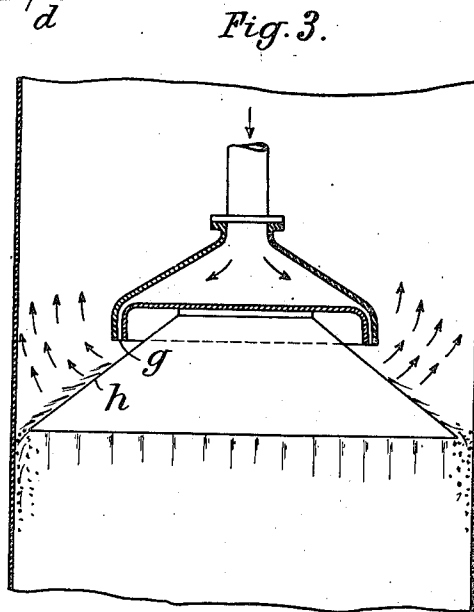
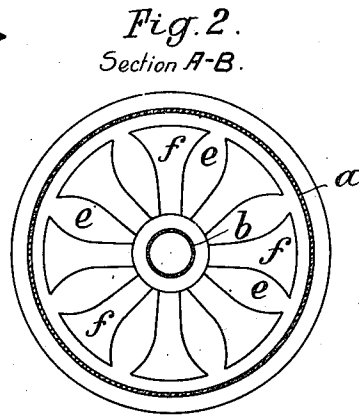
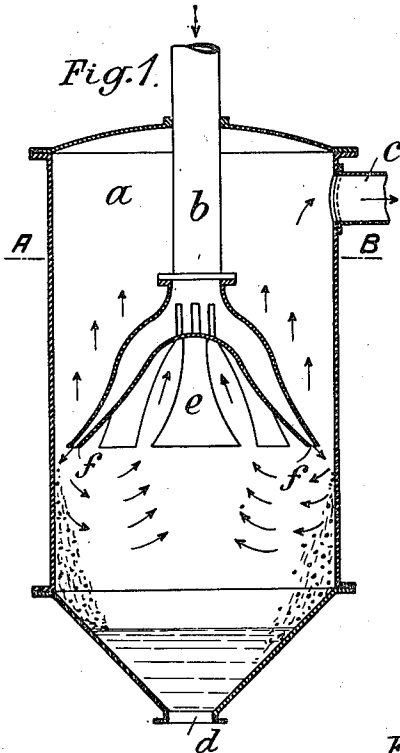


G. J. ULRICI.
STEAM PURIFIER.
APPLICATION FILED MAY 27, 1913.

1,147,463.

Patented July 20, 1915.
4 SHEETS—SHEET 1.



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4 SHEETS—SHEET 2.

Fig.4.

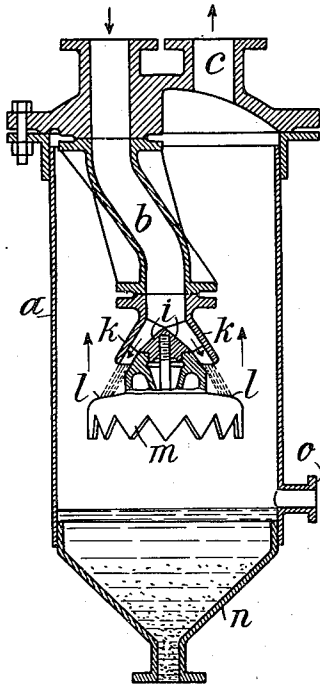


Fig.5.

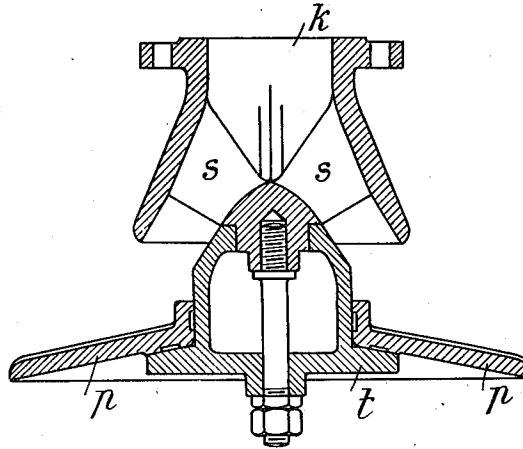


Fig.6.

