

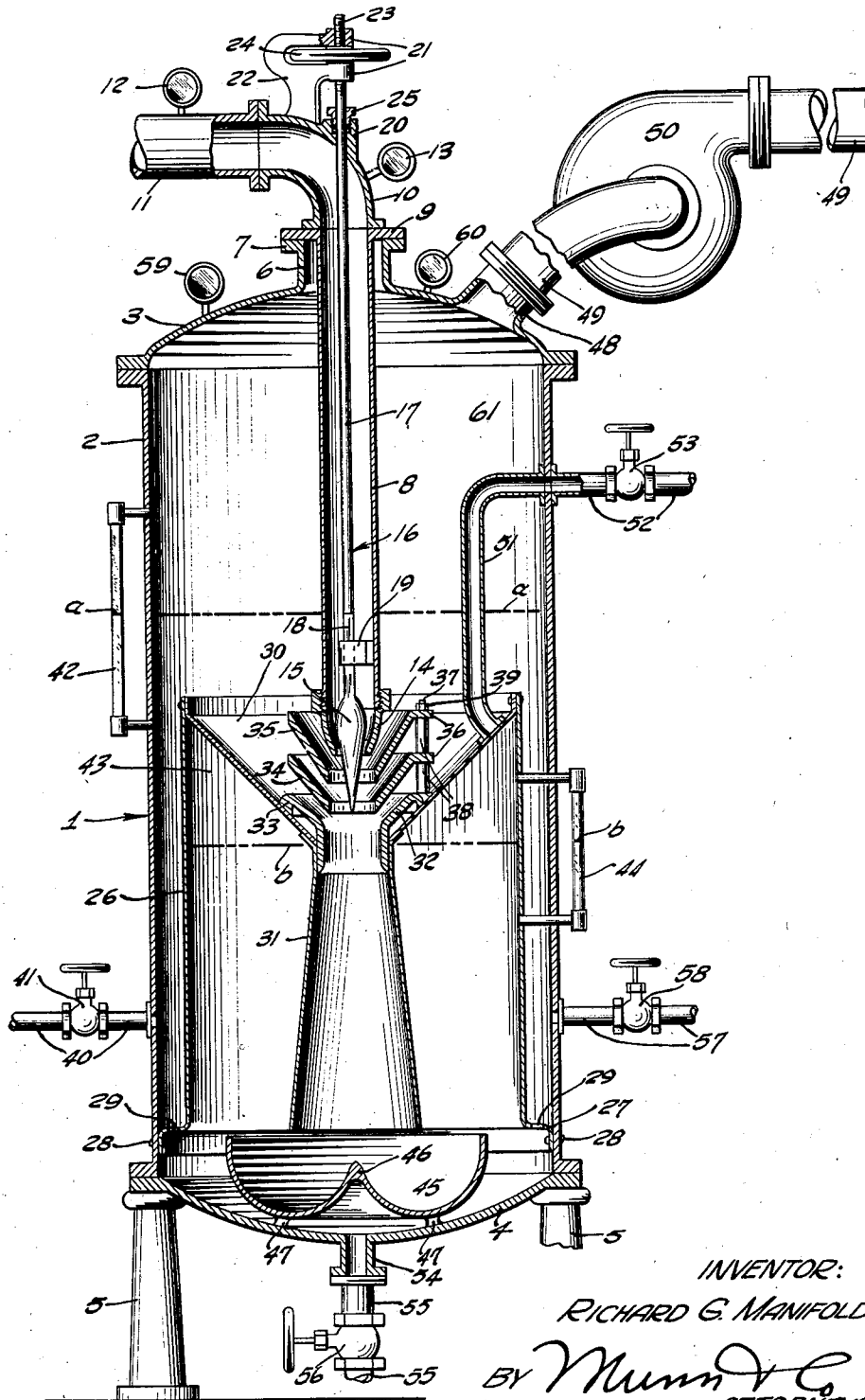
June 2, 1931.

R. G. MANIFOLD

1,808,424

STEAM PURIFYING APPARATUS

Filed June 27, 1928



INVENTOR:

RICHARD G. MANIFOLD.

BY *Munn & Co.*
ATTORNEYS.

UNITED STATES PATENT OFFICE

RICHARD G. MANIFOLD, OF LOS ANGELES, CALIFORNIA, ASSIGNOR TO THE FRONTIER DEVELOPMENT COMPANY, OF LOS ANGELES, CALIFORNIA, A CORPORATION OF NEVADA

STEAM PURIFYING APPARATUS

Application filed June 27, 1928. Serial No. 288,708.

