Oct. 8, 1935. S. P. MILLER 2,016,751

OPERATION OF COAL DISTILLATION PLANTS

Original Filed April 18, 1929 4 Sheets-Sheet 1

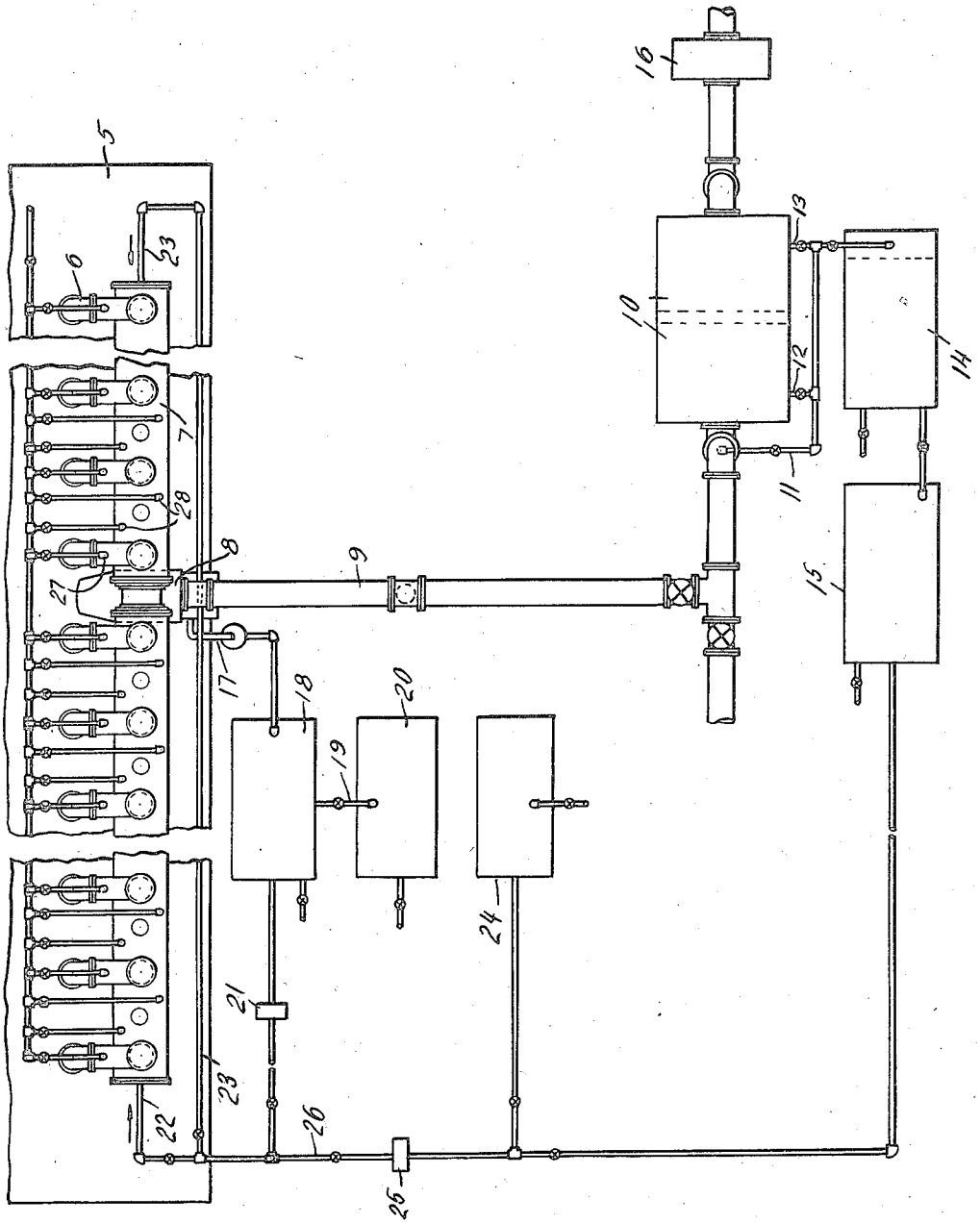

Fig. 1.