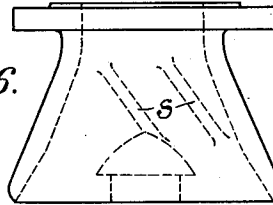


Fig.7.

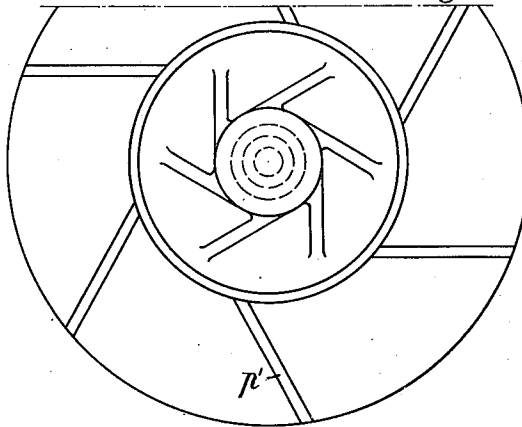
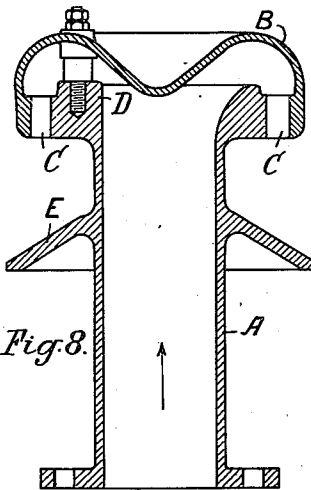


Fig.8.



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4 SHEETS—SHEET 3.

Fig. 9.

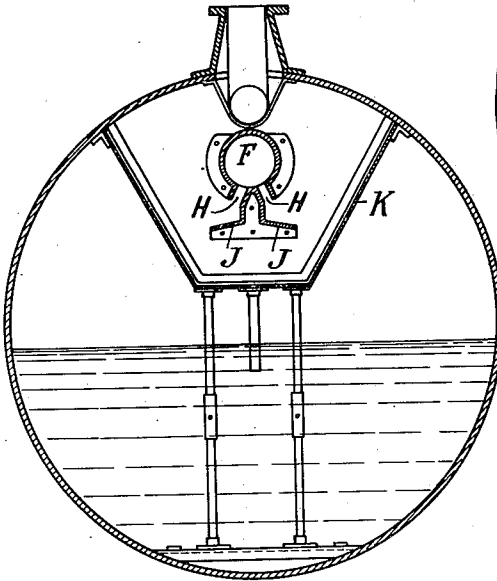


Fig. 10.

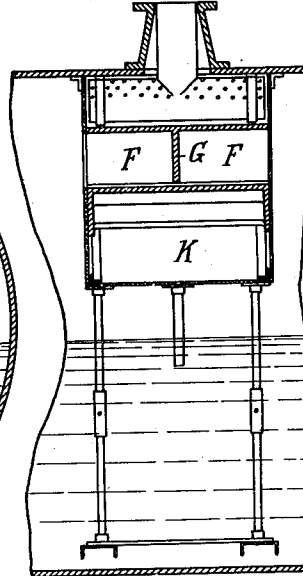
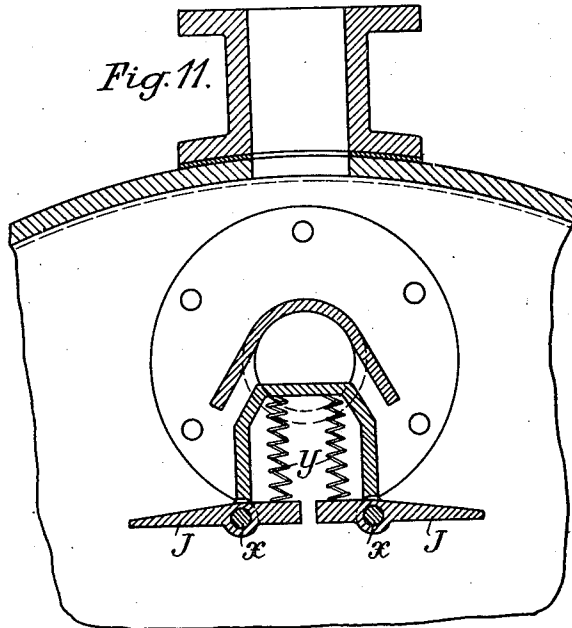


Fig. 11.



