Feb. 5, 1946. N. C. BEESE 2,394,357

SEPARATION OF GASES

Filed Aug. 25, 1939 2 Sheets-Sheet 1

Fig. 1.

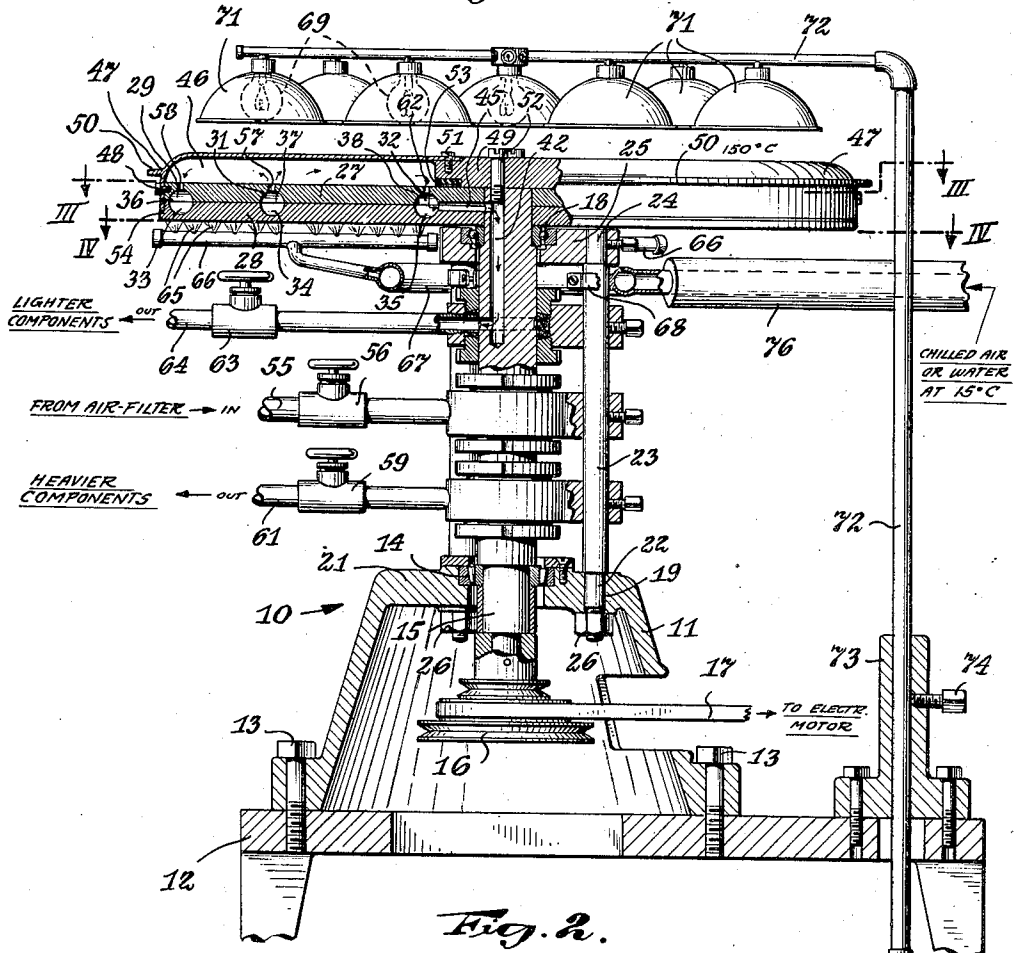
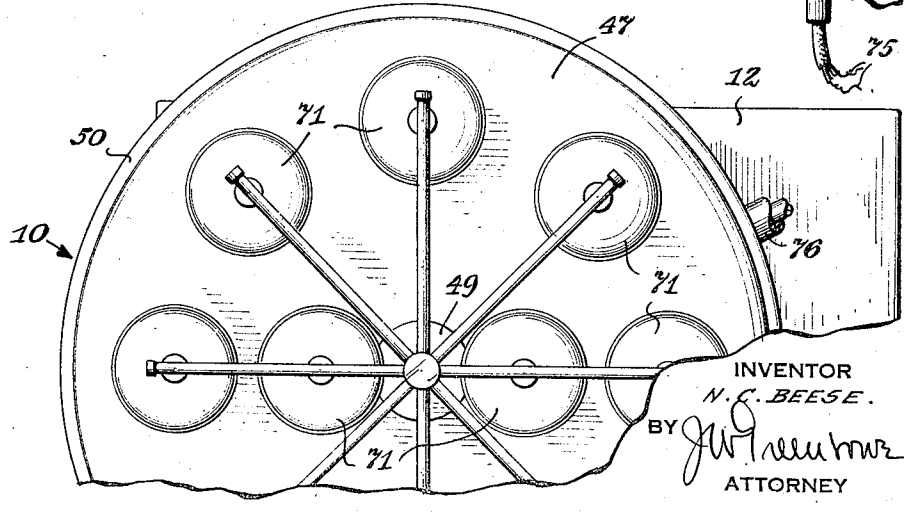


