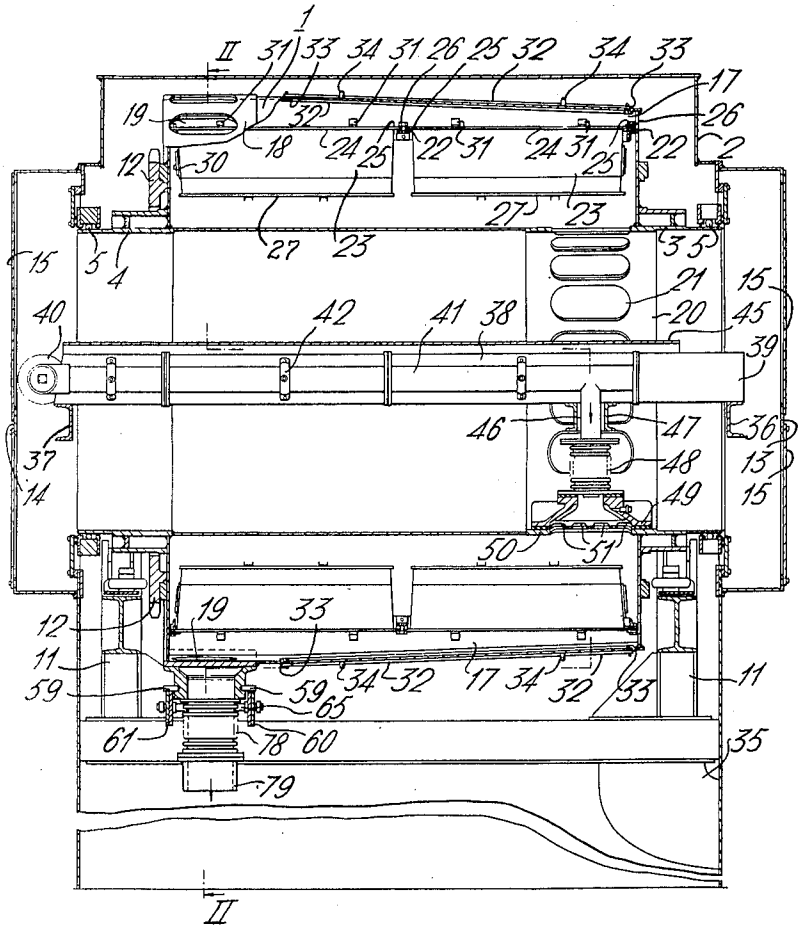
May 24, 1966 A. STEPHENS 3,252,273

SOLVENT RECOVERY PLANT

Filed March 2, 1962 2 Sheets-Sheet 1

FIG.1.




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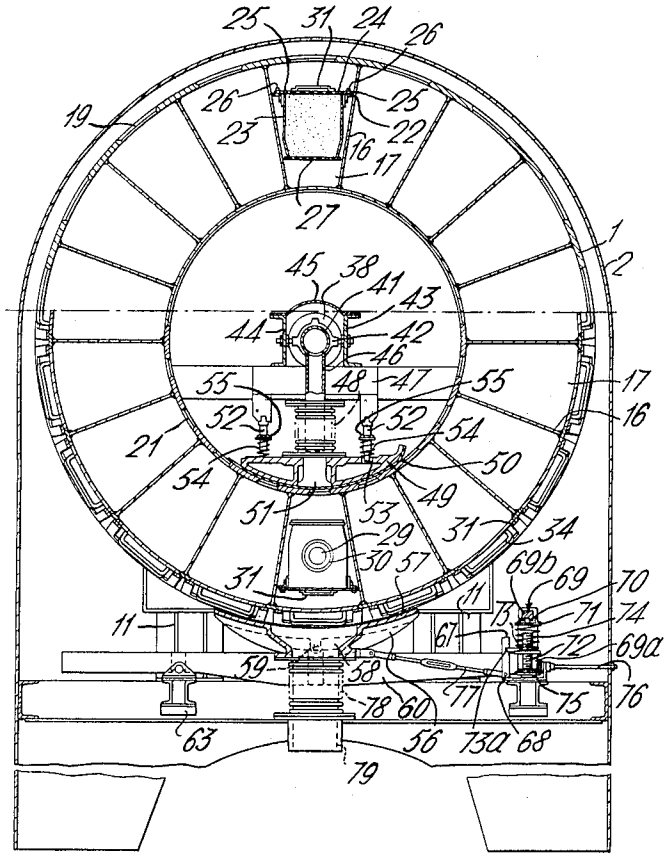
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FIG.2.