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4 SHEETS—SHEET 4.

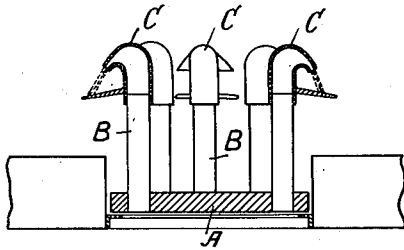


Fig. 12.

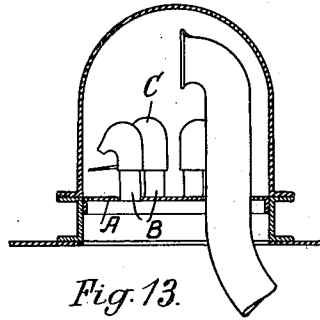


Fig. 13.

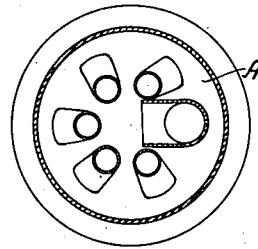
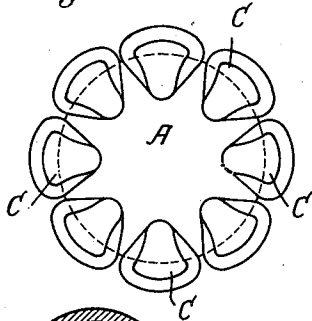


Fig. 15.

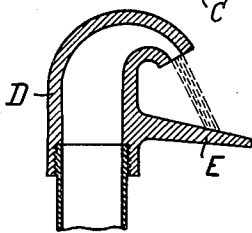


Fig. 14.

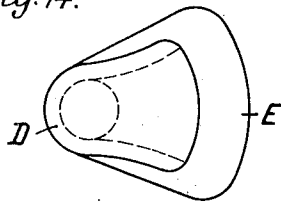
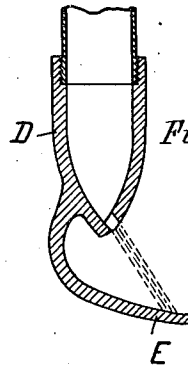
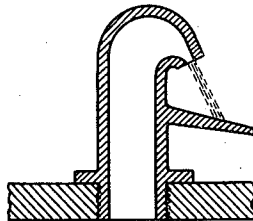


Fig. 16.



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UNITED STATES PATENT OFFICE.

GERARDUS JACOBUS ULRICI, OF DUSSELDORF-GRAFENBERG, GERMANY.

STEAM-PURIFIER.

1,147,463.

Specification of Letters Patent.

Patented July 20, 1915.

Application filed May 27, 1913. Serial No. 770,179.

To all whom it may concern:

Be it known that I, GERARDUS JACOBUS ULRICI, a subject of the King of Prussia, and residing at Dusseldorf-Grafenberg, Germany, have invented certain new and useful Improvements in Steam-Purifiers, of which the following is a specification.

My invention relates to a novel apparatus by means of which steam from a boiler can be perfectly freed from mud and water. Numerous proposals have already been made with this object in view. My own experience is, however, that, even when employing a high degree of superheat and simultaneously employing large water-separators of the usual construction no success has yet been obtained with present practical means in separating the water and mud from the steam continuously and in a really satisfactory manner, especially when there is a varying demand for steam. This is sufficiently proved by the accumulations of water in steam-engines and of mud in steam-turbines. The reasons for previous failures are attributable both to imperfect knowledge of the steps to be taken for obtaining complete separation of the water and mud from the steam, and to improper construction of the apparatus.