Fig. 2.



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Fig. 3.

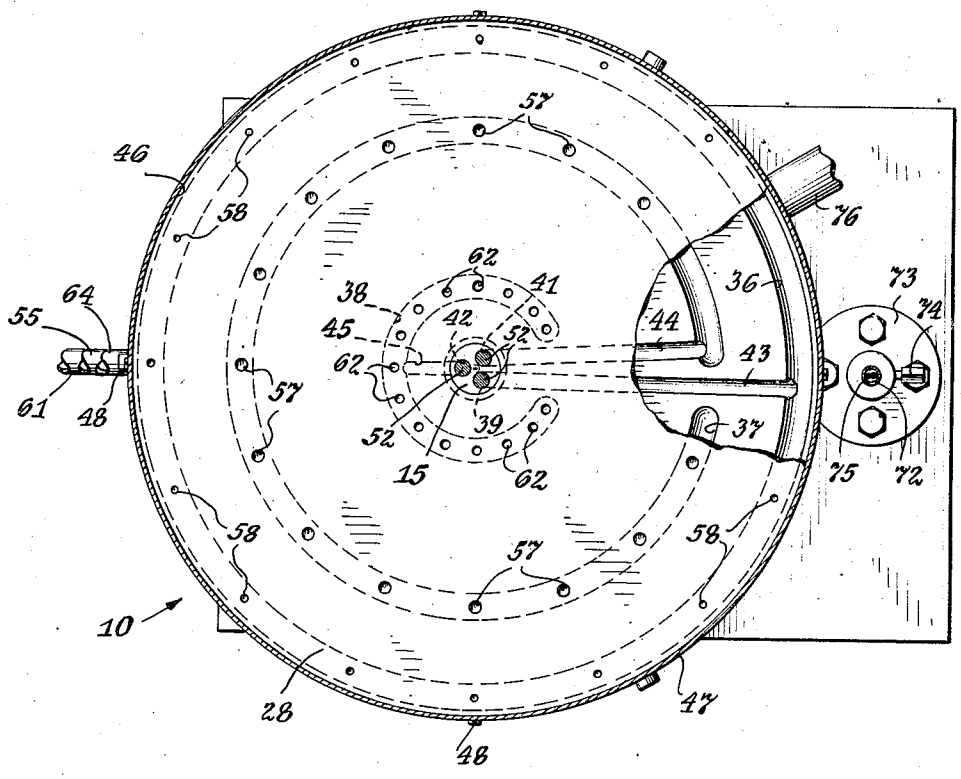
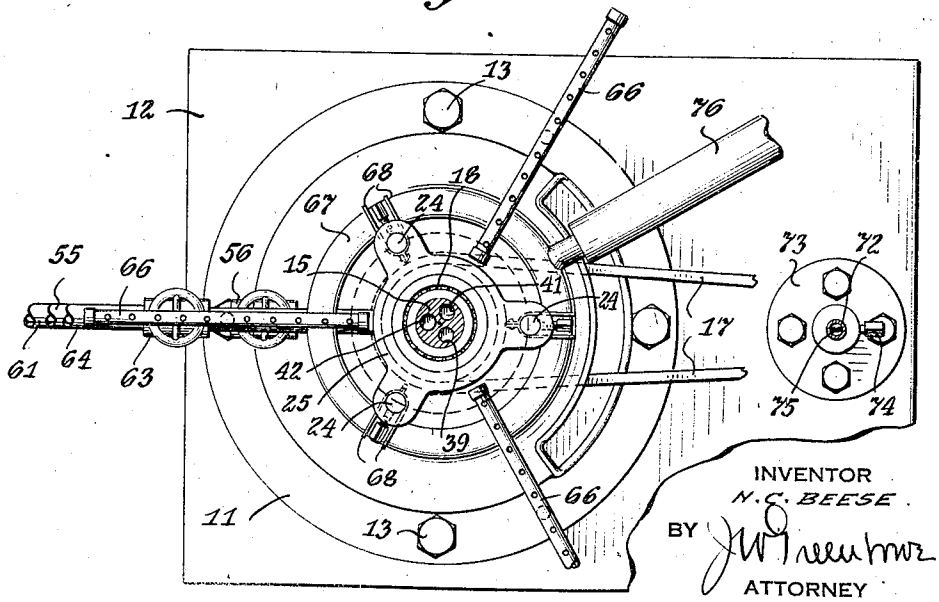


