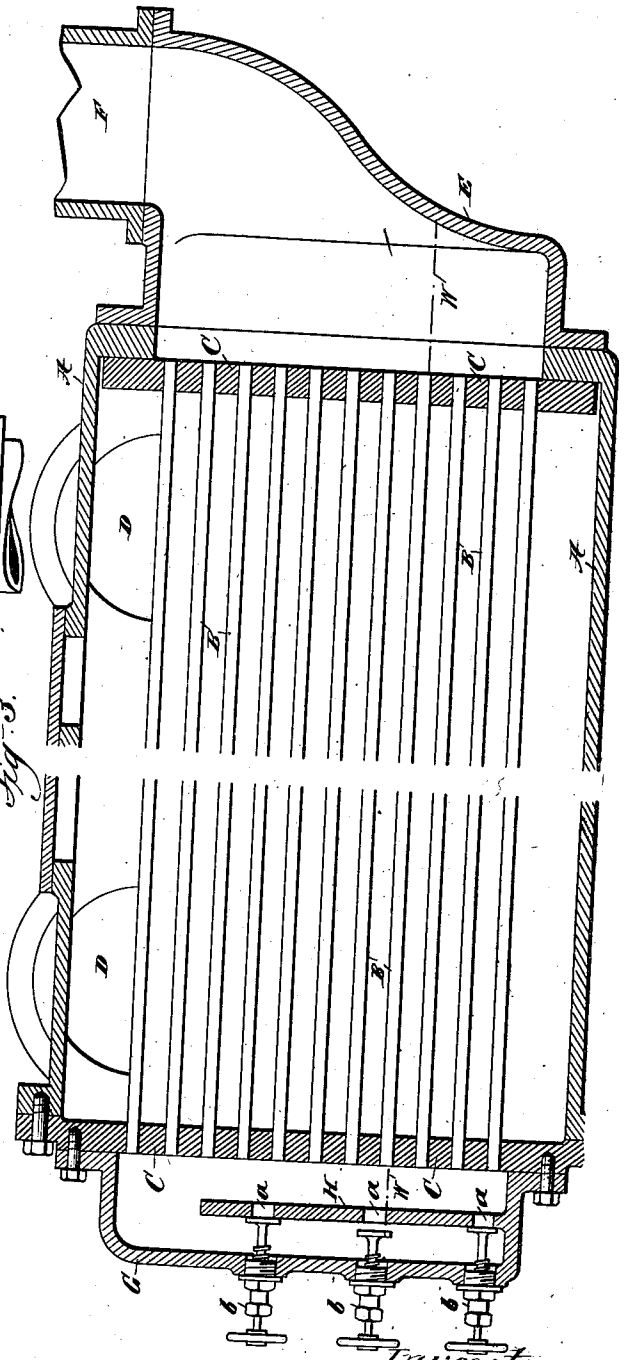


Fig. 3.

Attest:
Geo. H. Bates.
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(No Model.)

5 Sheets—Sheet 2.

C. C. WORTHINGTON.

SURFACE CONDENSER.

No. 447,396. Patented Mar. 3, 1891.

Fig. 4.