In known systems, the live steam, either as an undivided whole or separated into only a few compact columns, has been directed against baffle-plates in the separator in order to obtain the desired effect by the force of impact. Such effect was, however, very imperfectly obtained because that portion of the column of steam which first of all encountered the resistance of the baffle was immediately diverted from the plates in order that it might continue its course, and consequently the remaining portions of the current of steam were hindered from direct contact with the baffle. Heretofore it has been possible to bring only an infinitesimal portion of the particles of steam with their full energy of flow into direct contact with the baffle. Other particles only graze against the plate and only their direction is changed with the whole of the remaining particles, a large number of drops of water thus never being able to be separated. The separated drops are, however, mixed with the current of steam passing over the baffle, and according as the velocity of this current is lower or higher, are carried along to a less or a greater extent and driven on to

the place at which the steam is used. In studying these conditions I have come to the conclusion that to avoid faulty operation of water separators based on the effect of impact, the following conditions must simultaneously obtain:—The whole of the particles of steam must strike the baffle with the fullest energy of impact in order that water and mud, and especially the particles of water emulsified with the steam, can be separated from the latter. The separated water and mud must be able to be conducted away without being affected by the oncoming steam. I have found that a practicable method of separating from the steam all those particles which are required to be separated, is to arrange that the entire current of steam be divided into veils or thin jets which can impact independently and without mutually disturbing one another on the resistance arranged in the separator. The direction of impact of the divided parts of the current of steam must not be changed; this can be successfully effected when the distance between the outlet and the baffle is made small enough, the energy of flow of the steam being almost annihilated by the impact and the direction of flow being reversed. The position of the baffle-plates relative to the direction of flow from the nozzles can be readily so arranged that the steam coming from the baffle and the particles of water and mud which are separated thereat move subsequently in opposite directions. These conditions are complied with in the construction of the new apparatus described hereinafter.

Several illustrative embodiments of my invention are represented by way of example in the accompanying drawings, wherein:—

Figures 1 and 2 are sectional elevation and plan, respectively, diagrammatically, showing one form of my improved apparatus; Fig. 3 is a sectional elevation diagrammatically showing a second form; Fig. 4 is a sectional elevation showing a modified form; Fig. 5 is a sectional elevation of a fourth form; Fig. 6 is an elevation of the nozzle employed in the apparatus shown in Fig. 5, and Fig. 7 a plan of the same form; Fig. 8 is a sectional elevation of a fifth form of nozzle; Figs. 9 and 10 are two sectional elevations taken at right angles to one another showing a sixth form, and Fig. 11 is a sectional elevation of a

seventh form; Figs. 12, 13 and 14 are elevation and plan views showing other modified forms, and Figs. 15 and 16 are sectional elevations of two additional modified forms.

Referring first to Figs. 1 and 2, the apparatus is inclosed in a vessel *a* connected to an inlet pipe *b* and an outlet pipe *c*. *d* designates the branch pipe for the separated water and mud. From the inlet pipe *b* which conducts the column of steam from the boiler depends the distributing device, whose function is to split up into suitably fine portions the entering column of steam. In this embodiment, the current of steam is split up by the distributing apparatus or tubular member *e* centered within vessel *a* and from whose nozzles *f*, *f* the steam issues split up into a large number of thin veils, films or jets. The numerous separate threads or films of steam strike with their full energy of flow against the wall of the vessel or against special rigid baffles mounted in the latter. It is obvious that owing to the small distance of the nozzle-orifices from the wall or the baffles no appreciable curvature of the several threads or films of steam can take place. As soon as impact has occurred, owing to the large cross-section of the vessel the steam flows on with a greatly reduced velocity and no disturbing eddies between the steam and the particles separated therefrom can form. The particles of water and mud separated from the distributed steam by the impact flow downward with considerable velocity in so far as they are not diverted at an acute angle to the wall of the vessel inwardly and downwardly. The necessarily slow-moving steam flowing downwardly continually loses velocity because ample space is allowed wherein it can spread out. Consequently, owing to the upward direction of the current of steam in the upper portion of the vessel the velocity of the steam in the lower portion is zero in the vertical direction, and the steam which turns upward is quite unable to hold water or to carry it upward. The whole of the particles of steam flow upward through the device *e* between the various nozzles *f*, and the steam flowing through the outlet *c* is perfectly free from water-bubbles because that portion of water which was emulsified with the steam was conglomerated into drops when the powerful impact occurred, and these drops were subsequently separated. It is obvious that in this disposition of the nozzles relatively to that wall of the vessel which serves as the baffle it is impossible for the purified steam to again hold particles of water and mud as is obvious from the path taken by the steam and the conditions imposed on it for its exit.

