

July 24, 1951

E. B. MILLER

2,561,990

METHOD OF DESULPHURIZATION OF GASES

Filed Oct. 14, 1947

8 Sheets-Sheet 1

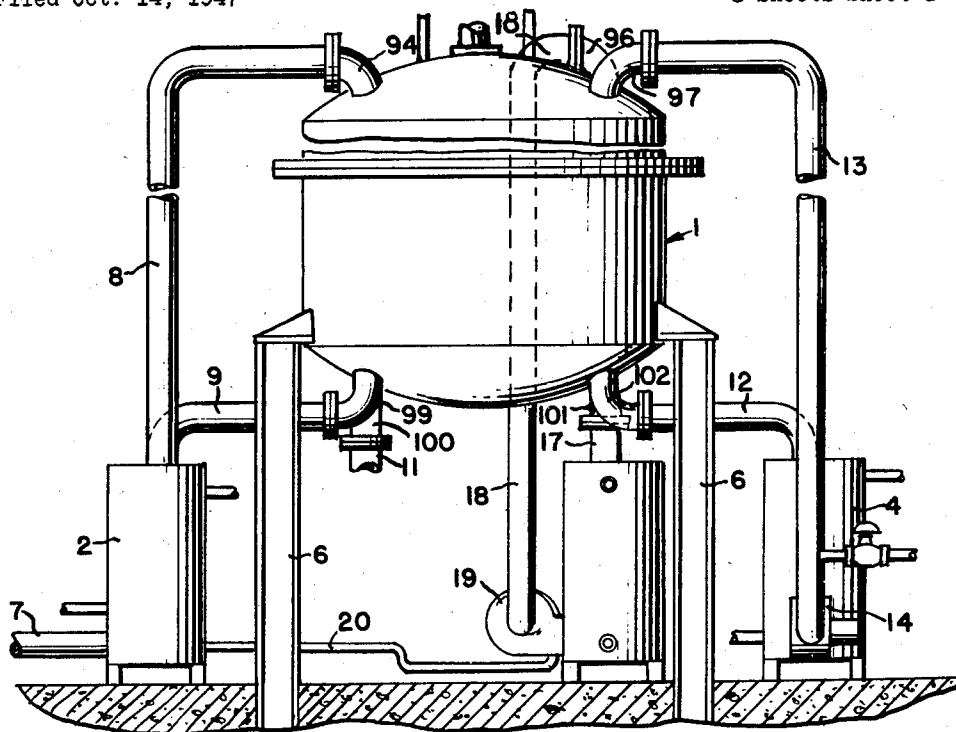


FIG. 1.

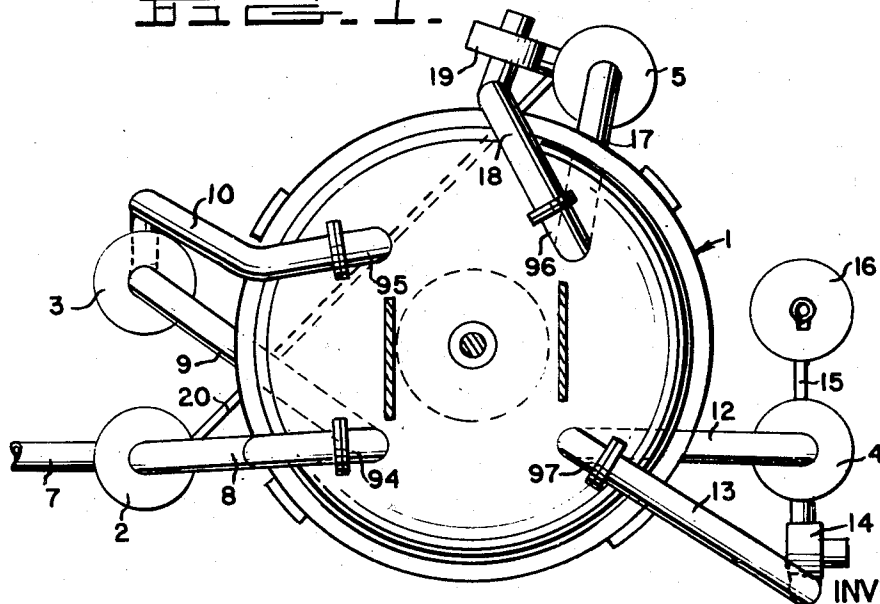


FIG. 2.

INVENTOR  
E. B. Miller

BY *Adams + Bush*

Attorneys

July 24, 1951

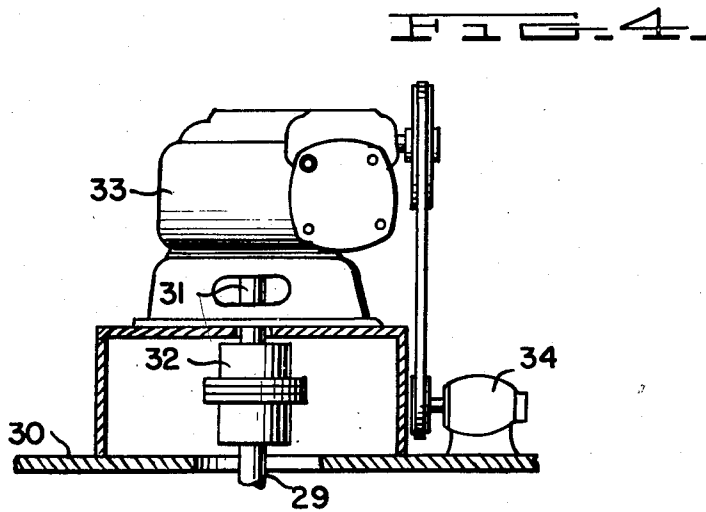
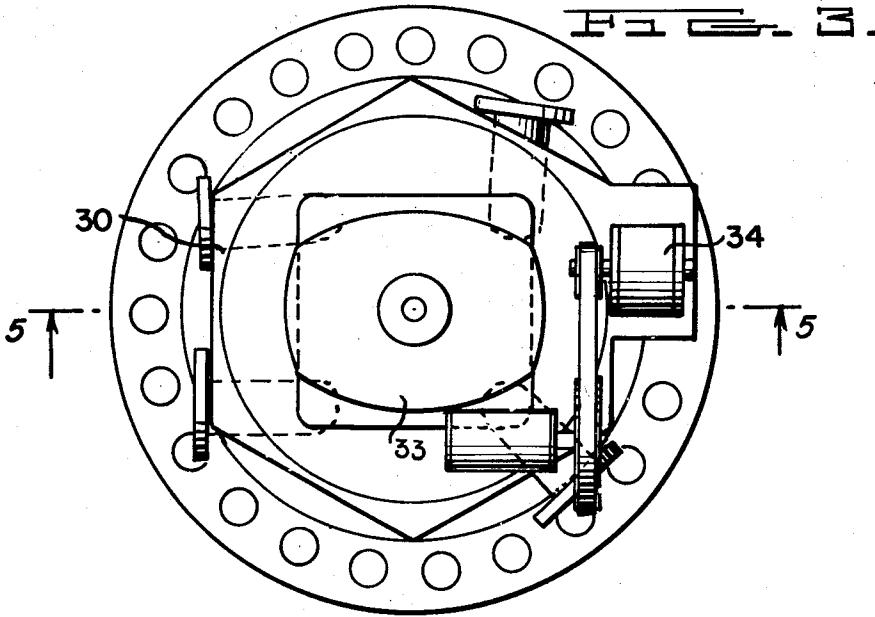
E. B. MILLER