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Fig. 2.

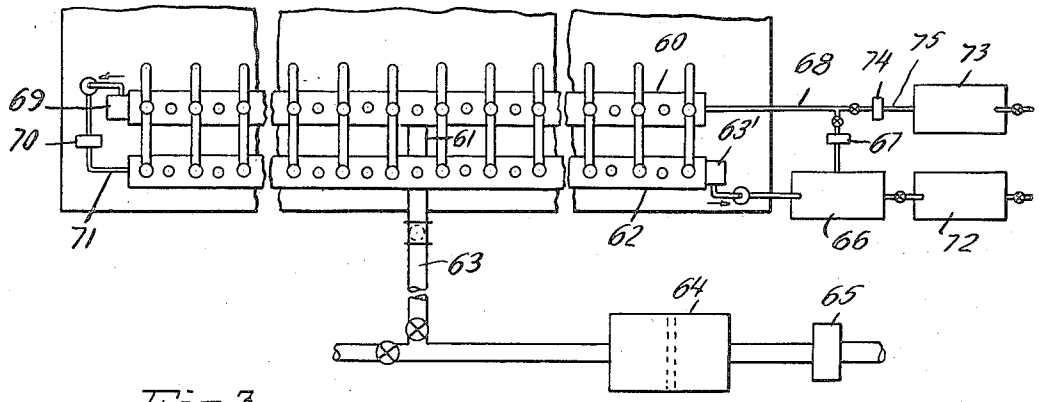


Fig. 3.

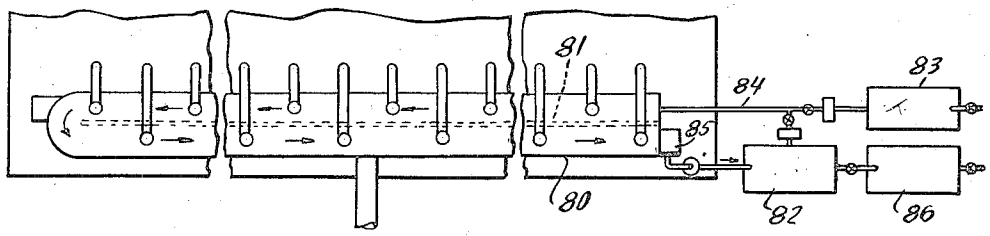


Fig. 5.

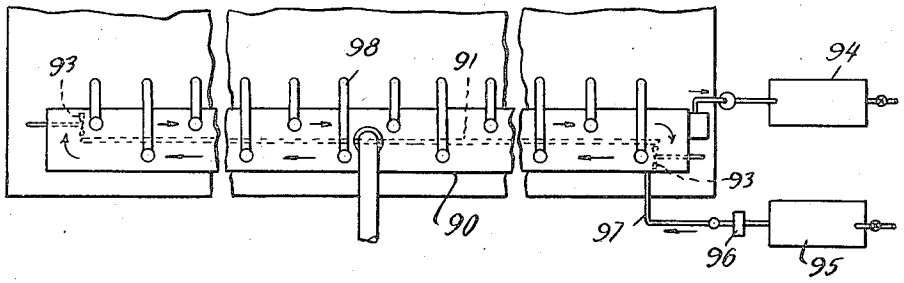


Fig. 4.

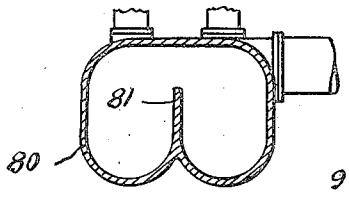
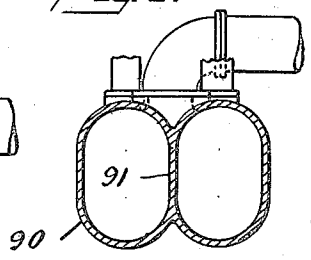


Fig. 6.