My invention relates to apparatuses for purifying steam, and it refers especially to such apparatuses as are adapted for use in connection with natural-steam wells. The steam issuing from such wells, particularly when the wells are located in the vicinity of old volcanoes, is often mixed with non-condensable gases, dust or other dissoluble matter, and with chemicals soluble in water, and thus causes a considerable damage to turbines, engines, or other devices depending upon steam for their operation.

The main object of my invention is to construct an apparatus of this character so that it is adapted to be connected with any source of steam supply, such as a natural-steam well, and that it is adapted to remove from the steam that passes through the apparatus such non-condensable gases, dust or other foreign dissoluble or soluble substances as may be contained in the steam when it enters the apparatus, thus adapting the apparatus for use in connection with the various devices, in which steam is utilized for different purposes, and thereby preventing damage to such devices by the gases and substances carried with the steam from the well.

Another object of the invention is to provide an apparatus of the aforementioned character with means for leading therefrom the non-condensable gases and the soluble and dissoluble substances separately from one another and from the steam led from the apparatus, thus making it possible to recover from the gases and substances such elements as may be of value in one way or another.

With the above mentioned objects and with other objects in view, the invention consists in the novel construction and combination of parts hereinafter described, illustrated in the accompanying drawing, and set forth in the appended claims, it being understood that various changes in the form, proportion, size and minor details of construction within the scope of the claims may be resorted to without departing from the spirit, or sacrificing any of the advantages, of the invention.

The drawing shows in longitudinal mid-section a preferred embodiment of a steam-purifying apparatus, constructed and ar-

ranged according to the principle of my invention. This apparatus is indicated in general by the numeral 1 and comprises a receptacle in the form of a cylindrical casing 2, flanged at its top and bottom and provided with a peripherally flanged, interiorly concave closure head 3, which with its flange is secured by any suitable means to the flange at the top of the casing, while a similarly flanged, interiorly concave closure head 4, is suitably secured to the flange at the bottom of the casing. In order to support the apparatus 1, any suitable means may be provided. For instance, pedestals 5 may be arranged in suitable places under the bottom closure head 4 and may be integral with the closure head or otherwise suitably secured thereto.

An upward tubular extension 6, co-axial with the casing 2 and preferably terminating in a flange 7, is formed on the top closure head 3, and a pipe 8, provided at its upper end with a flange 9, which is suitably secured to the flange 7 so that the pipe 8 thereby has a steam-tight connection with the tubular extension 6, leads through the tubular extension and reaches downward a certain distance into the casing 2 and co-axially therewith. On the top of the flange 9 is secured by any suitable means so as to form a steam-tight joint therewith one of the flanged ends of an elbow 10, the other end of which has a steam-tight connection with the flanged end of a pipe 11, leading from a source of steam supply, such as a natural-steam well, not shown, and the pipe 11 may have connected therewith a thermometer 12, while a pressure gauge 13 may be connected with the elbow.

At its lower end the pipe 8 is threaded and has screwed thereon a nozzle 14, the opening of which is co-axial with the pipe and is adapted to be engaged by the lower, somewhat pear-shaped end portion 15 of a valve member 16. From this lower end portion the valve member is formed with a stem 17, which for a little distance from the junction with the portion 15 preferably is of a transversely square formation, as shown at 18. This square portion of the valve stem fits

slidably but non-rotatively in a guide member 19, which is secured within the pipe 8. While the valve member 16 thus is prevented from turning, it is at the same time allowed to slide with the portion 15 to or from a position for closing the nozzle 14.

From the square portion 18 the stem 17 is rounded and extends upward through the pipe 8 and the elbow 10 and also slidably through a protrusion 20, formed on the top of the elbow, and slidably through a pair of hubs 21 on a bracket 22, which is suitably secured on the top of the elbow, the openings in the protrusion 20 and the hubs being co-axial with the openings in the guide member 19 and the nozzle 14 so as to insure the proper working of the valve member 16. The stem 17 is threaded for some distance at its upper end portion, as shown at 23, and has screwed upon this threaded portion a handwheel 24, which is fitted with a minimum of play between the hubs 21, so that by the rotation of the handwheel in the required direction the valve member may be quickly moved to or from its position for closing the nozzle 14. In order to prevent leakage of steam around the valve stem 17 through the protrusion 20, the latter is preferably provided with gland-and-packing means 25.

A cylindrical shell 26, which has at its lower end an annular flange 27, fits with this flange within the casing 2, adjacent to the lower end thereof, and may be secured to the casing in any preferred manner, as by rivets 28, in order to make the shell virtually integral with the casing. By means of the flange an annular space is thus provided between the cylindrical walls of the shell and the casing. The arrangement of the shell is otherwise such that a little space is also provided between the lower end of the shell and the bottom of the casing formed by the interiorly concave closure head 4, while a comparatively large space is provided between the upper end of the shell and the top of the casing formed by the closure head 3.