2,561,990

METHOD OF DESULPHURIZATION OF GASES

Filed Oct. 14, 1947

8 Sheets-Sheet 2



INVENTOR.  
E. B. Miller  
BY *Adams & Bush*  
Attorneys

July 24, 1951

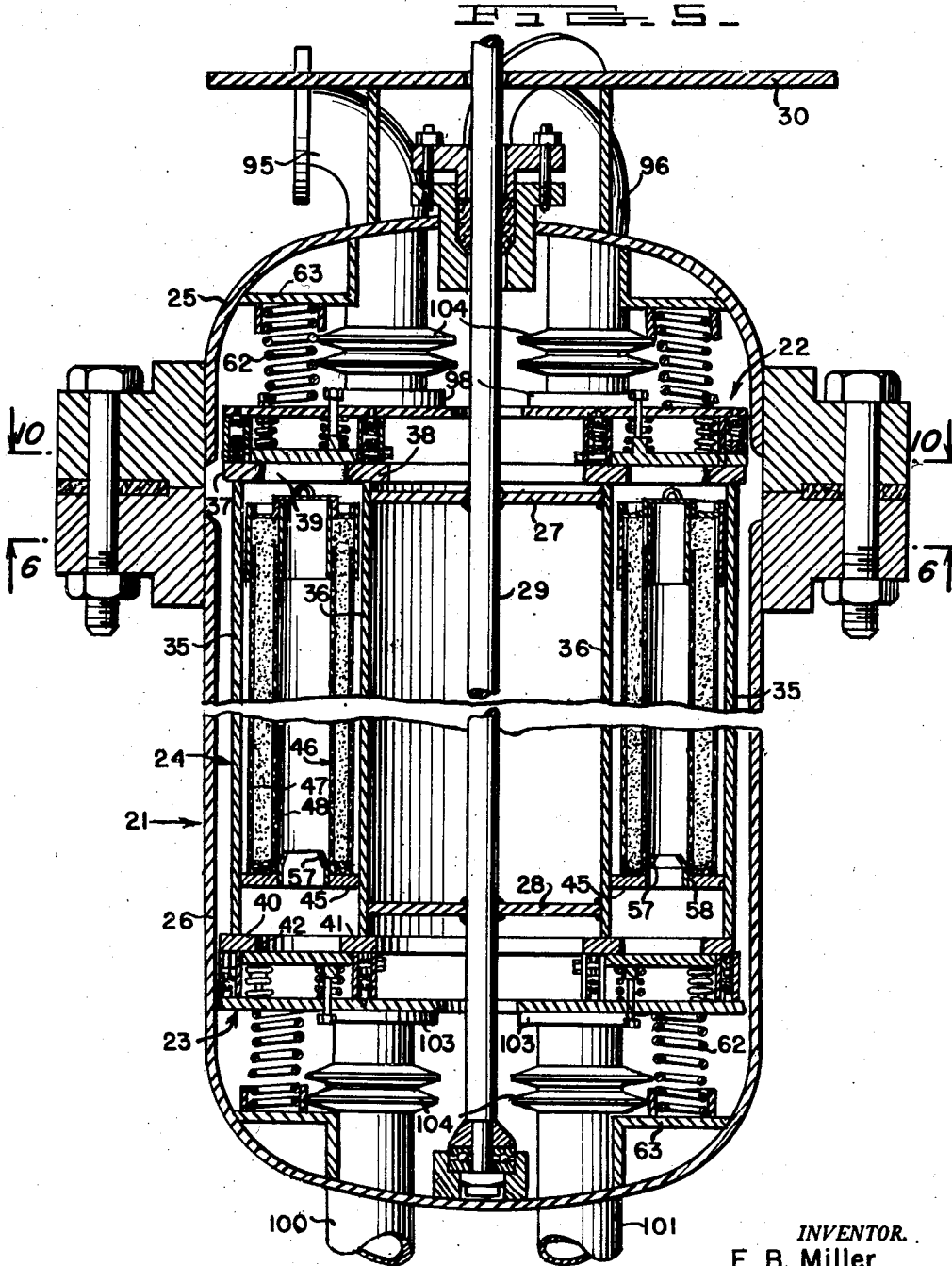
E. B. MILLER

2,561,990

METHOD OF DESULPHURIZATION OF GASES

Filed Oct. 14, 1947

8 Sheets-Sheet 3



INVENTOR.  
E. B. Miller

BY *Adams & Bush*

Attorneys

July 24, 1951

E. B. MILLER

2,561,990

METHOD OF DESULPHURIZATION OF GASES

Filed Oct. 14, 1947

8 Sheets-Sheet 4

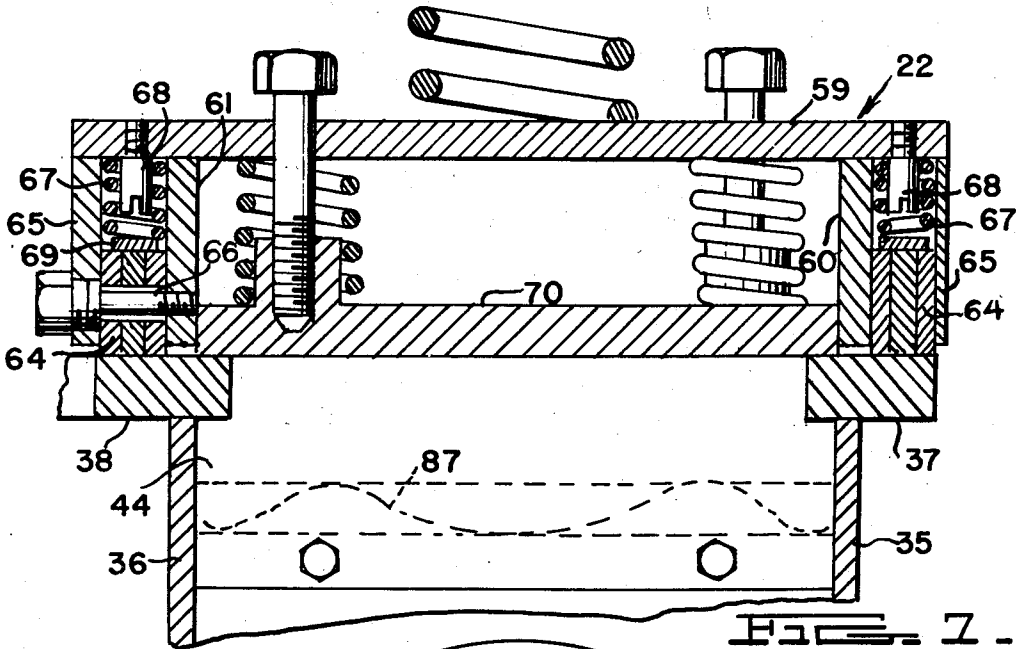


FIG. 7.

