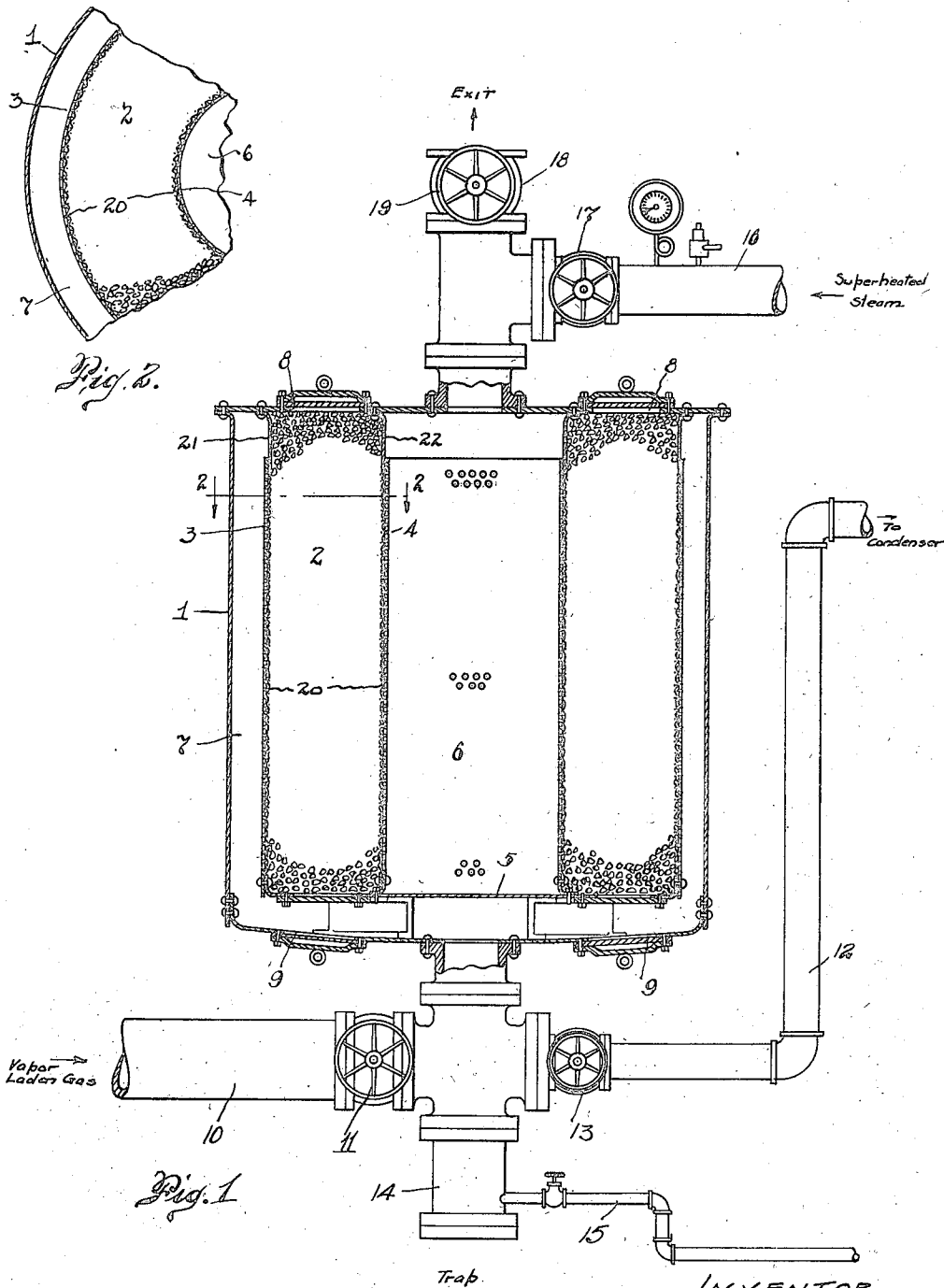


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 ADSORPTION APPARATUS FOR SOLVENT RECOVERY, ETC.
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ADSORPTION APPARATUS FOR SOLVENT RECOVERY, ETC.