Fig. 4.



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2,394,357

SEPARATION OF GASES

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Application August 25, 1939, Serial No. 291,871

12 Claims. (Cl. 183—2)

This invention relates to the separation or purification of gases, and more particularly to a method and apparatus for separating the heavier from the lighter components of gases.

The principal object of my invention, generally considered, is the separation of the heavier and lighter components of gases in a convenient and expeditious manner.

One feature of the invention is the increasing of the gravitational difference between the components of gases by rotation, so that the heavier component is thrown to the periphery, leaving the lighter component near the axis.

Another feature of my invention is the employment of a thermal gradient across the gas, in order to cause an agitation effecting separation of the gas into its components.

A further feature of my invention is the provision of apparatus for separating the heavier and lighter components of gases, comprising a rotatable cylindrical chamber, the diameter of which is large as compared with its axial dimension, and rotating said chamber at high speed while maintaining one end wall at a temperature difference as compared with the other end wall, thereby preferably producing a temperature gradient of about 125° C. axially through the enclosed gas.

Other features and objects of the invention will become apparent as the description proceeds.

Referring to the drawings illustrating my invention:

Figure 1 is a side elevational view, partly in axial section, of apparatus employing my invention.

Figure 2 is a partial plan of the apparatus shown in Figure 1.

Figure 3 is a horizontal sectional view, on the line III—III of Figure 1, in the direction of the arrows.

Figure 4 is a horizontal sectional view, on the line IV—IV of Figure 1, in the direction of the arrows.

Referring to the drawings in detail, like parts being designated by like reference characters, there is shown a centrifugal machine 10, comprising a base 11 mounted on a platform or other support 12, and secured thereto by means of bolts 13. The base 11 carries a lower conical roller bearing 14, in which rotates a normally vertical shaft 15 carrying a cone of drive pulleys 16, operated by a belt 17 from an electric motor (not shown) or other source of power.

In order to maintain the shaft 15 vertical, and provide for the support of the necessary upper ball or roller bearing 18, apertures 19 are provided in the upper wall 21 of the base 11 for receiving the reduced sections 22 of standards 23, the upper ends of which are similarly reduced, as indicated at 24, and enter a collar 25 which carries the roller bearing 18. The standards 23 are secured to the base 11 in any desired manner, as by means of nuts 26 threadably engaging the lower ends thereof and adapted to tighten into engagement with the lower surface of the wall 21.

The upper end portion of the shaft 15 carries a pair of normally horizontal, generally circular, plates 27 and 28, of brass or other material of sufficiently high heat conductivity to provide for efficient heat transfer and maintenance of substantially uniform temperature throughout said plates. These plates are desirably grooved, as indicated at 29, 31, 32, 33, 34 and 35, to provide annular conduit 36, and nearly completely annular conduits 37 and 38, connected to ports 39, 41 and 42 in said shaft 15 by means of radial ducts 43, 44 and 45, in order to provide for the supply of gas to be treated and the withdrawal of the components into which said gas is separated, and sufficiently thick to permit operating the device above or below atmospheric pressure. The two parts 27 and 28 are soldered, or otherwise securely connected, to isolate the gas conduits and provide for good thermal conductivity therebetween. The conduits communicate with a chamber 46, defined by the plate 27 and a generally circular, flanged cover plate 47 of similar material, secured thereto as by means of bolts 48. The body portions of the plates 47 and 27 are preferably spaced a distance small, say about one centimeter, compared with their diameters, which may be greater than one foot. The central or axial portion of the cover 47 is secured to a hub member 49, as by means of bolts 51, said upper hub being in turn secured to the shaft 15 by means of bolts 52. In order to make the chamber 46 gas-tight, packing 53 and 54 is desirably employed. Said packing may be of a character and size to substantially heat-insulate the cover plate 47 from the composite bottom plate 27—28. A peripheral rib or ribs 50 may be provided on the cover 47 to minimize the transfer of heat therefrom to the bottom plate.