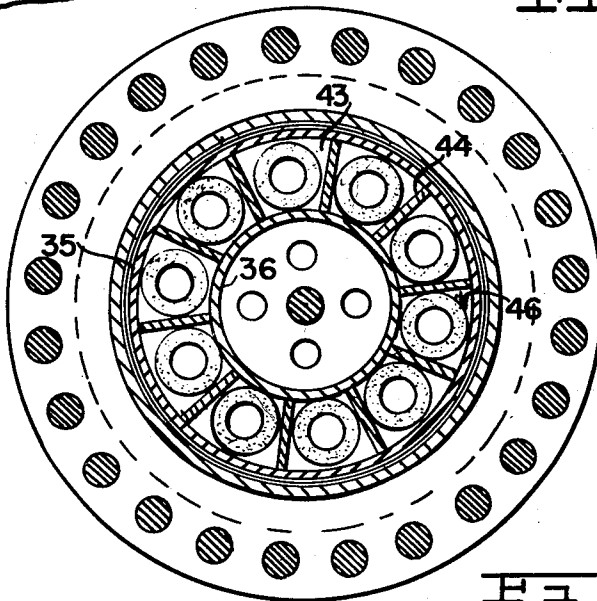


FIG. 6.

INVENTOR.  
E. B. Miller

BY *Adams & Bush*

Attorneys

July 24, 1951

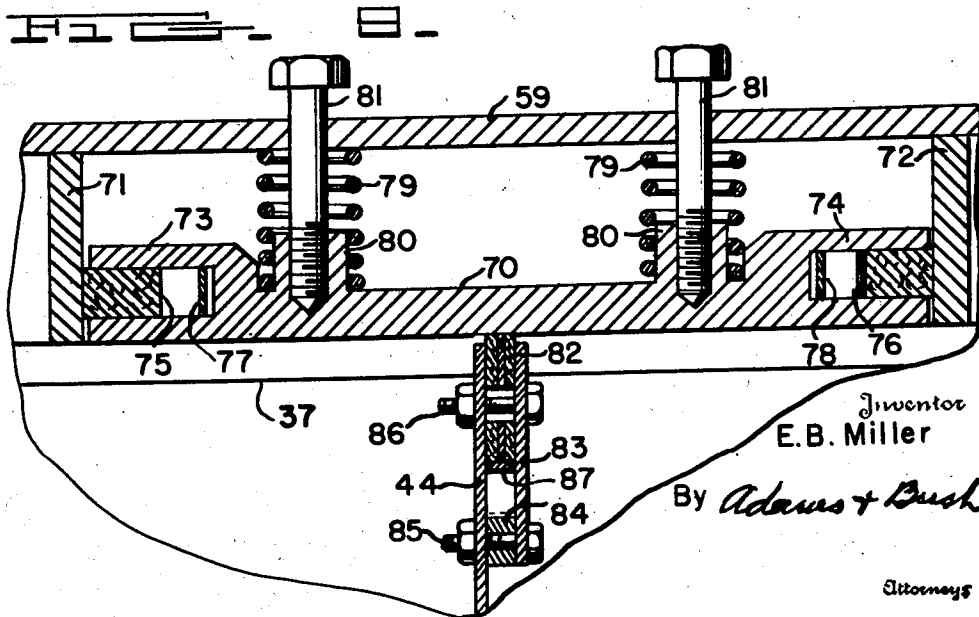
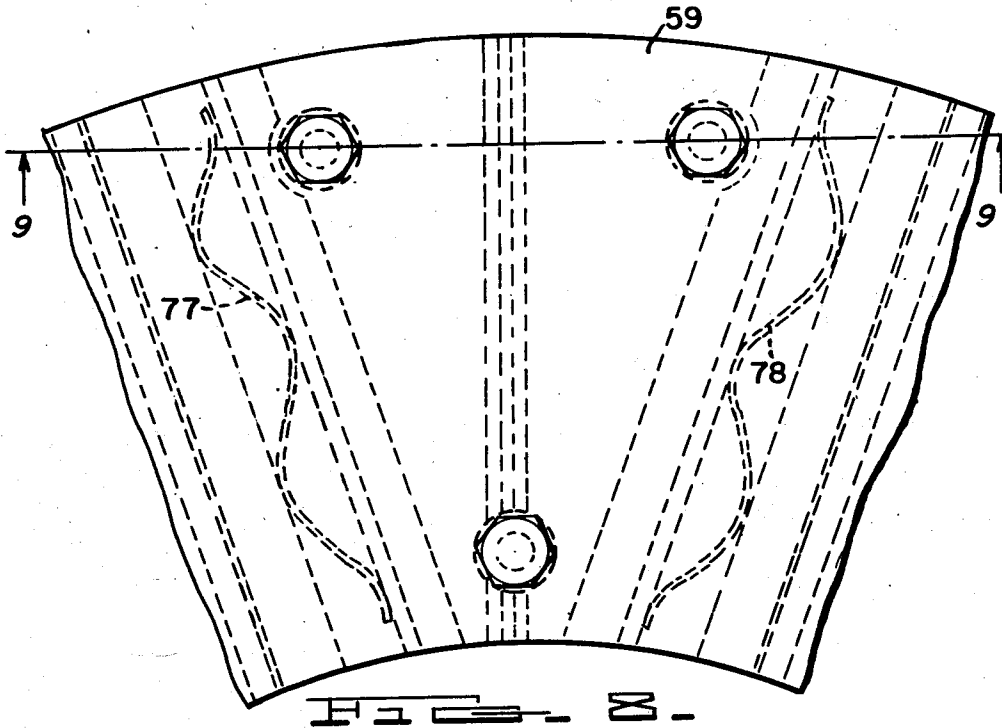
E. B. MILLER

2,561,990

METHOD OF DESULPHURIZATION OF GASES

Filed Oct. 14, 1947

8 Sheets-Sheet 5



July 24, 1951

E. B. MILLER

2,561,990

METHOD OF DESULPHURIZATION OF GASES

Filed Oct. 14, 1947

8 Sheets-Sheet 6

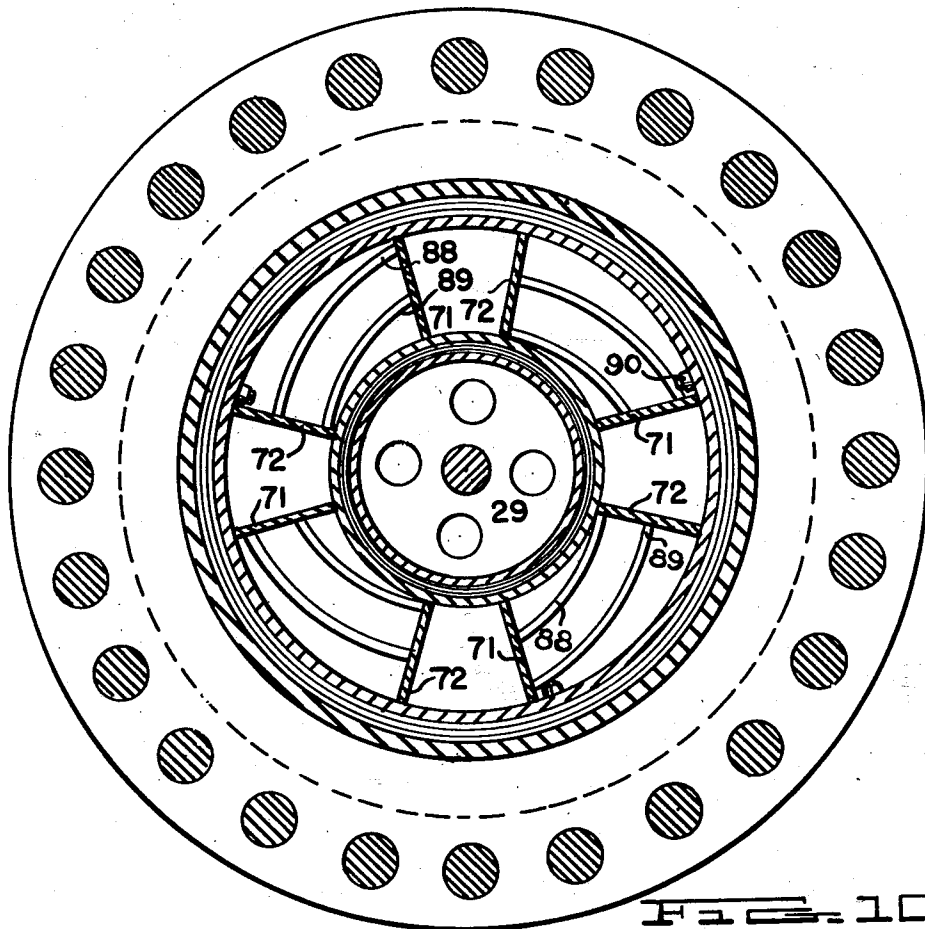


FIG. 10.