In the flange are suitably arranged apertures 29 for the purpose of causing a restricted flow of liquid from the space below the shell into the space between the shell and the casing.

The shell 26 has at its top a funnel-shaped head 30, which is flanged at its inlet end and is secured with this flanged end to the shell in any suitable manner so as to make the connection between the head and the shell fluid-tight. Preferably, the head 30 is co-axial with the pipe 8 and extends with its outlet end downward and within the shell to a level below the valve member 16. At its outlet end the head 30 has a tube 31 suitably fixed thereto, the tube preferably extending within the shell 26, as shown in the draw-

ing, to a level with the flanged end portion 29 of the shell and also preferably widening somewhat towards its lower end.

Between the nozzle 14 and the head 30 are directing elements, which are shaped somewhat like the head and are arranged in a spaced relation to one another in the same direction as the head. In the present instance the elements are shown as three in number, the lowermost element 32 preferably being formed at its wide end with a peripheral flange portion 33, which fits the interior of the head and is secured to the latter in any suitable manner. Each of the other elements 34 and 35 has at its wide end a perforated lateral lip 36 for receiving therein a stud 37, which is screwed with its lower end into the flange portion 33, and spaced sleeves 38 are placed on the stud respectively above and below the lip on the intermediate element 34, while a nut 39 is screwed on the upper end of the stud, so that the elements are thereby firmly held in their spaced relation, as determined by the sleeves, and co-axially with the pipe 8 and the head 30.

The casing 2 is connected with a source of water supply, not shown, by means of a pipe 40 which has connected therewith a valve 41 for controlling the flow of water into the casing, and a level glass 42 may be connected with the casing so as to make visible to an operator the level at which the water is properly maintained in the casing, this level being represented in the drawing by a heavy line *a* above the head 30. The water above the head 30, of course, will flow into the head and over and between the directing elements 32, 34 and 35 and through the tube 31 and will rise in the shell 26 to a level represented by a heavy line *b*, so that within the shell and above this level a chamber 43 is formed for collecting non-condensable gases therein. By means of a level-glass 44, connected with the shell by pipes, which extend through the casing 2 and in fluid-tight relation thereto, the level *b* may be also observed from the outside of the casing.

Below and concentric with the tube 31 is a cup 45. The bottom of this cup is preferably shaped centrally somewhat like a cone, as shown at 46. The apex of this cone is directed toward the tube so that the cup thus constitutes a baffle, the purpose of which presently will be explained. Legs 47 may be provided for the cup so as to raise the cup from the bottom of the casing formed by the interiorly concave head 4, and any suitable means may be employed for securing the cup with its legs to the head.

The casing 2 is provided with several outlet means. One of them comprises a tubular extension 48 on the head 3 at the top of the casing. This tubular extension forms the outlet for purified steam, produced within the casing in a manner hereinafter de-

scribed, and has a steam-tight flange connection with pipes 49, which serve to lead the steam to any suitable place, not shown, for the utilization of the steam. If the pressure of the steam should be low, it may be found expedient to have a suction fan 50 connected with the pipes 49. The fan, however, may be regarded as an emergency equipment rather than a necessity. In fact, its use may seldom or never be required.

For the purpose of providing an outlet for the non-condensable gases from the chamber 43 the head 30 and the casing 2 have suitable openings therein, and a pipe 51 has steam and gas-tight connections with the head 30 and the casing in these openings, so that the non-condensable gases will pass from the gas chamber and through and out of the casing separately from the other fluids and substances therein. At the opening in the casing another pipe 52, which has a valve 53 connected therewith, is secured to the outside of the casing and leads to a suitable receptacle, not shown, so that the gases, if found to be of any value, may thus be utilized.

As stated before, the head 4 is interiorly concave so that mud and other foreign substances, carried with the steam or the water into the casing, may be collected thereon. In order to lead such foreign substances from the casing, the head 4 has thereon below the cup 45 a downward tubular extension 54. This extension has a flange connection with pipe 55 which leads to a suitable place of discharge, not shown, and the pipe has a valve 56 connected therewith so that the discharge of foreign substances from the pipe is thereby controlled.

In order to draw off the liquid mixture of water and condensate that flows into the space between the shell and the casing 2 and also in order to draw off such substances as may be held in solution in the liquid, the casing has therein an opening leading from the space between the shell and the casing and communicating with the pipe 57, which has a valve 58 connected therewith and leading to a suitable place of discharge, not shown. If these substances are of any value, they may thus be recovered by any suitable means.