Air or other gas to be separated, desirably at a pressure of about one half atmosphere, or between 20 and 40 centimeters of mercury is introduced to the chamber 46 through supply pipe 55, valve 56, supply port 41, duct 44, conduit 37, and out of a series of ports 57, from which the gas is distributed when the machine is in operation. The heavier component (or compo-

nents) of the air, or other gas to be separated, is withdrawn through the outlet ports 58, conduit 36, radial duct 43, port 39, through valve 59, and outlet pipe 61, at a higher pressure, because of the centrifugal action. The pressure may still be below atmospheric, necessitating a vacuum pump. In a similar way, the lighter component (or components) of the air or gas is withdrawn from the chamber 46 through ports 62, conduit 38, radial duct 45, conduit 42, valve 63, and outlet pipe 64, as by means of a vacuum pump.

In order to maintain a desired temperature gradient across the chamber 46, in the present instance, I provide for cooling the lower plates 27 and 28, as uniformly as possible, as by means of jets of chilled air or water 65, issuing from axially extending underlying pipes 66, fed from annular collar 67, supported from the standards 23 as by means of clamps 68. The upper wall or plate 47 of the chamber 46 is, in the present instance, heated, as uniformly as possible, as by a plurality of radiant heaters 69, disposed in suitable reflectors 71, and supported thereover from a standard 72, adjustably positioned in a base 73, by means of a set screw 74, and supplied with suitable energy by means of an electric cable 75.

In practicing the process of my invention, the cooling medium, desirably chilled to about 15° C., is supplied from insulated pipe 76 to the jets 65, while the chamber 46 is rotated at high speed by means of the belt 17 from the electric motor previously referred to. The speed of rotation is desirably from 3000 to 5000 R. P. M. At the same time the source of heat 69 keeps the upper wall 47 at a relatively high temperature, desirably at about 150° C., so that the temperature gradient across the chamber is desirably as near as possible to 125° C. or above.

During said rotation and maintenance of the temperature gradient, the air, or other gas to be separated, is introduced to the chamber 46, as by opening the valve 56 to allow it to be fed to said chamber through ports 57. The valves 59 and 63 are opened, allowing the heavier component to pass out of the ports 58 to the outlet pipe 61, and the lighter component to pass through the ports 62 to the outlet pipe 64.

From the foregoing disclosure, it will be seen that I have provided for the continuous separation of the heavier and lighter components of gas in a convenient and expeditious manner. The main feature is the centrifugal separation of the components in a manner somewhat similar to that in which cream is separated from milk, the difference being that the gases which may be treated do not ordinarily separate gravitationally. The centrifugal separation in the present instance is made possible by thermal agitation caused by maintaining a relatively steep temperature gradient across the gas while separating the components. The thermal gradient established by one hot wall and an opposite cold wall causes a differential concentration of the gaseous components. This "thermal diffusion" causes a lamellar flow of light gas along the heated wall toward the axis of rotation, and a corresponding lamellar flow of heavy gas along the cold wall toward the periphery, thereby facilitating separation of the components.

Although I have shown the flat, cylindrical gas chamber as disposed with its axis vertical, it will be understood that, if desired, the axis may be horizontal, but preferably not diagonal.

Although a preferred embodiment of my invention has been disclosed, it will be understood that modifications may be made within the spirit and scope of the appended claims.

I claim:

1. The method of separating the heavier and lighter components of a gas, comprising introducing said gas into a chamber formed by plates disposed opposite one another and maintained at different temperatures, rotating said chamber, and drawing the lighter component off from the axial portion and the heavier component off from the peripheral portion of said chamber.

2. The method of separating the heavier and lighter components of a gas, comprising introducing said gas into a chamber, formed by plates positioned opposite one another and maintained at different temperatures, intermediate the periphery and axis of said chamber, rotating said chamber, and withdrawing the lighter component from the axial portion and the heavier component from the peripheral portion of said chamber.