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United States Patent Office 3,252,273 Patented May 24, 1966



3,252,273

# SOLVENT RECOVERY PLANT

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Filed Mar. 2, 1962, Ser. No. 177,030
Claims priority, application Great Britain, Oct. 13, 1961, 36,871/61
6 Claims. (Cl. 55—179)

The invention relates to apparatus for continuously adsorbing and recovering solvent vapours by using a solid adsorbent such as activated carbon, of the kind in which the adsorbent is contained in a closed annulus divided into compartments by radial partitions and rotatable in a closed outer casing, and in which means are provided for continuously flushing the adsorbent in a radial direction in one part of the annulus during the adsorbing and recovering period.

The invention is also applicable to other purposes such as the drying of air or other gases, and it is among the objects of the invention to improve the efficiency of such apparatus.

According to the invention apparaus for continuously adsorbing and recovering solvent vapours by using a solid adsorbent such as activated carbon comprises a closed annulus of substantially rectangular axial section divided into compartments by radial partitions and rotatable in a closed outer casing, in which there is provided at or near one end of the closed annulus outer circumferential spaced ports each port registering with one compartment, and at or near the other end of the closed annulus inner circumferential similarly spaced ports, and an inlet and outlet for steam to pass through said ports, mounted in one longitudinal axial plane, the inlet being in the same radial plane as the inner ports and the outlet being in the same radial plane as the outer ports, the inlet and outlet each terminating in a stationary shoe which is in sliding steam-tight contact with the surfaces of the annulus so as to isolate one or more compartments from the remainder during rotation of the annulus so that steam may be passed through the isolated compartment or compartments to reactivate the carbon simultaneously with the continuation of the adsorbing and recovery operation in the remaining compartments.

According to the invention furthermore, apparatus for continuously adsorbing and recovering solvent vapours by using a solid adsorbent such as activated carbon comprises a closed annulus of substantially rectangular axial section divided into compartments by radial partitions and rotatable in an outer casing, in which each compartment is provided with mounting means whereby one or more perforated boxes containing the adsorbent may be mounted therein, and in which the closed annulus is provided with outer spaced ports in one radial plane, each port being in register with one compartment, and with inner similarly spaced ports in one radial plane, and there is provided an inlet and outlet for steam mounted in the same longitudinal axial plane, the inlet for steam being in the same radial plane as the inner spaced ports and the outlet for steam being in the same radial plane as the outer spaced ports, the inlet and outlet for steam each terminating in a stationary shoe in sliding steam-tight contact with the inner and outer peripheral surfaces of the annulus respectively to isolate one or more compartments from the remainder in the rotation of the annulus.

Thus, in apparatus according to the invention maximum use may be made of the adsorbent by the disposition of the inlet port and outlet port of each compartment at opposite ends and on opposite sides of the compartment while also ensuring that the adsorbent is effectively reactivated by the steam.



The provision of one or more carbon-containing boxes mounted in the compartments of the closed annulus affords several advantages, one of which is that maintenance of the plant is made easier as the boxes may be readily removed for repacking with carbon, or for repairing and replacing by a fresh box. The carbon-containing boxes are advantageously constructed of thin metal plates, the top and bottom plates of which are perforated.