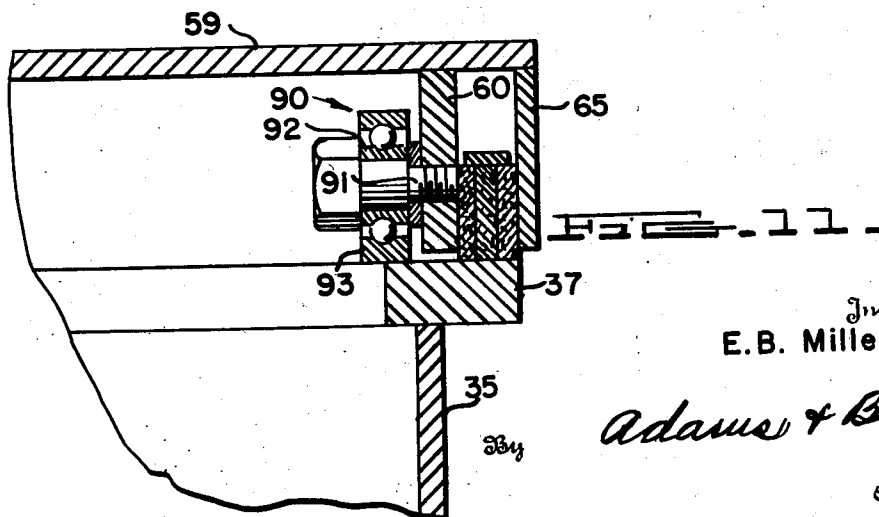


FIG. 11.

Inventor  
E. B. Miller

*Adams & Bush*

Attorneys

July 24, 1951

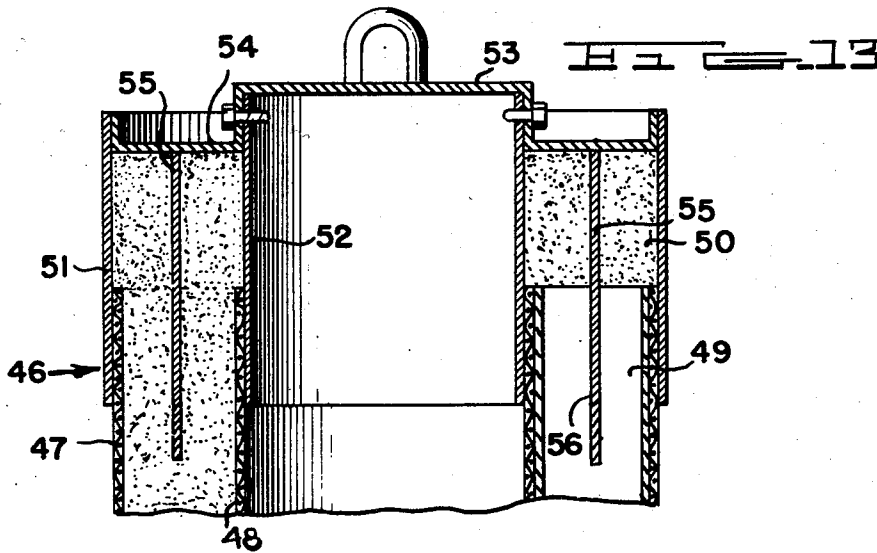
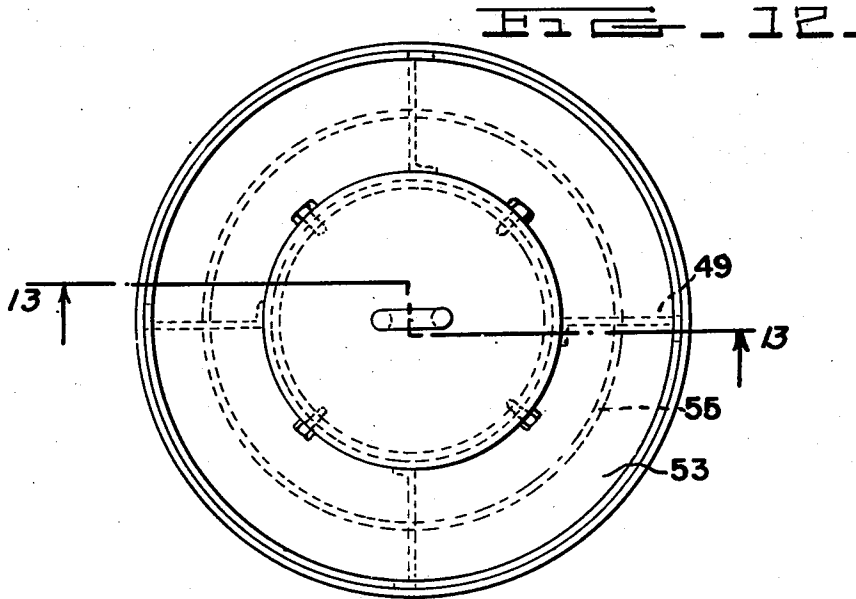
E. B. MILLER