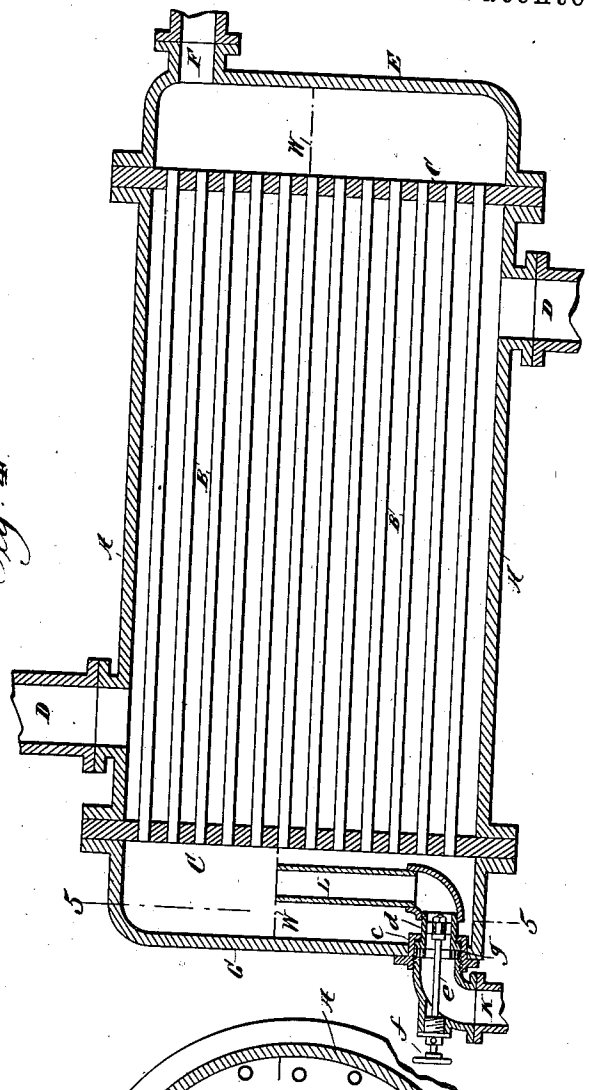
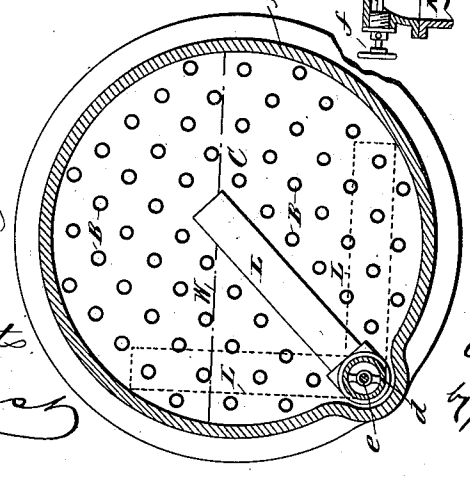


Fig. 5.



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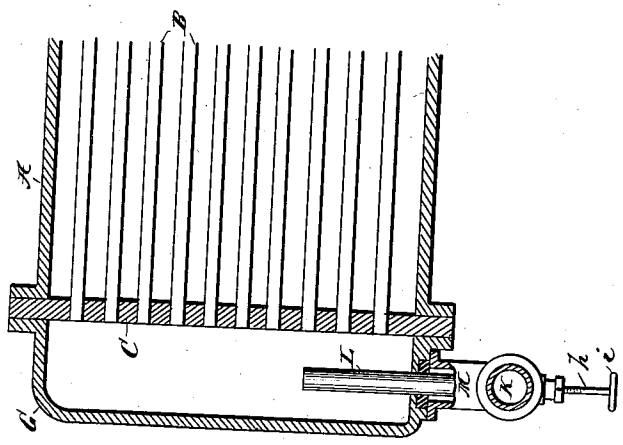
C. C. WORTHINGTON.

SURFACE CONDENSER.

No. 447,396.

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Fig. 6.



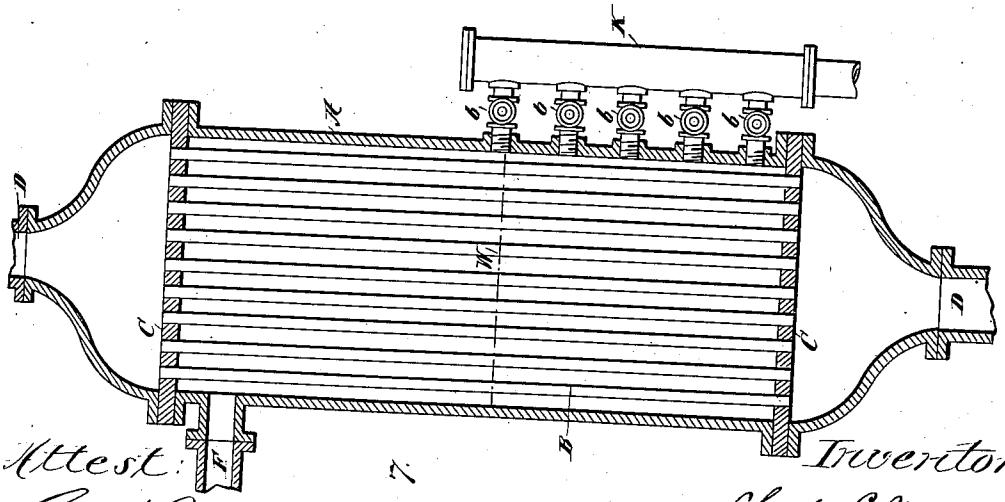


Fig. 7.