One construction according to the invention is diagrammatically illustrated by way of example in the accompanying drawings in which:

FIGURE 1 is a side elevation partly in section of the apparatus; and

FIGURE 2 is a sectional end elevation on the line II—II of FIGURE 1.

An annular drum **1** is horizontally mounted to be rotatable about its longitudinal axis in a closed outer casing **2**. At each end, the casing **2** is formed with coaxial holes in which are rotatably mounted trunnion ends **3**, **4** of the annular drum **1** by means of ball or roller bearings **5**, sealing being effected in convenient manner. It should be understood that any mounting and sealing means which ensure that the annular drum **1** is rotatable about its longitudinal axis and is internally sealed from the outer casing **2** is suitable for use in apparatus constructed according to the invention. If it is found necessary additional support for the annular drum **1** may be provided by support members **11** provided at the position of each trunnion end **3**, **4** on which two or more rotatable rollers (not shown) may be mounted so as rotatably to support each trunnion end **3**, **4**.

At one trunnion end, namely that designated **4** in FIGURE 1, a toothed chain wheel **12** is provided whereby the annular drum **1** may be rotated by means of a chain drive from an electric motor or other driving means through reduction gearing or by hand at a speed advantageously in the range of 2 to 5 revolutions per hour, or more or less.

End plates **13**, **14** are provided on the casing **2** at the position of the mounting of the annular drum **1** so as to seal off the interior of the annular drum **1**. The end plates **13**, **14** may each be provided with one or more holes, closed by cover plates **15** whereby maintenance of the plant is facilitated.

The annular drum **1** is divided by radial partitions **16** into a number of compartments **17**—for example eighteen compartments. At one end the annular drum **1** has mounted thereon an outer circumferential band **18** provided with spaced ports **19** each of which is in register with one compartment **17**. At the other end the annular drum **1** is provided with an inner circumferential band **20** having spaced ports **21** each of which is in register with one compartment **17**.

In each compartment **17** inwardly projecting ledges **22** are provided or otherwise formed at the same relative position on each partition **16** and adapted to receive one or more, for example two, substantially cuboid or trapezoidal boxes **23** the tops **24** of which are formed with flanges **25** or the like, whereby the boxes **23** may be fixed, for example by bolts **26**, to the ledges **22** and sealed therefrom. The tops **24** and bottoms **27** of each box **23** are perforated and each box is provided with an opening through which the box may be filled with carbon and a closure plate to close the opening. Each box **23** is provided with handles **31**, whereby the box may be easily removed when the bolts **26** or other securing means are released.

In order that the boxes **23** should be readily accessible, and to simplify manufacture and maintenance of the apparatus, the outer periphery of the annular drum **1** at the positions of the compartments **17** is formed by plate members **32** secured to the drum **1** with strips **33** of seal-

ing material interposed between the undersurfaces of the plate members 32 and the outer periphery of the drum 1 over the contacting surfaces. The plate members 32 are advantageously provided with outwardly projecting handles 34, whereby the plates or lids 32 may be easily removed and the particular compartments 17 and the respective carbon-containing boxes 23 examined when the members 32 are unbolted.

Solvent-laden vapour enters the apparatus through an inlet at a convenient position, for example at 35, in the outer casing 2 and passes through the ports 19 into the compartments 17, through the activated carbon in the boxes 23 where it is stripped, through the ports 21 into the interior or core of the annular drum 1, and leaves the apparatus via an outlet which may be at the position of one of the cover plates 15 in the end 14 of the casing 2.

On beams 36, 37, mounted horizontally and perpendicular to the longitudinal axis of the annular drum 1 in the space enclosed by the end plates 13, 14 respectively, is mounted a tube 38 which is closed at one end 39 and passes through the middle or interior of the annular drum 1 and connects at the open end with a hole or port 40 in the plate 14. A steam pipe 41 is advantageously mounted in the tube 38 and lagged therefrom The steam pipe 41 and the tube 38 are positioned relative to each other and the axis of the annular drum by locating members 42 engaging with the steam pipe 41, the tube 38 and plate and angle members 43, 44, 45 enclosing the tube 38 over at least part of its length.