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To all whom it may concern:

Be it known that I, ROLLAND R. ETTER, a citizen of the United States, and a resident of East Cleveland, county of Cuyahoga, and State of Ohio, have invented a new and useful Improvement in Adsorption Apparatus for Solvent Recovery, Etc., of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle, so as to distinguish it from other inventions.

The present improvements, relating, as indicated, to apparatus for solvent recovery, have more particular regard to the recovery of volatile hydrocarbon vapors from admixtures thereof with air or other gases, such as commercial natural and artificial fuel and lighting gas. Thus in various manufacturing processes involving the use of benzene and other similar solvent agents, considerable quantities of such agents ordinarily are converted into vapor form and so lost. It has also been found that a considerable quantity of naphtha and high test gasoline are present in the form of vapors in commercial natural gas, and the recovery and liquefaction of such vapors has become an important phase of the industry.

The present invention has as its object the provision of a simple and compact apparatus whereby vapors of the character just referred to may be readily and economically recovered from relatively dilute mixtures of the same with atmospheric air or other gaseous constituents. To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims, the annexed drawing and the following description setting forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawing:—

Fig. 1 is a central vertical section of an apparatus embodying the present improvements; and Fig. 2 is a broken horizontal section showing a portion of such apparatus.

The main element of the apparatus as illustrated in the foregoing drawing is a closed chamber 1, preferably of the cylindrical form shown, within which is located

an annular compartment 2 formed by means of two circular walls 3 and 4 concentrically arranged with respect to each other and the outer cylindrical wall of such chamber. Said walls 3 and 4 are perforated and rest on a false bottom 5 that is spaced a suitable distance from the lower end or bottom of the chamber 1, and that serves to seal off the lower end, both of the annular compartment 2 and of the central compartment 6 that is formed inside of the wall 4. The space between the false bottom 5 and the lower end of chamber 1, however, has free communication with the annular space 7 that is left between the walls 1 and 3. The upper end of internal compartment 2 is closed by the top wall of chamber 1, save where manholes 8 are provided, in order to afford access to the interior of compartment 2. Other manholes 9 in the bottom of chamber 1 afford access to the space between such bottom and false bottom 5 for the purpose of inspection and cleaning.

Connected with a central opening in the bottom of chamber 1 is a vapor supply line 10 controlled by a valve 11 also a line 12 controlled by a valve 13 that leads to a suitable condenser, not shown. There is, in addition, connected with such opening, a chamber 14 provided with a valve-controlled drain pipe 15 that serves to collect any condensate that may form in the connection just described, or in the bottom of the chamber, such bottom being interiorly concave so as to cause any liquid in the chamber to flow towards the aforesaid central opening therein.

Similarly connected with a central opening in the upper wall of chamber 1 is a steam supply line 16 controlled by a suitable valve 17 whereby, when desired, superheated steam, or equivalent heating medium, at any prescribed pressure and temperature may be introduced into compartment 6. There also leads from the same opening in the upper wall of chamber 1, an exit duct 18 controlled by a valve 19.

In operation, the internal chamber 2 is filled with a suitable adsorbent material, the character of which will depend upon various considerations, including the particular vapor or gas which it is desired to recover and also upon the gaseous medium with which such vapor or gas is admixed. For the purpose of recovering benzene from an admixture

of air, for example, the compartment in question is preferably filled with activated carbon, although silica gel, as well as other adsorbents, may be utilized if desired, provided they are adapted to give up the adsorbent volatile compound when exposed to superheated steam, or equivalent heating medium. Assuming the compartment in question to be filled with such adsorbent material, the manholes 8 being conveniently provided for this purpose, and that valves 13 and 17 are closed, valve 19 in the exit 18 is opened, and then valve 11 in the supply line 10. The mixture of air and volatile compound, if not already under sufficient pressure, is either forced by means of a fan or equivalent device associated with said line 10, or is drawn by similar means attached to exit 18, into the space between the bottom of chamber 1 and false bottom 5, and thence into the annular space 7 that surrounds the annular compartment 2. The walls of the latter being perforated, the gaseous mixture passes readily therethrough, and through the filling of adsorbent material between such walls, with the result that the volatile constituent is adsorbed to a degree depending upon the rate of flow, the thickness of the annular layer of material and other factors, including that of temperature. The residual unadsorbed gas escapes into the central compartment 6 and thence passes out through exit 18.