The head 3 may also be provided with a thermometer 59 and a pressure gauge 60, so that an operator is thereby enabled to observe the temperature and the pressure of the purified steam in the steam space, indicated at 61, above the level *a* in the casing.

It being assumed that the apparatus is connected with the respective sources of steam and water supply, as before described, the operation of the apparatus is as follows: The valve 41 is opened so as to allow water to enter the casing 2 until it is above the level of the shell 26, preferably at the level represented by the line *a*, the valves 56 and 58

being closed. The water will then flow into and through the directing elements 35, 34, and 32, through the head 30 and the tube 31 and into and over the cup 45 and will fill the space at the bottom of the casing 2 below the flange 27 as well as the space between the tube 31 and the shell 26, approximately up to the level *b*. As soon as the water reaches the levels *a* and *b* the valve 41 is closed or is kept open only sufficiently for maintaining a virtually constant quantity of water at these levels in the apparatus.

The handwheel 24 is then turned so as to open the valve 16 and thus to allow the steam to be quickly injected through the pipe 8 and the nozzle 14 towards the directing elements 35, 34 and 32 where its mingling with the water causes it to be condensed. By means of the elements the flow of the liquid mixture of the water and the condensate is directed downward. As the steam continues to flow from the pipe 8 with great velocity, it forces a stream of the liquid downward against the baffle cup 45. The cone-shaped center 46 of the cup causes the stream of liquid to be diverted equally in all directions towards the periphery of the cup and upwards, and as the stream of the liquid leaves the cup it is thus greatly expanded, and, in consequence, the velocity thereof is correspondingly reduced, the velocity of the liquid being still further reduced towards the level *b* in the space between the tube 31 and the shell 26 on account of the shape of the tube which causes a widening of the space towards this level.

The velocity of the liquid being thus reduced, the liquid passes into the space at the bottom of the casing below the flange 27 and is forced upward through the apertures 29 in the flange into the space between the shell and the casing. These apertures are so designed that they will offer a certain resistance to the flow of liquid therethrough, thus causing the pressure on the liquid above the apertures to be considerably lower than the pressure on the liquid below the apertures. Because of the reduced pressure the liquid above the apertures boils and flashes into steam, which fills the steam space 61 above the liquid level *a* in the casing 2 and is led from the casing through the extension 48 and the pipes 49 to the place for utilization thereof.

It should be observed that the apparatus 1 is like a steam injector in the respect that, on account of the velocity of the steam, the pressure upon the water is greater than the pressure upon the incoming steam, and the water attains a higher temperature than is possible before its increase of pressure occurs. In my experiments I have thus found that the temperature in the lowermost directing element 32 is the same as the temperature required for vaporizing the water under the

increased pressure at this portion. Because of the gravity of the water, the pressure below the tube 31 is somewhat greater. Steam is therefore not released until the pressure is reduced in the annular space between the walls of the shell 26 and the casing 2.

At the same time as the liquid mixture of water and condensate passes into the space between the tube 31 and the shell 26, such non-condensable gases as are carried with the liquid will rise in bubbles therethrough into the gas chamber 43, in which the liquid mixture below the level *b* causes the collected gases to be under a constant pressure, the gases being expelled from the chamber when the valve 53 is opened and being led through the pipe 52 to the receptacle for the gases, as already has been described.

Owing to the gravity of the mud, sand and gravel or other non-dissoluble foreign substances suspended in the liquid, such substances do not follow the upward path of the liquid from the cup 45 and are not drawn through the apertures 29 but are caused to sink to the bottom of the casing and are drawn off therefrom whenever the valve 56 is opened. It is thus clear that these foreign substances can not be carried with the purified steam into turbines or other apparatuses, which depend upon steam for their operation and which could be seriously damaged if the foreign substances were allowed to enter therein.

By actual experiments I have found that the pressure of the purified steam in the steam space 61 is only a trifle lower than the pressure of the steam when it is led from its source into the pipe 8. The apparatus 1 is thus particularly adapted for purifying steam from steam wells, so that virtually the original steam pressure may be maintained and that thus, by the use of the apparatus, steam may be obtained in an economical manner and also that the apparatus operated by the steam can not be injured thereby, thus prolonged the life of such apparatuses.