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5 Sheets—Sheet 4.

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SURFACE CONDENSER.

No. 447,396.

Patented Mar. 3, 1891.

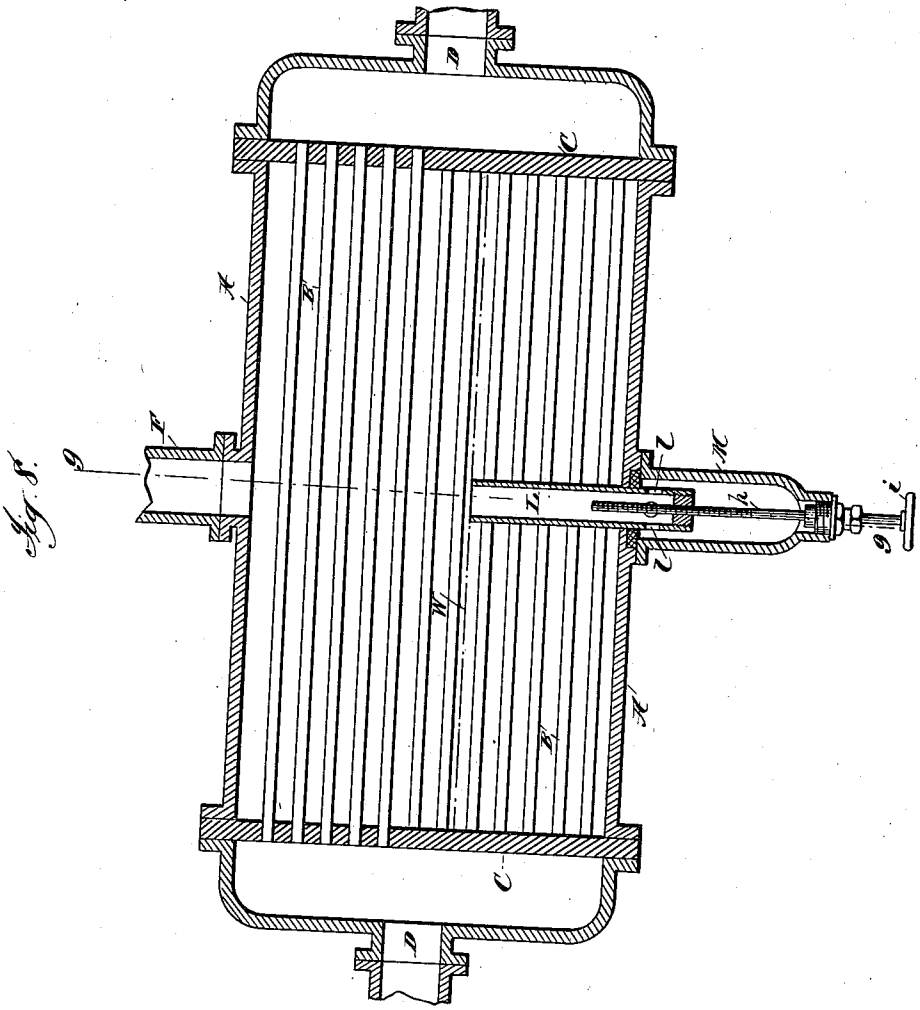


Fig. 8.