In the axial plane of the inner ports 21 the steam pipe 41 is provided with an outlet pipe 46 which passes through a beam 47 to a bellows 48. A shoe 49 formed at one face to the shape of the internal surface of the annular drum 1 and provided on that face with a layer 50 of sealing material, has a central hole 51 which is in connection with the bellows 48. The shoe 49 is mounted to be vertically movable on rods or shafts 52 passing through holes 53 in the shoe 49 and fixedly mounted on the horizontal beam or bracket 47. Compression springs 54 are mounted on the members 52 to exert a force pressing the shoe 49 onto the inner surface of the drum 1 and the force exerted may be varied by movement of spring-seating members 55 in threaded or other suitable engagement with the rods 52. Thus, as the drum 1 rotates each of the ports 21 in turn comes into register with the hole 51 and steam is passed into one of the compartments 17.

In the same longitudinal axial plane as the steam inlet which is preferably the vertical plane, a steam outlet is provided comprising a shoe 56 formed at one surface to the shape of the outer circumference of the drum 1 and provided on that surface with a layer 57 of suitable sealing materials, the shoe 56 being formed with a central hole or vent 58 and being mounted so that the hole or vent 58 registers with each of the ports 19 in turn during rotation of the drum 1. The shoe 56 is mounted in steam-tight engagement with the outer surface of the drum 1 the mounting comprising collinear stub shafts 59 each rotatably mounted in or on one of a pair of parallel beams 60, 61 each of which is pivotally mounted on brackets 63. The beams 60, 61 are connected to the ends of downwardly extending arms 69*a* of a stirrup or supporting member 69. The cross-bar 69*b* of the stirrup 69 is, at its mid-point, universally mounted by means of a ball-and-socket 70 on one end of a support member comprising a mounting 71 for the ball of the ball-and-socket 70 slidably mounted on a threaded shaft 72 which carries a nut 73. A fixed bracket 67 mates in a slot in a lug 73*a* integral with the nut 73. The bracket 67 thus prevents the nut 73 from rotating whilst allowing it to move vertically.

A compression spring 74 is provided round the shaft 72 between the nut 73 and the vertically slidable member 70, the lower end of the spring 74 seating on the nut 73. Bevel gears 75 are provided whereby on rotation of an adjusting rod 76 extending outside the casing 2 the force exerted on the cross-bar 69*b* of the stirrup 69 by the spring 74 may be varied thereby varying the contact pressure between the shoe 56 and the outer surface of the drum 1. A connecting link 77 of adjustable length is pivotally connected to the shoe 56 and the bracket 67 whereby the shoe 56 may be so positioned that the steam inlet 58 registers with the ports 19 during rotation of the drum 1. The hole or vent 58 of the shoe 56 is connected with a bellows 78 and an outlet pipe 79 through which the effluent steam passes.

In operation solvent-laden vapour enters the outer casing 2 of the apparatus at 35 and may first be passed through filter boxes or the like mounted in the base of the apparatus to remove particles of dust and the like which would choke the perforations in the carbon boxes 23 and impair the efficiency of the plant. A heater or cooler may also be included in the plant if necessary. The solvent-laden vapour after entering the outer casing 2 passes through the ports 19 into the compartments 17 of the rotating annular drum 1 and into the carbon boxes 23 via the perforations in the tops 24 of the boxes 23. The activated carbon in the boxes 23 strips the solvent from the vapour and the stripped vapour passes via the perforations in the bottoms 27 of the boxes 23 and the inner ports 21 of the annular drum 1 into the interior of the annular drum 1 and out through an outlet in the end plate 14.

As the annular drum 1 rotates successive compartments 17 come into register with the flushing means and the carbon in the boxes in the compartment in register with the flushing means is stripped of the solvent and reactivated by steam entering the compartment by the respective port 21 and passing out through the respective port 19 to the steam outlet pipe 79 which is connected with a separator if the solvent is insoluble in water or a collector and still if the solvent is soluble in water.