2,561,990

METHOD OF DESULPHURIZATION OF GASES

Filed Oct. 14, 1947

8 Sheets-Sheet 7



Inventor  
E. B. Miller

Adams & Bush

Attorneys

July 24, 1951

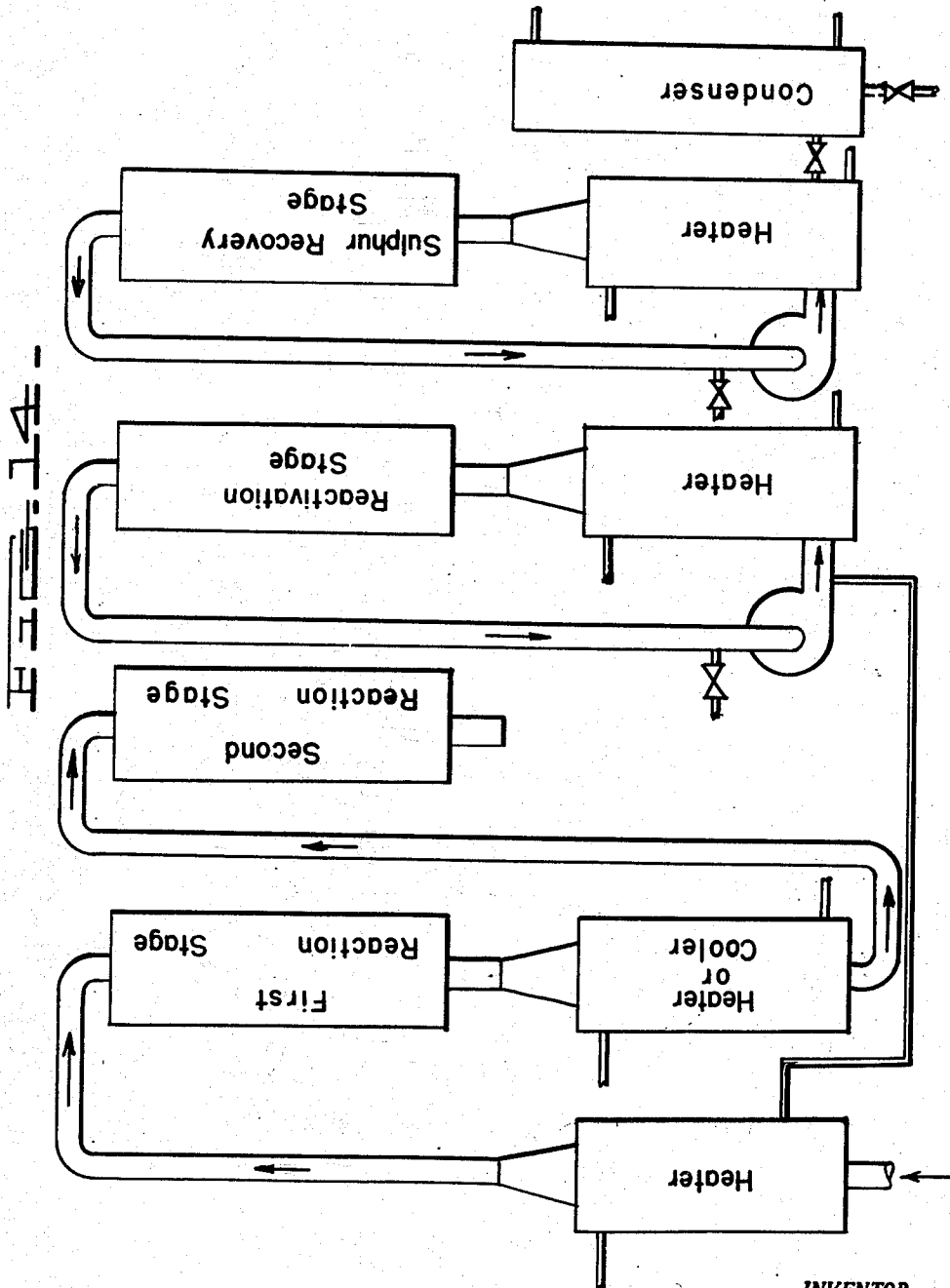
E. B. MILLER

2,561,990

METHOD OF DESULPHURIZATION OF GASES

Filed Oct. 14, 1947

8 Sheets-Sheet 8



INVENTOR.  
 E. B. Miller  
 BY *Adams & Bush*  
 Attorneys



# UNITED STATES PATENT OFFICE

2,561,990

## METHOD OF DESULPHURIZATION OF GASES

Ernest B. Miller, Houston, Tex., assignor to Jefferson Lake Sulphur Company, New Orleans, La., a corporation of New Jersey

Application October 14, 1947, Serial No. 779,824

4 Claims. (Cl. 23—225)

1

This invention relates to the desulphurization of gases and has more particular reference to a method of catalytic desulphurization of gases and the recovery of sulphur therefrom.

One object of the present invention is to provide a novel method of catalytic desulphurization of gases and the recovery of sulphur therefrom.

Another object of the invention is to provide a converter in which a plurality of catalyzing units are successively moved into and through one or more reaction chambers and then into and through a sulphur recovery chamber and, finally, into and through an activation chamber in which they are prepared for a repetition of the cycle.

Another object of the invention is to provide a converter, as characterized above, wherein the reaction, sulphur recovery, and activation chambers are mounted within a pressure vessel to permit equalization of pressures within and without the chambers.

Another object of the invention is to provide a converter in which a large surface area of relatively thin layers of granular catalytic material, offering a minimum of resistance to the flow of gases, is condensed into a small cubic space.

Another object of the invention is to provide a system for catalytic desulphurization of gases and the recovery of sulphur therefrom, including a converter as characterized above, wherein means are provided for controlling the temperature of the gases to be desulphurized during their passage through the converter.

Another object of the invention is to provide a system for the catalytic desulphurization of gases under high pressure and the recovery of sulphur therefrom.

Another object of the invention is to provide a system, as characterized above, wherein means are provided for continuously heating and recirculating a regenerating medium through the activation chamber of the converter and for bleeding a portion of the regenerating medium back into the gas to be desulphurized.

Another object of the invention is to provide a system, as characterized above, wherein means are provided for continuously heating and circulating a medium through the sulphur recovery chamber of the converter to remove the sulphur from the catalyst material and including means for separating the recovered sulphur from such medium.

Other objects and advantages of the invention will appear in the specification when considered

2

in connection with the accompanying drawings, in which:

Fig. 1 is a side elevation showing the mounting and arrangement of the apparatus of the invention, but omitting the converter driving mechanism;

Fig. 2 is a plan view of the apparatus shown in Fig. 1;

Fig. 3 is a plan view of the converter;

Fig. 4 is a side elevation, partly in section, of the converter driving mechanism;

Fig. 5 is a vertical sectional view of the converter; taken on line 5—5 of Fig. 3, but omitting the driving mechanism;

Fig. 6 is a horizontal sectional view of the converter, taken on line 6—6 of Fig. 5, but drawn to a smaller scale;

Fig. 7 is an enlarged vertical sectional view of the seal shown in the right hand side of the upper manifold of Fig. 5;

Fig. 8 is a plan view of the seal shown in Fig. 7;

Fig. 9 is a vertical sectional view taken on line 9—9 of Fig. 8;

Fig. 10 is a horizontal sectional view, taken on line 10—10 of Fig. 5;

Fig. 11 is a partial vertical sectional view of a manifold, showing the details of a roller;

Fig. 12 is a plan view of a tubular catalyst containing unit;

Fig. 13 is a vertical sectional view, with part broken away, taken on line 13—13 of Figure 12; and

Fig. 14 is a diagrammatic view showing the flow of the gas to be desulphurized and the flow of the regenerating and sulphur recovering media through the system.

In general, the invention comprises a method of continuously directing the flow of the gas to be treated into and through one or more reaction chambers, heating or cooling the gas to a predetermined temperature prior to its passage into each reaction chamber; continuously heating and directing the flow of a sulphur recovery medium into and through a sulphur recovery chamber, and then separating the recovered sulphur from the medium; continuously heating and recirculating a regenerating medium into and through an activation chamber; and continuously and successively moving a plurality of catalyzing units into and through the chambers.

For the purposes of illustration, the invention will be described in connection with the catalytic desulphurization of sour gas and the recovery of sulphur therefrom.

Referring now to the drawings, there is shown

3

in Figs. 1 and 2, one embodiment of apparatus and the arrangement thereof for carrying out the method of this invention. The apparatus shown includes a four-stage converter 1, two stages of which are used as reaction chambers in which the sour gas is brought into intimate contact with the catalyst, another stage is used as a recovery chamber in which the sulphur is separated from the catalyst, and the remaining stage is used as an activation chamber in which the catalyst is regenerated; a heater 2 for heating the sour gas prior to its passage through the first reaction stage; a heat exchanger 3 for heating or cooling the sour gas between the first and second reaction stages; a heater 4 for heating the medium circulated through the sulphur recovery stage; and a heater 5 for heating the regenerating medium prior to its passage through the activating stage. The converter is preferably supported in a raised position by a suitable framework, indicated at 6.