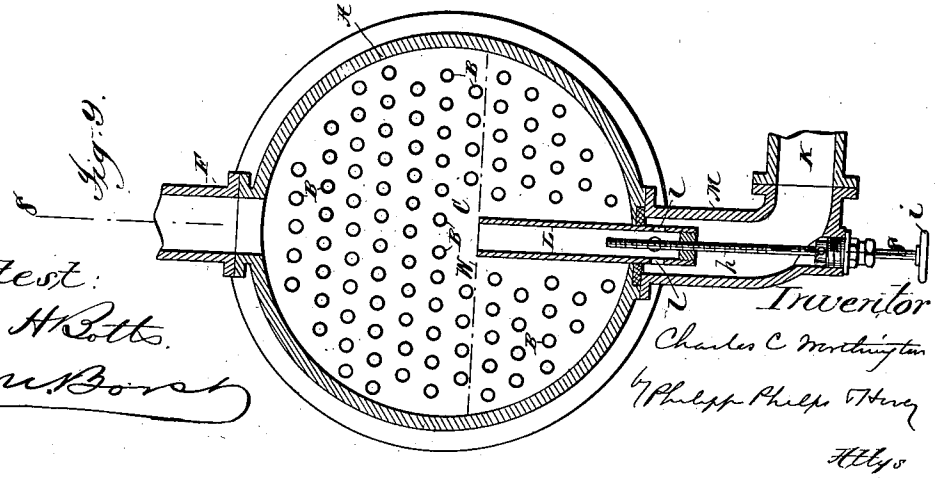


Fig. 9.

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(No Model.) 5 Sheets—Sheet 5.

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SURFACE CONDENSER.

No. 447,396. Patented Mar. 3, 1891.

Fig. 11.

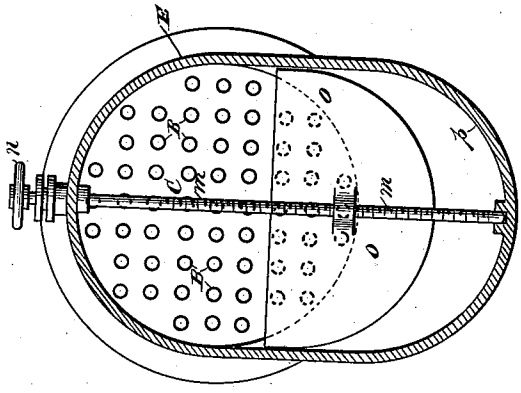
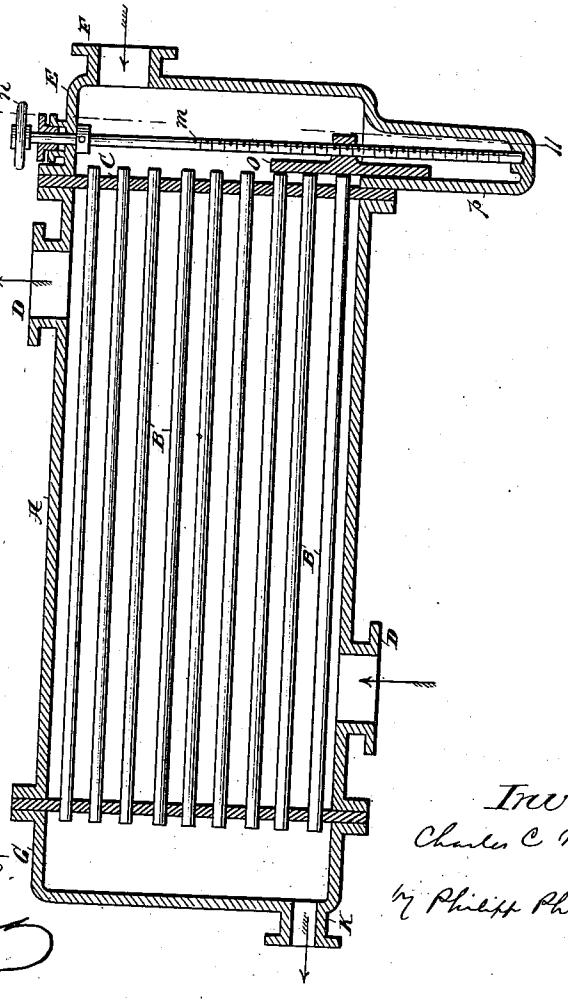


Fig. 10.



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UNITED STATES PATENT OFFICE.

CHARLES C. WORTHINGTON, OF IRVINGTON, NEW YORK.

SURFACE CONDENSER.

SPECIFICATION forming part of Letters Patent No. 447,396, dated March 3, 1891.

Application filed June 24, 1890. Serial No. 356,535. (No model.)