At the end of a period of time sufficiently long to permit the activated carbon, or other equivalent material in compartment 2, to adsorb the volatile constituent from the air or other gas supplied through line 10 to approximately the saturation point of such carbon, the valves 11 and 19 are closed, and valves 13 and 17 opened in the order indicated. As a result superheated steam will be admitted into the central compartment 6 of the chamber 1, thence passing in a reverse direction to that just described for the air through the internal compartment 2 into the annular space 7 and out through the connection with the bottom of said chamber 1 to line 12. The steam removes the volatile compound from the activated carbon, or other filling material in such compartment 2, and carries it to the condenser which operates in familiar manner to condense the mixed vapor into a liquid, from which the volatile compound may be separated upon settling, or by other means, as will be readily understood. Any moisture that condenses in chamber 1 or in line 12 is drained into the trap 14, from which it may be withdrawn, as previously described.

By means of an apparatus constructed as aforesaid, the adsorbent material may be disposed in the form of a thin layer or shell, and yet present a uniform resistance throughout the entire extent of such layer

to the passage therethrough of either the original mixture of gases or the superheated steam, or equivalent heating medium. The use of such thin shell permits the steam to be employed at a relatively low pressure, (such pressure may be as low as one pound above atmospheric pressure) at a corresponding decreased cost of operation. Thus, the difference, compared with the use of steam at a pressure of from ten to fifteen pounds, is as one to ten or even greater. Moreover, by admitting the steam, or equivalent heating medium, into the center of annular chamber 2, loss from radiation is kept down, and when flow is reversed it is the cooler adsorbent material with which the gas first comes into contact, thus cutting down the time required for changing from one phase of operation to the other. The disposition of such adsorbent material in the fashion described presents equal, if not greater, advantages in the charging phase of the operation, since the large surface area exposed to the gas flow for any given amount of the material admits of the use of a lower pressure than would otherwise be possible without decreasing the velocity of such flow, or in other words the capacity of the apparatus. The compactness of this apparatus will be obvious, while the arrangement of connections and valves is such as to permit of the convenient manipulation of the apparatus so that the latter will require the minimum of attention on the part of the operator.

As previously described, the walls 3 and 4, which laterally define the annular chamber 2, consist of plates, the size of the perforations and their spacing being gaged to suit the character of the adsorbent material used. However, as shown, a woven wire screen 20 may be used to line such walls interiorly of such chamber and thus assist in retaining the finer particles of the material from escape, without, however, interfering with the free passage of the gases or vapors through such walls. Furthermore, in order to facilitate the assembly of the apparatus and the taking apart of the same, said walls 3 and 4, instead of being extended entirely up to the top wall of chamber 1, and there attached, are discontinued a short distance below such top wall, and separate imperforate walls 21 and 22 are attached to said top or cover, being of such a length as to depend a suitable distance below the upper edges of walls 3 and 4, and at the same time closely fitting the same. It will also be noted that the lower portions of walls 3 and 4 are imperforate, the object in both cases being to prevent these gases or steam from "channelling" or short-circuiting around the ends of the filler of adsorbent material.

It will be understood of course that in

any installation of size, a battery of chambers like chamber 1 will be utilized, so that the flow of vapor-laden gas need not be interrupted when any particular chamber is cut out in order to recover the adsorbed vapor (benzol, gasoline, etc.) from the material filling said chamber 2. A sufficient number of units, in other words, will be employed, so that while certain ones are adsorbing such vapors others may be in the process of being blown out, whereupon the connections will be reversed and the operation of the plant as a whole thus rendered continuous.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. In apparatus for solvent recovery, the combination of an annular chamber having approximately concentrically disposed perforate walls and containing adsorbent material, and connections for alternately passing vapor-laden gases and a heating medium transversely through said chamber thus filled, from the exterior to the open central space surrounded by said chamber, or vice versa as desired.