The sour gas to be desulphurized is delivered, under suitable pressure, from a source of supply (not shown) to the first reaction stage heater 2, by means of a pipe line 7. The gas is heated in the heater to about 200° C. and then passes through pipe line 8 to the first reaction stage of the converter. During its passage through the first reaction stage, the hot sour gas is brought into intimate contact with the catalyst and is partially desulphurized. From the first reaction stage, the partially desulphurized gas passes through pipe line 9 to the heat exchanger 3, where its temperature, which may have changed during its passage through the first stage, is readjusted to 200° C. From the heat exchanger, the heated partially desulphurized gas passes through pipe line 10 to the second reaction stage of the converter. During its passage through the second reaction stage, the hot partially desulphurized gas is brought into intimate contact with the catalyst and the final desulphurization takes place, leaving the gas sweet. After passing through the second stage, the now sweet or desulphurized gas is delivered, through pipe line 11, to its point of use (not shown).

The sulphur recovery medium, preferably steam, is supplied to the recovery medium heater 4, where it is superheated to about 800° F., and from the heater passes through pipe line 12 into the sulphur recovery stage of the converter. During its passage through the recovery stage, the superheated steam is brought into intimate contact with the catalyst and vaporizes the sulphur contained therein. From the recovery stage, the steam and sulphur vapor pass through pipe line 13 to a fan or blower 14, by means of which the steam and vapor are recirculated through the heater 4 and the recovery stage. A portion of the steam and sulphur vapor is bled off from the heater 4 by means of a pipe line 15 and passes into a sulphur condenser 16, from which the condensed liquid sulphur may be drained through a suitable drain valve. The sulphur condenser is preferably of the steam cooled type and the sulphur liquefies at about 300° F. The steam is discharged from the condenser through a suitable pressure relief valve located in the top of the condenser.

The regenerating medium, preferably air, is supplied under suitable pressure to the regenerating medium heater 5, where it is heated to about from 1000° F. to 1100° F., and, from the heater, passes into the activation stage of the converter through pipe line 17. During its pas-

4

sage through the activating stage, the heated air is brought into intimate contact with the catalyst and burns off any remaining particles of sulphur and impurities in the form of tars or carbonaceous matter contained in the sour gas.

From the activation stage, the hot air, together with the burnt off sulphur in the form of SO<sub>2</sub> passes through pipe line 18 to a fan or blower 19, by means of which it is recirculated through the heater 5 and the converter. A portion of the hot air with its SO<sub>2</sub> content is bled off the discharge line of the blower 19 and passes through pipe line 20 into the sour gas heater 2 so that the contained sulphur may be recovered, and the oxygen contained therein may be used to oxidize the gas in the first stage reaction chamber. The oxygen contained in the mixture of air and SO<sub>2</sub> which remains in the catalytic mass as it moves from the activation stage to the second reaction stage provides a part of the oxygen needed for oxidizing the gas in the second reaction stage.

The converter is similar in construction to the dehydrator shown in my co-pending application, Ser. No. 706,108, filed October 28, 1946, for Method of and Apparatus for Dehydrating Gas and Recovering Condensable Hydrocarbons Therefrom, now Patent No. 2,507,608, issued May 16, 1950, and comprises a pressure vessel 21; upper and lower manifolds 22, 23, fixedly mounted within the vessel; a compartmentized annular drum 24 rotatably mounted with the pressure vessel between and in communication with the manifolds; and suitable driving mechanism for rotating the annular drum.

The pressure vessel 21 is preferably formed in two parts, an upper flanged shell or cap 25 and a lower flanged shell 26 suitably secured together, as by bolting, to form a gas-tight joint.

The annular drum 24 is fixedly attached, as by means of plates 27, 28, to a central vertical shaft 29 suitably journaled in bearings carried by the upper and lower shell members 25, 26. The mechanism for rotating the annular drum is supported on a platform 30 mounted on the upper shelf 25 and includes a shaft 31 connected to the upper end of the shaft 29 by a coupling 32. The shaft 31 is driven by suitable reduction gearing mounted in a housing 33, the reduction gearing being belt-driven by a motor 34.

The rotatable annular drum 24 comprises two spaced concentric cylinders 35, 36, which form the side walls; two spaced annular plates 37, 38, each secured to the top of the cylinders 35, 36, respectively form the top of the drum, the space between the annular plates 37, 38 forming an annular opening 39 in the top of the drum; two spaced concentric annular plates 40, 41, each secured to the bottom of the cylinders 35, 36, respectively form the bottom of the drum, the space between the annular plates 40, 41 forming an annular opening 42 in the bottom of the drum.

The rotatable annular drum is divided into a plurality of compartments 43 by radial partitions or diaphragms 44. In each of the radial compartments 43, near the bottom thereof, there is provided a plate 45 attached to the walls of the compartment, as by welding, to form a gas-tight joint. Each plate 45 forms a support for one or more tubular catalyst containers 46. In the particular embodiment shown, only one such container is shown mounted in each compartment.

The catalyst containers 46 are identical in construction and, as shown in Figs. 12 and 13, each comprises two concentric tubular wire screens 47, 48, held in spaced relation by a plurality of longi-

5

tudinal radial fins 49, with the annular space between the screens closed at the bottom. The mesh of the screens is such as to retain a granular catalyst material 50 in the annular space between the screens. Although the invention is not limited thereto, it is preferred to employ a catalyst wherein granular silica gel or a substance having substantially the same structure is the carrier for the active material, preferably iron oxide.

Each of the containers 46 is closed at its top by means of concentric hoops 51, 52 mounted on the concentric screens 47, 48 and a cover plate 53 detachably connected to the inner hoop 52, as by screw bolts, and having a depending annular trough-shaped flange 54 fitting between the hoops 51, 52. A depending annular fin 55 is secured to the flange 54 and projects downwardly between and below the hoops 51, 52, and fits in slots 56 formed in the upper ends of the radial fins 49, all as shown in Fig. 13. The construction being such that, as the catalyst settles down, leaving a space between the top portion of the wire screens devoid of catalyst, the fin 55 will prevent gas from passing through the space devoid of catalyst. Each container 46 is detachably mounted on a nozzle 57 projecting upwardly from an opening 58 formed in the plate 45, as clearly shown in Fig. 5. The nozzle 57 is secured in the opening 58, as by welding, to form a gas-tight joint.

The top and bottom manifolds 22, 23 are mounted on the top and bottom of the annular drum 24, in communication with the annular openings 39, 42 formed in the top and bottom of the drum. The manifolds are identical in construction and each is formed in the shape of an annular trough having an annular top (or bottom) 59 and annular side walls 60, 61 (see Fig. 7).