To all whom it may concern:

Be it known that I, CHARLES C. WORTHINGTON, a citizen of the United States, residing at Irvington, county of Westchester, and State of New York, have invented certain new and useful Improvements in Surface Condensers, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to surface condensers, its object being to provide a condenser of this kind in which the degree of the vacuum and the temperature of the water of condensation may be adjustable independently of the amount or temperature of the cooling-water or other cooling medium passed through the condenser.

The usual method of condensation in that class of engines with which surface condensers are employed is well known and need not be particularly described herein, it being understood that the exhaust-steam, being led by the exhaust-pipe of the engine to one end or side of the condenser, is condensed therein, and the water of condensation, together with air and uncondensable vapor, is drawn off from the other end or side of the condenser by an air-pump, and is passed to the hot-well, from which the boiler is fed.

The form of surface-condenser in general use consists of a series of pipes connected at their ends by steam-tight heads, the whole being inclosed in a casing. The steam may be passed through the pipes and cold water forced through the casing, or vice versa, as desired. This form of condenser is modified in many ways, the principle, however, remaining the same, by which a supply of cold water passed through the condenser cools the surface with which the exhaust-steam from the engine is brought in contact and condensed.

While my improved condenser is of general application to condensing-engines of the class described, it is of especial value as applied to pumping-engines of this same class, and will be described as applied thereto.

In condensing-engines in which, as described, the water of condensation is pumped to a hot-well to supply the boiler it is necessary that the condensation should be so adjusted that the temperature of the water delivered to the hot-well by the air-pump should be as high as possible consistently with the production of the necessary vacuum. By a more complete condensation a better vacuum may be obtained; but the temperature of the water of condensation will be correspondingly lowered, and experience has shown that a vacuum of not more than twenty-six to twenty-seven inches, varying to a slight extent in different engines and under different conditions in the same engine, results in the greatest economy. It is necessary, therefore, that every condensing-engine of this class shall be provided with means by which the condensation and the temperature of the water drawn off from the condenser may be adjusted, and this adjustment has heretofore been secured by varying the amount of water passing through the condenser.

In pumping-engines it is impracticable to vary the amount of water passing through the main in accordance with the requirement of the condenser, and systems in which the condenser forms a part of the main and receives all the water passing through the latter, and in which the water of condensation passes to the boiler without reheating, have failed to give the best results, especially as the relation of the water pumped to the steam expended varies greatly in this class of engines, depending upon the pressure in the force main and the amount and temperature of the water pumped. It has heretofore been customary, therefore, to provide pumping-engines with either an independent water-circulating system for the condenser by which the amount of water passing through the latter may be adjusted independently of the amount of water passing through the main or with means for reheating the water of condensation. This necessitates either another and independent pump or a system of valves and pipes to deflect a portion of the main, water through the condenser. I secure a perfect adjustment of the condensation while permitting all the water of the main to pass through the condenser and avoiding the use of any independent circulating system or reheater by providing a condenser in which the condensing-surface with which the steam is brought in contact may be adjusted as desired.

For a full understanding of my invention

a description of various forms of condenser embodying my invention will now be given, reference being had to the accompanying drawings, forming a part of this specification, in which like letters of reference indicate like parts, and in which—

Figure 1 is a plan view of a surface condenser applied to a duplex pumping-engine of the common class. Fig. 2 is an end view of the same. Fig. 3 is a section on the line 3 3 of Fig. 1, showing the construction of the condenser in detail. Fig. 4 is a central longitudinal section of another form of my improved condenser. Fig. 5 is a cross-section taken on the line 5 5 of Fig. 4. Fig. 6 is a central section of one end of a condenser, showing another means for adjusting the condensing-surface. Figs. 7, 8, and 9 show condensers arranged reversely to those of the preceding figures, the water passing through the tubes and the steam through the casing about the tubes. Fig. 7 is a central longitudinal section of a vertical condenser. Fig. 8 is a central longitudinal section on the line 8 8 of Fig. 9, showing a horizontal condenser. Fig. 9 is a cross-section on the line 9 9 of Fig. 8. Fig. 10 shows a condenser in which the condensing-surface is reduced by closing some of the condensing-pipes mechanically; and Fig. 11 is a cross section on the line 11 11 of Fig. 10.