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OPERATION OF COAL DISTILLATION PLANTS

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Fig. 7.

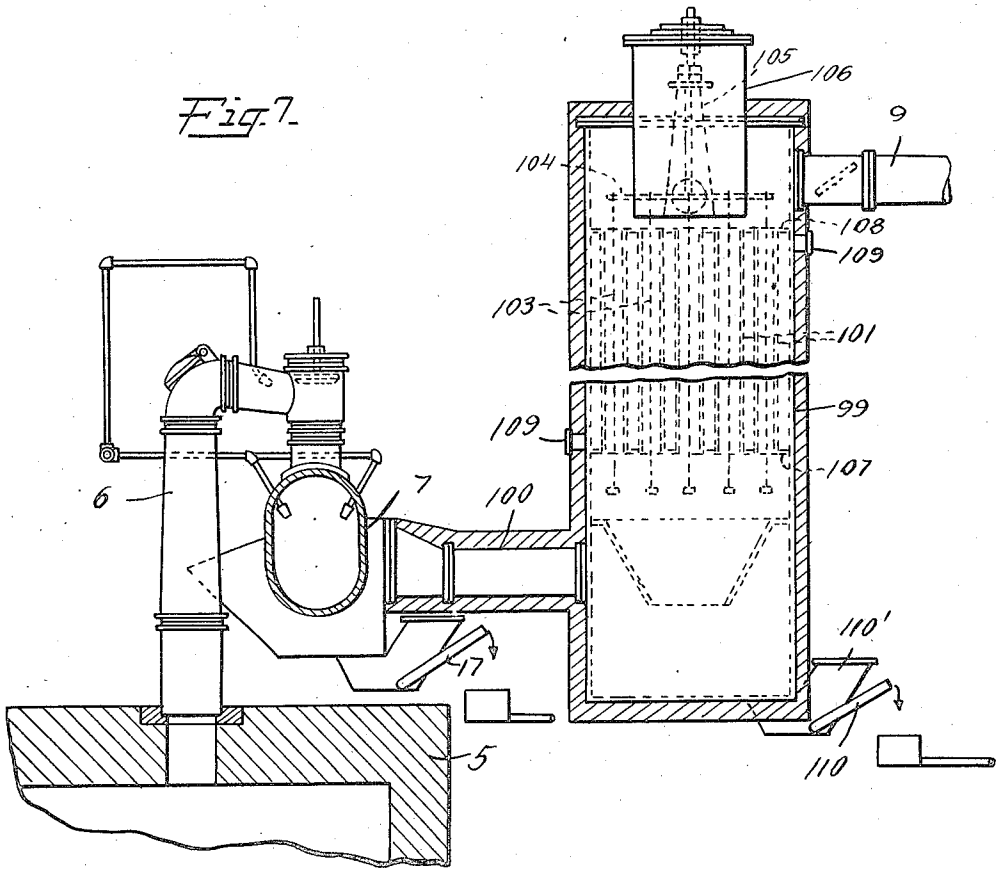
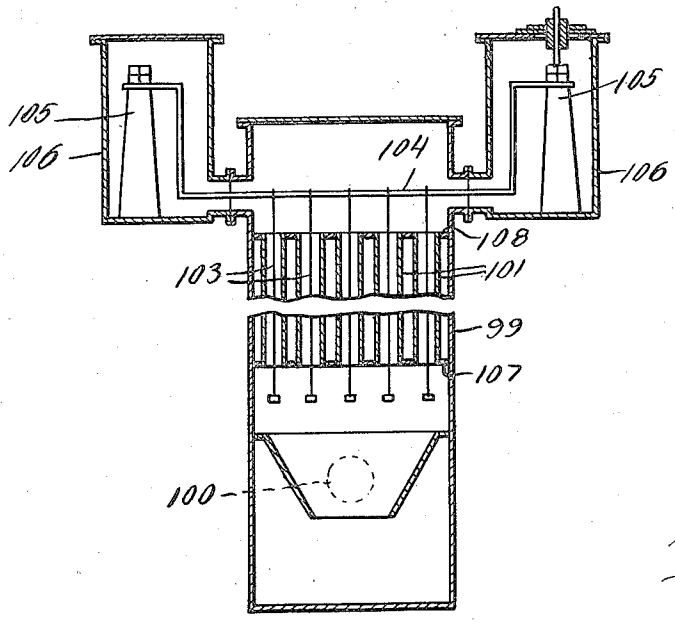