From the foregoing it is clear that the construction and the arrangement of the apparatus 1 is such that the water moves in a circuit therein and that the water therefore is used repeatedly, with the exception of such slight additions thereto, or withdrawals therefrom, as may be required. When, for instance, the apparatus is connected with a natural-steam well, and when thus steam is lead in a superheated condition into the apparatus, more steam by weight is discharged from, than taken into, the apparatus. Under such a condition of the steam, the valve 41 is left open so that water is fed continuously into the apparatus through the pipes 40. On the contrary, if the incoming steam is wet, the condensation thereof causes more water to be continuously added to the water circuit

and necessitates the opening of the valve 58 in order to draw off the surplus through the pipes 57. In whatever condition steam is injected into the apparatus, the aim is, as before mentioned, to keep a virtually constant quantity of water at the levels *a* and *b* in the apparatus, because, with the water approximately at these levels, the apparatus will then function to the best advantage.

I claim as my invention:

1. A steam-purifying apparatus comprising a receptacle adapted for receiving and condensing steam therein; means for supplying water to the receptacle; means providing a water circuit within said receptacle; means for leading steam into the receptacle and for injecting the steam into the water circuit so that the steam is absorbed and condensed by the water; flow restraining means within the circuit enabling the steam to build up a superior pressure on the steam inlet side of said restraining means, whereby the water on said inlet side may be raised to a temperature approximating that of the incoming steam, and whereby said heated water in part flashes into steam on passing said restraining means; means for leading said last mentioned steam from the receptacle; means for collecting and for maintaining under pressure in the receptacle and separately from the incoming and the purified steam such non-condensable gases as are carried into the water circuit; and means for leading the non-condensable gases from the receptacle.

2. A steam-purifying apparatus comprising a receptacle adapted for receiving and condensing steam therein; means for supplying water to the receptacle; means providing a water circuit within said receptacle; means for leading steam into the receptacle and for injecting the steam into the water circuit so that the steam is absorbed and condensed by the water; flow restricting means within the circuit enabling the steam to build up a superior pressure on the steam inlet side of said restraining means, whereby the water on said inlet side may be raised to a temperature approximating that of the incoming steam, and whereby said heated water in part flashes into steam on passing said restraining means; means for leading the purified steam from the receptacle; means for precipitating such foreign substances as are carried into the receptacle and are held in suspension in the water circuit; means for leading the precipitated substances from the receptacle; and means for leading the liquid mixture of water and condensate, and therewith also such substances as are dissolved in the liquid mixture, from the receptacle.

3. A steam-purifying apparatus comprising a receptacle adapted for receiving and condensing steam therein; means for sup-

plying water to the receptacle; means providing a water circuit within the receptacle; means for leading steam into the receptacle and for injecting the steam into the water circuit so that the steam is absorbed and condensed by the water; flow restricting means within the circuit enabling the steam to build up a superior pressure on the steam inlet side of said restraining means, whereby the water on said inlet side may be raised to a temperature approximating that of the incoming steam, and whereby said heated water in part flashes into steam on passing said restraining means; means for collecting and for maintaining under pressure in the receptacle and separately from the incoming and the purified steam such non-condensable gases as are carried into the water circuit; means for leading the non-condensable gases from the receptacle; means for precipitating in the receptacle such foreign substances as are carried into the receptacle and are held in suspension in the water circuit; and means for leading the precipitated substances from the receptacle.

4. A steam-purifying apparatus comprising a casing adapted for receiving and condensing steam therein; a shell having at its lower end an apertured flange, which is secured within the casing so that an annular space is formed between the shell and the casing; a head secured at the top of the shell and provided with a passage for fluid there-through, the head having a tubular extension extending within the shell to the lower end of the shell and in a spaced relation to the latter; means for leading water into the annular space so that the water rises to a level above the head and assumes another level in the shell, thereby providing a circuit for the water and forming between the head and the water level in the shell a chamber, in which non-condensable gases are adapted to be collected and maintained under pressure; means for leading steam into the casing and for injecting the steam into the fluid passage so as to cause the steam to be absorbed and condensed by the water thereby heating the latter to the boiling point and to increase the pressure upon the water in this portion of the circuit, the pressure on the water entering the annular space being reduced on passing through the apertures in the flange, so that the water in that portion of the circuit within the annular space boils and flashes into purified steam above the first-mentioned water level in the casing; means for leading the last mentioned steam from the casing; means for leading the liquid mixture of water and condensate, as well as such substances as are dissolved in the liquid, from the casing; means for causing such non-condensable gases as may be carried into the circuit to pass therethrough into the collecting cham-

ber for the gases; and means for leading the gases from the chamber.

Signed at Los Angeles, in the county of Los Angeles, and State of California, this 15th day of June, A. D. 1928.

RICHARD G. MANIFOLD.

70

75

80

85

90

95

100

105

110

115

120

125

130