Referring now to Figs. 1 to 3, the condenser is formed of a series of pipes B, which are connected at their ends by means of steam-tight heads C, the pipes and heads being surrounded by a casing A, forming the outside of the condenser, all as is common in this class of construction. The casing of the condenser is provided at each side with a port by which the main D communicates with the condenser, the water of the main thus passing through the latter. In these figures the condenser is shown as constructed to be placed upon the suction-main of a duplex engine, the upper side of the condenser being provided with two ports communicating, respectively, with the branch main for the two sides of the engine. It will be understood, however, that the condenser may be applied to a pumping-engine of any other class and to either the suction or force main, as desired.

At one end, outside the head C, the condenser is provided with a steam-chamber E, communicating with the steam-exhaust pipe F and with the tubes B, and at its other end with a discharge-chamber G, which is divided into two parts by means of the partition H, which extends from the base of the condenser upward to any desired point opposite the tubes B. This partition H divides the discharge-chamber G into an inner and an outer chamber, the former communicating with the pipes B and the latter with the discharge-pipe K, through which the water of condensation and the air are drawn from the condenser by the air-pump and led to the hot-well. The partition H is provided with a series of ports *a*, of different heights above the base of the condenser, these ports being controlled by valves *b*. It is evident that by opening the lowest port *a* all the water of condensation will pass from the inner discharge-chamber G and the pipes B, and the entire series of pipes will be used to conduct the steam from the exhaust F to the discharge-chamber G, the surface of the entire series of pipes thus forming the condensing-surface for the steam. By closing the lowest port *a* and opening any one of the upper ports—for instance, the second port, as shown—the level of the water of condensation within the inner discharge-chamber, the pipes B, and the steam-chamber E, as shown by the line W, will be raised correspondingly, and this level may be adjusted to any point desired, the adjustment being limited only by the number of ports in the partition H. As the level of the water of condensation about the condensing-surface is thus raised, the steam will pass through fewer of the pipes B, and the condensing-surface will therefore be decreased and the temperature of the water of condensation correspondingly raised. By this means an accurate adjustment of the condensation may be secured, so that the vacuum produced and the temperature of the water of condensation shall bear to each other that relation that results in the greatest economy of the engine.

In Figs. 4 and 5 is shown another means for varying the extent of the condensing-surface, the general construction of the condenser being the same as that of the condensers previously described. In the construction shown in these figures, however, the discharge-chamber G at the end of the cylinder is entered near the base of the condenser by a pipe L, which communicates with the discharge-pipe, and when in its vertical position extends nearly to the top of the discharge-chamber, the partition H of Fig. 3 being omitted. This pipe is pivotally mounted, so as to be adapted to be swung from a vertical to a horizontal or any intermediate position, as indicated in Fig. 5, its central position being shown by full lines. The swinging pipe L may be mounted in any suitable manner, and the operating means may be of any form. I have shown a simple and convenient construction, in which the pipe L connects with the pipe K by means of a collar *c*, set into the casing of the discharge-chamber and flanged inward inside the chamber to hold an outward flange on a sleeve *d*, to which the swinging pipe is attached. To the sleeve *d* is secured a rod *e*, which passes through the wall of the discharge-pipe outside the chamber, and is provided with a handle *f*, by which the sleeve and its attached pipe L may be rotated through a partial circle. A packing *g* will preferably be inserted between the sleeve *d* and the end of the pipe K.

In Fig. 6 is shown a construction similar to that of Figs. 4 and 5, except that the pipe L

is arranged to slide vertically through the base-wall of the discharge-chamber and opens below into a chamber M, which forms an enlargement of the discharge-pipe K. The pipe is adjusted by means of the screw *h*, provided with a handle *i*, this adjusting construction being the same as shown in detail in Figs. 8 and 9. It is evident that by this construction of a swinging or sliding discharge-pipe a greater range of adjustment is secured than by the means shown in Figs. 1 to 3, and that the swinging pipe especially permits a very quick adjustment.