Fig. 8.



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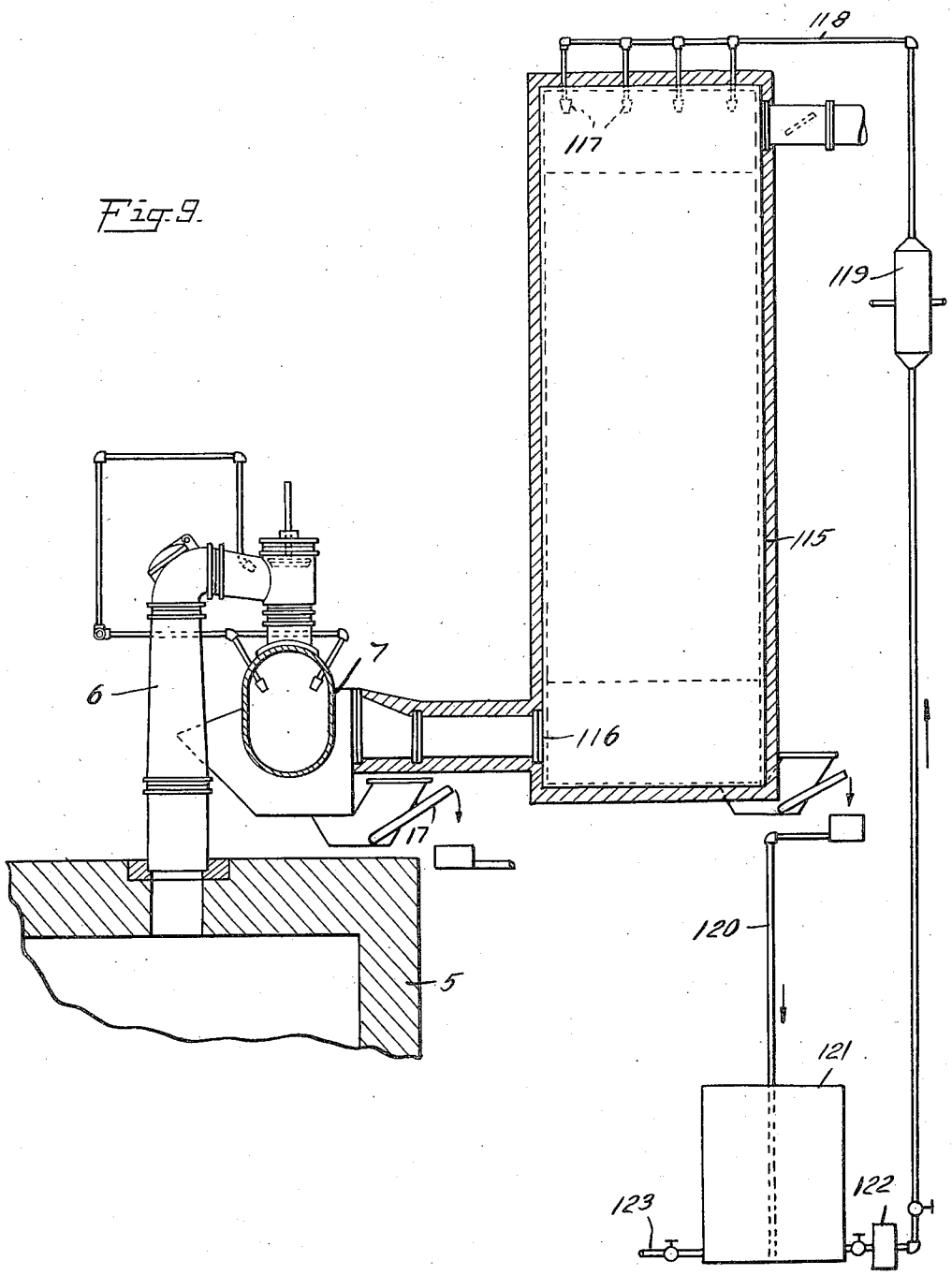
OPERATION OF COAL DISTILLATION PLANTS