Whereas the distributing apparatus in the form shown in Figs. 1 and 2 comprises a plurality of nozzles, the embodiment shown

in Fig. 3 shows that my invention is not limited to this form. The number and cross-section of the nozzles can be chosen to suit external conditions, and a single nozzle *g*, preferably of annular form, such as is shown in Fig. 3 may suffice. In this case a single, annular nozzle is employed for discharging the steam from the distributing device, and in combination with this nozzle is a special baffle *h*, here shown funnel-shaped, depending into the separator chamber itself below the nozzle *g*. The conditions under which foreign particles are completely separated from the steam are perfectly fulfilled here also, as the drawing clearly shows.

Figs. 4 to 11 show several other forms of purifier, and indicate the great variety of possible forms when the purifier is applied to various purposes.

The embodiment illustrated in Fig. 4 is one in which special regard is paid to obtaining proper operation for a considerable time. Deposits of mud on the baffle weaken the force of impact of the steam and hence lower the efficiency of the apparatus. The apparatus illustrated in Fig. 4 is designed to keep the hard baffle-surfaces always clean and to conduct the mud with certainty from these surfaces. The steam from the nozzle *i*, *h* impacts on the rigid baffle-plate *l* on which the current of steam, suitably finely distributed owing to the form of the nozzle-orifice, strikes at an angle to this plate. The foreign substances contained in the steam are separated in the manner already described. Owing to the jets of steam impacting the baffle at an angle, the separated mud cannot adhere, even when it is sticky, but is mechanically driven over the edge of the plate. In order to facilitate the mud being discharged, the baffle-plate has a notched edge *m*. The effect of the teeth so formed is that the mixture of mud and water thrown around the edge of the baffle runs off from the points of the teeth. The vessel *a* comprised in the apparatus is preferably provided with a bottom outlet *n* and, over the funnel-like mud-receiver, is the lateral branch pipe *o* for discharging the water which settles above the mud.

Figs. 5 to 7 show an embodiment designed with a view to keeping the baffle clean so as to obtain the maximum efficiency. The baffle is rotatable in order to utilize the force of the steam for mechanically driving it around and consequently also for continually maintaining it clean. In the nozzle-body *k* guides or vanes *s* are arranged obliquely to the direction of flow of the steam, as clearly shown in Figs. 6 and 7. The baffle *p* whereonto the steam to be cleaned is directed is rotatably mounted on the corresponding bearing-flange *t*, and the upper surface of the baffle may have radial ribs *p'*. When steam flows through the nozzle-

zle, the baffle *p* is set into rotation and the centrifugal force so coming into play prevents all oily and greasy substances from adhering.

5 The steam-purifier shown in Fig. 8 is specially suitable for locomotives, and is assumed to be mounted inside the dome above the horizontal boiler. The unpurified steam flows up the tube A and over the upper edge thereof. The latter is covered by a guide-plate B and is suitably thickened not only to form the nozzle-orifice C between the guide-plate B and itself, but also to permit the plate B to be fastened thereon. Guide-plate B causes the direction of the steam to be reversed so that it is emitted through nozzles C in a direction opposite to that in which it passes through tube A. At a suitable distance from the nozzle-orifice C formed in this simple manner is located the rigid baffle E which is carried by the tube A and whose baffle-surface is inclined relatively to the axis of the nozzle. When the nozzle is parallel to the axis of the tube, as stated above the baffle is inclined, but when the nozzle is not vertical it is possible for the surface of the baffle to be at right angles to the tube.

10 Figs. 9 and 10 show another embodiment of my purifier specially adapted for the top drum of a water-tube boiler. As seen in these figures, a closed chamber K is built in the cylindrical upper drum. The pipe F for conveying the unpurified steam has a partition wall G in the middle and supplies steam to the two longitudinal nozzles H. Below and at a predetermined distance from these nozzles are two plates J which are inclined at an angle to the nozzles and serve as baffles for the veil or jet of steam impinging on them. The mud and water mixed with the steam are here separated and fall downward, while the deflected steam is purified and issues from the boiler. The symmetrical arrangement of two baffles shown is of course not essential. The nozzle and baffle may be arranged only on one side, if desired.