In Figs. 7, 8, and 9 are illustrated forms of condensers in which the main connects directly with the pipes, the water passing through the latter and the steam through the casing surrounding the pipes, this being a common reversal of the construction previously described. In the condenser shown in Fig. 7 the level of the water of condensation inside the casing A and about the condensing-surface is adjusted by means of a series of cocks *b* at different levels, communicating with the inside of the casing and with the discharge-pipe K. In Figs. 8 and 9 the construction is similar to that of Fig. 6, except that the sliding discharge-pipe L enters the casing instead of a discharge-chamber at the end of the condenser. For the purpose of adjustment the base of the pipe L is threaded upon the screw *h*, which is provided with the handle *i* and mounted in the lower wall of chamber M. The pipe L enters the chamber M, which forms an enlargement of pipe K and communicates therewith by ports *l*.

In all the constructions described the circulation in the body of water of condensation retained in the condenser will be very slow, the heated water on top being of lower specific gravity than that below, and thus the water that falls into it from the exposed condensing-tubes remains on top and the hot-well is supplied from this upper warmer stratum without disturbing the lower strata. I thus secure a high temperature of the feed-water, although retaining a body of the water of condensation within the condenser.

While I prefer to adjust the condensing-surface by varying the level of the water of condensation it is evident that mechanical devices may be used by which the condensing-surface shall be varied directly. A simple and convenient construction of this class is shown in Figs. 10 and 11, in which the rod *m* passes through the steam-chamber E, and is provided outside the chamber with a handle *n*, the rod being suitably packed where it passes through the wall of the chamber. This rod *m* is screw-threaded inside the chamber and by its rotation raises or lowers a gate *o*, which is constructed to fit closely over the ends of the pipe B, and thus closes a greater or less number of them according to its position. In the construction shown with a cylindrical condenser, the gate is of a segmental form and the steam-chamber is provided with a pocket *p*, receiving the lower side of the gate, and in which the entire gate may be held when all the pipes B are to be used. This construction is equally applicable in cases in which the pipes B form part of the main, and the steam-exhaust connects with the body of the condenser, reversing the operation described. In this case the same amount of water flows through the condenser at all times, the condenser being so constructed that the total capacity of the pipes will exceed that of the main. Where some of the pipes are closed by the gate the water passes through those left open, and the closed pipes are not cooled and form no part of the condensing-surface until reopened. In either case, whether the steam or water passes through the pipes B, it is therefore apparent that the movement of the gate *o* by opening or closing the pipes increases or decreases the effective condensing-surfaces.

While I have shown a condenser formed of a series of pipes surrounded by a casing, my invention is not to be limited to any special form of surface condenser, that shown being but one of the ordinary forms, and selected as that found most convenient for use and as best illustrating my invention. It is evident, also, that the means of adjustment may be varied widely without departing from my invention.

What I claim is—

1. A surface condenser having an adjustable condensing-surface, substantially as described.

2. A surface condenser provided with means for varying the extent of condensing-surface exposed to the steam in its passage through the condenser, substantially as described.

3. A surface condenser provided with means for varying the extent of surface exposed to the steam in its passage through the condenser, substantially as described.

4. A surface condenser provided with means for varying the amount of water of condensation remaining in the condenser and about the condensing-surface during its operation, substantially as described.

5. A surface condenser provided with means for varying the level of the water of condensation remaining within the condenser and about the condensing-surface during its operation, substantially as described.

6. The combination, with a surface condenser, of a discharge-pipe for the water of condensation and means for varying the level of the discharge-port, substantially as described.

7. The combination, with a surface condenser, of a movable discharge-pipe entering the condenser or discharge-chamber, and means for adjusting the position of the discharge-pipe to vary the level of the discharge-port, substantially as described.

8. The combination, with a surface condenser, of a discharge-pipe extending into the condenser or discharge-chamber and pivot-

ally mounted to swing therein, whereby the level of the discharge-port may be adjusted, substantially as described.

9. The combination, with the main of a pumping-engine, of a surface condenser through which the water of the main passes, the steam-exhaust entering said condenser, a discharge-pipe for connection to the air-pump and hot-well, and means for adjusting the condensing-surface of the condenser, substantially as described.

10. The combination, with the main of a pumping-engine, of a surface condenser through which the water of the main passes, the steam-exhaust entering said condenser, a discharge-pipe for connection to the air-pump, and means for adjusting the level of the discharge-port, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

CHAS. C. WORTHINGTON.

Witnesses:
B. W. PIERSON,
LOUIS R. ALBERGER.