2. In apparatus for solvent recovery, the combination of an annular chamber having approximately concentrically disposed perforate walls, solid adsorbent material filling such chambers, and connections whereby vapor-laden gases and a heating medium may be passed transversely through said chamber thus filled, from the exterior to the open central space surrounded by said chamber or vice versa as desired.

3. In apparatus for solvent recovery, the combination of an annular chamber having approximately concentrically disposed perforate walls, a body of activated charcoal filling such chamber, and connections whereby vapor-laden gases and a heating medium may be passed transversely through said chamber thus filled, from the exterior to the open central space surrounded by said chamber or vice versa as desired.

4. In apparatus for solvent recovery, the combination of an annular chamber having approximately concentrically disposed perforate walls, said chamber having an opening in an end wall whereby access may be had to the interior of said chamber for filling or removing solid adsorbent material, a removable closure for such opening, and connections whereby vapor-laden gases and a heating medium may be passed transversely through said chamber thus filled, from the exterior to the open central space

surrounded by said chamber or vice versa as desired.

5. In apparatus for solvent recovery, the combination of a main chamber, an annular sub-chamber formed within said main chamber and having perforate side walls, said sub-chamber extending from one end of said main chamber and terminating short of the other end thereof, a closure for the central space surrounded by said sub-chamber at such last-mentioned end thereof, and independent external connections with such central space and with the space in said main chamber lying outside of said sub-chamber.

6. In apparatus for solvent recovery, the combination of a main chamber, an annular sub-chamber formed within said main chamber and having perforate side walls, said sub-chamber extending from the upper end of said main chamber and terminating short of the lower end thereof, a closure for the lower end of the central space surrounded by said sub-chamber, and independent external connections with such central space and with the space in said main chamber lying outside of said sub-chamber.

7. In apparatus for solvent recovery, the combination of a main chamber, an annular sub-chamber formed within said main chamber and having perforate side walls, said sub-chamber extending from the upper end of said main chamber and terminating short of the lower end thereof, a closure for the lower end of the central space surrounded by said sub-chamber, and independent external connections with the upper, end of such central space and with the lower end of said main chamber.

8. In apparatus for solvent recovery, the combination of a main chamber, concentrically disposed perforate walls therein defining an annular chamber spaced from the outer wall of said main chamber and leaving a central open space, adsorbent material filling such annular chamber, and connections with the space between said annular chamber and outer wall and with such central space, whereby vapor-laden gases and a heating medium may be passed transversely through said annular chamber, as desired.

9. In apparatus for solvent recovery, the combination of a main chamber, concentrically disposed perforate walls therein defining an annular chamber spaced from the outer wall of said main chamber and leaving a central open space, adsorbent material filling such annular chamber, a false bottom in said main chamber supporting the walls of said annular chamber and closing the lower end thereof and of such central open space, connections with the bottom of said main chamber for supplying vapor-

laden gases and for conducting vapors to a condenser, as desired, and other connections with the top of such central open space for exit or supplying a heating medium, as desired.

10. In apparatus for solvent recovery, the combination of a main chamber, concentrically disposed perforate walls therein defining an annular chamber spaced from the outer wall of said main chamber and leaving a central open space, adsorbent material filling such annular chamber, the walls of said annular chamber terminating short of the top of said main chamber, corresponding walls depending from such top

and interfitting with the aforesaid walls to complete said annular chamber, a false bottom in said main chamber supporting the walls of said annular chamber and closing the lower end thereof and of such central open space, connections with the bottom of said main chamber for supplying vapor-laden gases and for conducting vapors to a condenser, as desired, and other connections with the top of such central open space for exit or supplying a heating medium, as desired.

Signed by me, this 3rd day of January, 1921.

ROLLAND R. ETTER.