3. The method of separating the heavier and lighter components of a gas, comprising introducing said gas into a chamber formed by closely spaced plates maintained at different temperatures, rotating said chamber at high speed in order to cause the heavier component to be thrown to the periphery by centrifugal force, and withdrawing the heavier component from said peripheral portion and the lighter component from the axial portion of said chamber.

4. The method of separating the heavier and lighter components of a gas comprising introducing said gas into a chamber formed of plates, generally parallel to one another and maintained at a temperature difference of about 125° C., in order to maintain a relatively sharp temperature gradient through said gas, rotating said chamber about an axis substantially perpendicular to said plates, and drawing off the lighter component from the axial portion and the heavier component from the peripheral portion of said chamber.

5. The method of separating the heavier and lighter components of a gas, comprising introducing said gas into a chamber formed by plates, generally parallel to one another and maintained at a difference in temperature of approximately 125° C., intermediate the periphery and axis of said chamber, rotating said chamber at a speed of between 3,000 and 5,000 R. P. M. and withdrawing the lighter component from the axial portion, and the heavier component from the peripheral portion of said chamber while rotating.

6. Apparatus for separating the heavier and lighter components of a gas, comprising a chamber, means for maintaining opposite walls of said chamber at different temperatures, means for rotating said chamber, and means for drawing the lighter component off from the axial portion, and the heavier component off from the peripheral portion, of said chamber.

7. Apparatus for separating the heavier and lighter components of a gas, comprising a chamber defined by plates disposed generally parallel to one another, means for maintaining said plates at different temperatures, means for introducing a gas into said chamber intermediate the periphery and axis thereof, means for rotating said chamber, and means for withdrawing the lighter component from the axial portion, and the heavier component from the peripheral portion, of said chamber.

8. Apparatus for separating the heavier and lighter components of a gas, comprising a ro-

tatable chamber formed of generally circular plates spaced at a distance small compared with the diameter of said plates, means for maintaining said plates at different temperatures, means for rotating said chamber at high speed in order to cause the heavier component to be thrown to the periphery by centrifugal force, means for withdrawing said heavier component from said peripheral portion, and means for withdrawing the lighter component from the axial portion of said chamber.

9. Apparatus for separating the heavier and lighter components of a gas, comprising a chamber formed of plates disposed generally parallel to one another, means for maintaining said plates at a temperature difference of about 125° C., means for rotating said chamber about an axis substantially perpendicular to said plates, means for drawing off the lighter component from the axial portion of said chamber, and means for drawing off the heavier component from the peripheral portion of said chamber.

10. Apparatus for separating the heavier and lighter components of a gas, comprising a chamber formed of plates disposed generally parallel to one another, one of said plates having a peripheral flange connected to the opposite plate, means for heating said flanged plate and cooling the other plate in order to maintain a difference in temperature of approximately 125° C., means for introducing gas into said chamber intermediate the periphery and axis thereof, means for rotating said chamber at a speed of between 3000 and 5000 R. P. M., means for withdrawing the lighter component of said gas from the axial portion of said chamber, and means for withdrawing the heavier component thereof from the peripheral portion of said chamber, while the same is rotating.

11. Apparatus for separating the heavier and lighter components of a gas, comprising a base, a bearing in the top wall of said base, a vertical shaft mounted in said bearing, standards extending from said base and supporting an upper bearing for said shaft, a chamber mounted on the top of said shaft and comprising a lower wall defining peripheral, intermediate and axial conduits for gas, said shaft having three ports extending therealong, one connected to said peripheral conduit, one to said intermediate conduit and one to said axial conduit, collars supported by said standards around said shaft and pipes carried by said collars and respectively communicating with said ports in order to allow for the introduction and removal of gas, a cover plate completing said chamber and connected to said conduit-carrying plates, and means for cooling one surface of said chamber and heating the other surface.

12. Apparatus for separating heavier and lighter components of a gas, comprising an upright shaft mounted for rotation about its axis, a chamber secured to said shaft and comprising a wall defining peripheral, intermediate and axial conduits for gas, said shaft having ports extending therealong, one connected to each of said conduits, collars supported around said shaft, and pipes carried by said collars and respectively communicating with said ports in order to allow for the introduction and removal of gas, a cover plate completing said chamber and connected to said conduit-carrying plates, and means for maintaining said lower wall and cover at different temperatures.

NORMAN CARL BEESE.