A plurality of compression springs 62, mounted on brackets 63 suitably secured to the inner walls of the vessel 21, yieldably press the top and bottom manifolds against the top and bottom, respectively, of the annular drum. The top and bottom manifolds are held stationary relative to the rotation of the drum by means hereinafter to be described, and, to prevent the escape of gas between the rotating drum and the manifolds, sealing ring gaskets 64 are placed at the junction of the side walls of the manifolds and the drum. The sealing ring gaskets 64 are held in tight sealing engagement with the top and bottom of the drum by means of annular hoops 65 which encircle the gaskets and hold them against the side walls of the manifold. The upper (or lower) ends of the hoops 65 are secured to the top (or bottom) plate of the manifold, as by welding. The ring gaskets are retained between the hoops 65 and the side walls 60, 61 of the manifolds by means of a plurality of circumferentially spaced threaded bolts 66, which engage the ring gaskets and the lower portions of the hoops and side walls. The ring gaskets 64 are yieldably held in engagement with the top and bottom of the drum 24 by means of a plurality of compression springs 67 mounted on stud bolts 68 secured to the top (or bottom) of the manifolds and engaging annular plates or members 69 mounted on the top (or bottom) of the ring gaskets, all as clearly shown in Fig. 7.

At four circumferentially spaced points in the top and bottom manifolds, there are located seals which, by reason of the sliding contact of the radial partitions 44 against the under surface of the bottoms of the seals, divide the manifolds and drum into four sectors, each sector gas-tight with

6

respect to the adjacent sectors. The seals are identical in construction and the details thereof are best shown in Figs. 7, 8 and 9. Each seal includes a bottom or sealing plate 70 mounted within the manifold between spaced radial partition walls 71, 72. The bottom plate 70 is yieldably urged against the top (or bottom) of the drum and rests on the concentric annular plates 37, 38 which form the top of the drum (or plates 40, 41 which form the bottom of the drum), as shown in Fig. 7. The side edges of the plate are bifurcated, as shown at 73, 74, for the reception of gasket strips 75, 76, which are yieldably pressed outwardly against the partition walls 71, 72 of the seal by leaf springs 77, 78, as shown in Figs. 8 and 9.

The means for yieldingly pressing the bottom plate 70 of the seal against the top (or bottom) of the drum comprise a plurality of compression springs 79 mounted on projections 80, formed on the upper surface of the plate 70. The springs 79 engage the top (or bottom) of the seal and are held in position by bolts 81 projecting through the top (or bottom) of the seal and coiled springs and threaded into the projections 80 formed on the plate 70.

Each radial partition or diaphragm 44 has a portion of its top and bottom edges extending upwardly (or downwardly) between the edges of the openings in the top and bottom of the drum. A gasket 82 is secured on these portions and extends above (or below) their top (or bottom) edges and engages the under face of the bottom plate 70 of the seal.

Plates 83 are secured to the tops and bottoms of the partitions and are held spaced therefrom by a spacer strip 84, the plates and spacer strip being secured to the partitions by bolts 85. The gaskets 82 are confined between the partitions and the plates 83, as by means of bolts 86, and are pressed upwardly (or downwardly) against the under surface of the bottom plates 70 of the seals by means of leaf springs 87, all as shown in Fig. 9.

In order to prevent the gaskets 82 from being unduly pressed upwardly (or downwardly) when the gaskets are not engaging the bottoms of the seals, means are provided for spanning the reaches of the manifolds between the seals. These means comprise spaced pairs of curved plates 88, 89 which extend between and are secured to the partition walls of the seal, as shown in Fig. 10. The bottom surfaces of the plates 88, 89 are in the same horizontal plane as the bottom surfaces of the bottom plates 70 of the seals, so that, as the gaskets 82 move out of engagement with the bottom plate of the seal, they immediately engage the plates 88, 89.

A plurality of rollers 90 are mounted within the top and bottom manifolds. These rollers are circumferentially spaced within the manifolds and are adapted to engage the annular plates 37, 40 which form parts of the top and bottom, respectively, of the rotatable drum. These rollers are adapted to prevent frictional surface engagement between the side walls of the manifolds and the top and bottom of the drum. These rollers are identical in construction and mounting and each comprises a threaded stud bolt 91 screwed into the outer side wall 60 of the manifold; a ball race 92 fixedly mounted on the bolt; and a wheel 93 mounted on the ball race, all as shown in Fig. 11.

Four pipes or conduits 94, 95, 96 and 97 having threaded ends project through the cap of the vessel 21 and have their threaded ends secured to

7

the top plate of the top manifold by means of lock nuts 98 which form gas-tight joints. The pipes are welded to the cap and hold the top manifold stationary relative to the rotation of the drum. The four pipes are circumferentially spaced with respect to the top manifold and each is secured to and communicates with the manifold at a point located between the seals.

Four additional pipes 99, 100, 101 and 102, having threaded ends, project through the bottom of the vessel 21 and have their threaded ends secured to the bottom plate of the bottom manifold by means of lock nuts 103 which form gas-tight joints. These pipes are welded to the bottom of the vessel 21 and hold the bottom manifold stationary relative to the rotation of the drum. These pipes are circumferentially spaced with respect to the bottom manifold and each is secured to and communicates with the manifold at a point located between the seals. The width of the seals with respect to the radial compartments 43 containing the catalyzing units is such that at all times at least one of the partitions or diaphragms 44 is engaging the bottom plate 70 of the seal in gas-tight engagement.

From the foregoing, it will be readily seen that by the engagement of the radial portions with the seals, the manifolds and drum are divided into four gas-tight chambers or sectors, called, for convenience, the first reaction stage, the second reaction stage, the sulphur recovery stage, and the activation stage.

The drum carrying the tubular catalyst containers is rotated counter-clockwise, as viewed in Fig. 2, and, as it rotates, the tubular catalyst containers are successively moved through the four stages in the following order: the second reaction stage, the first reaction stage, the sulphur recovery stage, and the activation stage. The four pipes 94, 95, 96 and 97 are connected to pipe lines 8, 10, 18 and 13, respectively, and the four pipes 99, 100, 101 and 102 are connected to pipe lines 9, 11, 17 and 12, respectively, by means of which the sour gas, desulphurizing medium and reactivating medium flow into and through the converter.

The flow of the sour gas through the reaction stages, the flow of the sulphur recovery medium through the sulphur recovery stage, and the flow of the hot air through the activation stage are shown schematically in Fig. 14.

The sour gas to be desulphurized, together with the bled off mixture of air and SO<sub>2</sub> from the recirculating system for the regenerating medium, which is the oxidant, after being heated to the optimum reaction temperature in the first reaction stage heater, passes through pipe line 8 to the converter and enters the top manifold of the first stage through pipe 94. Then, it moves downwardly from the manifold through the opening in the top of the drum into the various compartments of the drum containing the tubular catalyst containers, as are at that time contained within the sector forming the first reaction stage. The sour gas passes through the pervious layer of catalytic material into the interior of the tubular container; thence, downwardly through the opening in the plate 45 into the bottom of the drum, and through the opening therein into the bottom manifold. From the bottom manifold, the now partially desulphurized gas passes through pipes 99 and 9 to the second reaction stage heat exchanger, where the temperature of the gas, which may have changed during its passage through the first stage, is

8

again adjusted to the optimum reaction temperature. From the second reaction stage heat exchanger, the partially desulphurized gas passes through pipes 10 and 95 into the top manifold of the second reaction stage. The gas moves downwardly through the second reaction stage, in a manner similar to its downward movement through the first reaction stage and during its passage further desulphurization takes place. After passing through the second reaction stage, the now sweet desulphurized gas passes through pipes 100 and 11 to its point of use or to apparatus for further treatment.