The operation of the steam may be continuous or periodic and is normally used at a pressure of 60 to 100 pounds per square inch or more or less, with or without superheat and the steam pressure in the adsorber may have any positive value up to about 5 pounds per square inch.

Further operational steps such as drying the carbon with hot air may be effected in similar manner to the flushing operation.

The apparatus of the invention may be constructed in a variety of sizes and two annular drums may be welded or otherwise joined together in the same outer casing, having steam inlets and outlets to the same steam supply and take-off to increase the capacity of the plant which may, for example, allow solvent-laden vapour to be passed through the apparatus at a rate of 10,000 cubic feet per minute or more or less for the single unit and 20,000 cubic feet per minute or more or less for the composite unit. It is, however, possible to build plants according to the invention to take any desired throughput of vapours.

What is claimed is:

1. Apparatus for continuously adsorbing and recovering a vapour from a gas stream by means of a solid adsorbent for the vapour, comprising an annular drum rotatable about its longitudinal axis and having a substantially cylindrical outer wall and a substantially cylindrical inner wall divided into a plurality of compartments by radial partitions with solid adsorbent in each of said compartments, a closed outer casing within which the annular drum is housed, a series of aligned ports in the outer wall of the annular drum enveloping one end of the longitudinal axis of the annular drum, at least one port of each the inner wall enveloping the opposite end of the longitudinal axis of the annular drum, at least one port of each series being in communication with each compartment, means for feeding a gas stream containing the vapour through the series of ports in the outer wall and along

the longitudinal axis of the annular drum such that the gas stream containing the vapour to be recovered passes through the solid adsorbent in the compartments and through the series of ports in the inner wall of the annular drum, an inlet and an outlet for gaseously desorbing one compartment at a time as the annular drum rotates about its longitudinal axis, a gas tight member through which the said inlet communicates with one compartment at a time through one port of the series of ports in the inner wall of the annular drum, and a gas tight member through which the outlet communicates with the same compartment through one port of the series of ports in the outer wall of the annular drum.

**2.** Apparatus for continuously adsorbing and recovering a vapour from a gas stream by means of a solid adsorbent for the vapour, comprising an annular drum rotatable about its longitudinal axis and having a substantially cylindrical outer wall and a substantially cylindrical inner wall divided into a plurality of compartments by radial partitions with solid adsorbent in each compartment housed within perforated containers, a closed outer casing within which the annular drum is housed, a series of aligned ports in the outer wall enveloping one end of the longitudinal axis of the annular drum, a series of aligned ports in the inner wall enveloping the opposite end of the longitudinal axis of the annular drum, at least one port of each series being in communication with each compartment, means for feeding a gas stream containing a vapour through one series of ports to the other along the longitudinal axis of the annular drum such that in passing through the annular drum the gas stream passes through the perforated containers and said other series of ports, an inlet and an outlet for a gaseous desorbing medium, a gas-tight member through which the said inlet communicates through a port in one of said series of ports



with a compartment, a gas-tight member through which the said outlet communicates with the same compartment through a port in one of the other of said series of ports, and means for removably mounting the perforated containers housing the said solid adsorbent in each of said compartments.

**3.** Apparatus according to claim **2**, in which each container is a box having a pair of oppositely disposed, perforated walls and being mounted in the compartment in such manner that solvent vapours entering the said compartment are constrained to flow into the box through one of said perforated walls.

**4.** Apparatus according to claim **2**, in which each container has in an end wall an opening provided with a removable closure plate.

**5.** Apparatus according to claim **2**, in which the outer wall of the said annular body is provided with a plurality of removable plates.

**6.** Apparatus according to claim **2**, including a dust filter adjacent to the annular drum within the outer casing, and through which solvent vapour may be passed before it enters said annular body.


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