15 In the embodiment shown in Fig. 11 the baffles J are movable, and their surfaces impinged on by the steam can be adjusted at various angles to the passages in the nozzles.

20 An important factor in thoroughly cleaning the steam is the force with which the steam impinges against the baffle. This force is determinable from the equation:—

$$k = \frac{1}{2}mv^2.$$

25 It therefore increases as the square of the speed. The embodiment shown in Fig. 11 is designed with a view to keeping *k* as uniform as possible, and to causing the mud to flow away more quickly, in order to keep the baffle clean when large deposits

of mud are suddenly formed, such as arise when rapidly varying demands for steam arise.

The baffles J are roughly of the form and arrangement shown in Figs. 9 and 10, and are not rigidly connected to the casting supporting them, but rotatable about axes X journaled in the latter, and they are held in their normal positions by any suitable regulating devices, such as springs *y* as shown.

When violent formations of steam have to be dealt with by the purifier both the velocity and force of impact of the steam increase. The result is that the movable baffles are pressed downward and consequently the mud is more readily discharged.

It is evident that the various requirements of a steam plant can be perfectly fulfilled with the hereindescribed forms of apparatus.

Figs. 12, 13, 14, 15 and 16 show modifications of the constructions diagrammatically illustrated in Figs. 1, 2 and 3.

In Figs. 12 and 13 is shown a plate A of any desired form, into which a number of tubes B are fastened. The plate is a closing plate on a steam-pipe or on the branch pipe of a boiler or a dome. At their ends remote from the plate the tubes carry caps C C. Each cap C comprises a tubular end-piece D, whose form depends on the position of the plate and may be bent as shown in Fig. 14 or straight as in Fig. 15, and a baffle E. The nozzles in these members may be formed as desired, so that the steam issues from them in the form of veils, jets, bands, films or the like. The cap and the baffle which is arranged at a certain distance from the opening in the former are so combined that the steam issuing from the orifice impinges obliquely against the upper surface of the baffle. As shown in Fig. 16, the pipe B and cap may be formed in one piece. Each pipe provided with a cap therefore forms in itself a complete purifier. These tubes B can be arranged either in rows or circles, or in other suitable manner according to the form of the plate. Such a battery of purifiers can therefore be used where, owing to the presence of pipe-mains and so on, it would not be possible, owing to lack of space to erect a single purifier, as, for example, in the domes of locomotives, in boilers having slanting tubes, and the like.

The steam to be cleaned flows through the tube onto the baffle, deposits on this the impurities and priming water and passes away in a direction opposite to that of the separated mud and water.

I claim:—

1. A steam purifier for completely separating from the steam both the entrained and emulsified water and all the mud, characterized by there being mounted in the

separating vessel, a steam distributing member having nozzles, combined with baffles co-acting with said nozzles, the arrangement being such that, owing to a suitably short distance between the nozzle-orifices and the baffles and to the angular position of the latter, all the particles of steam are subjected to the full force of impact on the baffles, and the purified steam and the separated particles are conducted away in opposite directions.

2. A steam separator and purifier comprising a casing, an inclosed steam distributing member having a contracted downwardly opening discharge duct, a baffle arranged opposite said duct and at an oblique angle relatively thereto, whereby the steam emitted from said duct is caused to strike the baffle at an oblique angle, and means for

subsequently reversing the direction of flow of the steam so that the steam and the particles separated therefrom by the baffle are conducted away in opposite directions.

3. A casing, an inclosed steam separator and purifier comprising a steam pipe, having a headed end, a guide plate which embraces said headed end and forms a nozzle opening therebetween, said guide plate being adapted to reverse the direction of the steam, and a baffle carried by the pipe below the nozzle, and arranged at an inclination to the axis of said nozzle.

In testimony whereof, I affix my signature in the presence of two witnesses.

GERARDUS JACOBUS ULRICI.

Witnesses:

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WOLDEMAR HAUPT.