The recovery of the sulphur from the catalytic material is effected in the recovery stage. The recovery medium, preferably steam, is pumped, by means of a fan or blower 14, through the recovery medium heater 4, where it is superheated, and from the heater through pipes 12 and 102 into the bottom manifold of the recovery stage of the converter. From the bottom manifold, the superheated steam passes through the opening in the bottom of the drum into the bottoms of the various compartments as are at that time contained within the sector forming the recovery stage; thence, upwardly through the openings in the plates 45 and up into the interior of the tubular catalyst containers, through the pervious layer of catalyst material into the compartments of the drum. As the superheated steam passes through the catalyst material, the sulphur is vaporized and removed therefrom and flows along with the steam. The steam and the vaporized sulphur then pass upwardly through the opening in the top of the drum into the top manifold. From the top manifold, the steam and vaporized sulphur pass through pipes 97 and 13 back to the fan or blower 14, by means of which they are recirculated through the heater and sulphur recovery stage of the converter. A portion of the steam and vaporized sulphur are bled from the heater and pass through pipe line 15 into the sulphur condenser 16, where the sulphur is liquefied and withdrawn through a suitable drain valve located in the bottom of the condenser. The steam escapes from the condenser through a suitable pressure relief valve located in the top thereof. By continuously recirculating the steam and sulphur vapor through the heater and recovery stage, and admitting a sufficient amount of new steam to compensate for the steam and sulphur vapor bled off to the sulphur condenser, a considerable amount of heat is saved and a highly efficient sulphur recovery working condition is obtained.

The burning off of any remaining sulphur particles and impurities from the catalytic material is effected in the activation stage. The regenerating medium, preferably air, is pumped by means of a fan or blower 19, through the regenerative medium heater 5 and from the heater through pipes 17 and 101 into the bottom manifold of the activation stage. From the bottom manifold, the hot air passes through the opening in the bottom of the drum into the bottoms of the various compartments of the drum as are at that time contained within the sector forming the reactivation stage; thence, upwardly through the openings in the plates 45 and up into the interior of the tubular catalyst container, through the pervious layer of catalyst material into the compartments of the drum. As the hot air passes through the catalyst material, any particles of sulphur remaining thereon, and impurities in the form of tars or carbonaceous matter, are burnt off

and the sulphur flows with the hot air in the form of  $\text{SO}_2$ . The hot air and  $\text{SO}_2$  pass through pipes 96 and 18 to the recirculation fan or blower 19, by means of which they are recirculated through the heater 5 and the converter. A portion of the hot air and  $\text{SO}_2$  is bled off the discharge line of the blower and passes through pipe line 20 into the incoming sour gas heater 2, so that the contained sulphur may be recovered and to provide an oxidant for the first reaction stage. By continuously recirculating the hot air and  $\text{SO}_2$  through the heater 5 and the reactivation stage of the converter, and admitting a sufficient amount of new air to compensate for the air and  $\text{SO}_2$  bled off to the sour gas heater, a considerable amount of heat is saved and high regenerative action is obtained, and, too, a considerable saving in sulphur in the form of  $\text{SO}_2$  is obtained. The mixture of hot air and  $\text{SO}_2$  which remains in the catalytic mass and the compartments of the drum as they move from the reactivation to the second reaction stage provides a part of the necessary oxidant for the second reaction stage.

By mounting the annular drum and the manifolds within a pressure vessel, the method may be carried out with high pressure gases and, too, the equalization of pressure within the drum, manifolds and vessel, permits the drum and manifolds to be made of lighter weight material, which adds considerably to the efficient and economical operation of the converter. This equalization is accomplished by means of a small opening formed in that portion of the pipe line 94 within the vessel 21. It is also considered desirable to provide each of the eight pipes 94, 95, 96, 97, 99, 100, 101 and 102 with expansion joints 104, located a short distance from their points of connection to the manifolds. This may be necessary, due to the unequal temperatures of the gases and media as they pass through the various sectors, thereby resulting in unequal expansion of the parts of the drum and manifolds.

From the foregoing, it will be seen that there has been provided a novel method of and improved apparatus for desulphurizing gases. The method comprises, broadly, the steps of continuously heating and directing the flow of a sour gas through the catalytic material at one or more points in its closed path; continuously heating and recirculating steam through the catalytic material at one point in its closed path to vaporize the sulphur therein, and bleeding off a portion of the vaporized sulphur, condensing and recovering it; and continuously heating and recirculating air through the catalytic material at still another point in its closed path to regenerate the catalyst; bleeding off a portion of the recirculated heated air and conducting it into the heated sour gas prior to its passage through the catalyst. At this point, it may be well to point out that the gas to be desulphurized flows through the catalyst in the same direction in the reaction stages, viz., from the outside to the inside of the tubular containers, while the recovery and regenerative mediums flow through the catalyst in the opposite direction in the recovery and activation stages, viz., from the inside to the outside of the tubular containers. This reversal of flow, as it were, has an important bearing in the practice of the method of the invention. In the reaction stages, due to the flow from "outside to inside" of the tubular containers, a heavier deposit of sulphur is made on the material adjacent to the outer circumference than adjacent to the inner circumference. By re-

versing the flow of the recovery medium, in the instant case superheated steam, the deposited sulphur is more quickly and efficiently vaporized. Also the impurities which have been deposited on the catalyst material are thicker or heavier on the material adjacent to the outer circumference than on the catalyst material adjacent to the inner circumference. Accordingly, by reversing the flow of the regenerating medium, in the instant case hot air, the deposited impurities are more quickly and efficiently removed.

While the invention has been described in connection with the desulphurization of sour gas, obviously, it is also applicable to the desulphurization of other types of sulphur containing gases and vapors which are subject to the action of a suitable solid catalyst.

Obviously, the invention is not restricted to the particular embodiment thereof herein shown and described. Moreover, it is not indispensable that all of the features of the invention be used conjointly, since they may be employed advantageously in various combinations and subcombinations.

What is claimed is:

1. In the recovery of sulphur from gases containing sulphur compounds involving the contact of a catalyst with the sulphur-containing gas with resultant liberation of elemental sulphur and its deposition on the catalyst, and subsequent treatment of the catalyst with a sulphur recovery medium to remove the sulphur and then with a regenerating medium to regenerate the catalyst for further contact with the sulphur-containing gases, the improvement which comprises rotating a series of separated thin beds of catalyst directly in succession and substantially continuously relative to and through a reaction zone, a sulphur recovery zone and a regenerated zone; continuously directing the flow of the sulphur-containing gas mixed with an oxidant gas through said reaction zone; heating the gaseous admixture to an optimum reaction temperature prior to its passage through the reaction zone; continuously withdrawing the desulphurized gas from the reaction zone; continuously directing the flow of a hot sulphur recovery medium through the sulphur recovery zone to vaporize the liberated sulphur deposited on the beds therein; continuously withdrawing the sulphur recovery medium together with the vaporized sulphur from the sulphur recovery zone; condensing and recovering the sulphur from the sulphur recovery medium; continuously directing the flow of a hot oxidizing medium through the regenerating zone to regenerate the catalyst; and continuously withdrawing the regenerating medium from the regenerating zone.

2. The method, as set forth in claim 1, wherein the direction of flow of the gas and oxidant admixture through the catalyst material in the reaction zone is opposite to the direction of flow of the sulphur recovery and regenerating mediums through the catalyst material in the sulphur recovery and regenerating zones respectively.

3. In the recovery of sulphur from gases containing sulphur compounds involving the contact of a catalyst with the sulphur-containing gas with resultant liberation of elemental sulphur and its deposition on the catalyst and the subsequent treatment of the catalyst with a sulphur recovery medium to remove the sulphur and then with a regenerating medium to regenerate the catalyst for further contact with the sulphur-