Original Filed April 18, 1929 4 Sheets-Sheet 4

Fig. 9.



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UNITED STATES PATENT OFFICE

2,016,751

OPERATION OF COAL DISTILLATION PLANTS

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Application April 18, 1929, Serial No. 356,041
Renewed January 15, 1935

6 Claims. (Cl. 202—30)

This invention relates to improvements in the operation of by-product recovery systems of coal carbonization plants and more particularly of coke oven batteries and gas retort plants and the operation thereof for the production of pitches and tarry oils or clean oils directly at the coal carbonization plant.

This application is in part a continuation of my co-pending application Serial No. 254,356 filed February 15, 1928.

In the ordinary operation of by-product coke ovens, the gases produced by the coking operation pass from the individual ovens thru uptake pipes and goose-necks to a collector main common to the ovens of the battery. The coke oven gases which leave the ovens at temperatures of from 600–700° C. or higher are cooled in the collector main and in condensers connected therewith. The major proportion of the tar separates out at these points. The separated coal tar is commonly shipped to tar distillation plants where it is subjected to distillation to produce pitches, distillate oils, etc.

Owing to the high temperature of the gases from the coke ovens, and particularly because of the enormous amount of heat carried thereto, the successful operation of the collector main in connection with these ovens has always been a serious problem. A certain amount of heavy tar or pitch may separate in the collector main and such tar or pitch, if subjected to the distilling effect of the gases at high temperature, results in the formation in the main of solid hard pitch or coke which adheres to the main and which can be removed in some cases only by shutting down the plant and digging it out. It is customary to flush the main with a mixture of tar and ammonia liquor or with ammonia liquor alone, but this practice does not always avoid the difficulty.

Because of the resulting lowered temperature of the gases caused by spraying the ammonia liquor into the collector main in sufficient quantity to prevent accumulations of pitch therein, the temperature of the gases is so reduced that a considerable proportion of the valuable oil constituents which are present in the gases as vapors is condensed and thrown down with the tar and can be removed therefrom only by subsequent distillation.

It is the object of the present invention to provide an improved method and apparatus permitting the control of the collector main by flushing it with a moving body or stream of tar whereby accumulations of pitch deposits are prevented and advantage can be taken of the heat carried by the coke oven gases to distill tar and to separate volatile products therefrom so that the latter can be recovered independently of the pitch constituents contained in the tar, which pitch constituents then constitute a separate product of the operation.

A further object of the invention is the separation from the hot gases of substantially all solid and pitchy constituents thereof, leaving oil vapors including vapors of high boiling oil constituents therein, which upon condensation, yield oils including oils of high boiling point. The gases and vapors leaving the collector main may be subjected to a cleaning operation at a high temperature and on cooling the resulting gases, clean oils which include clean oils of high boiling range may be condensed directly from the clean gases.

A further object of the invention is to provide a method of handling the gases in the collector main of a coke oven battery or other coal distillation plant so that the gases leave the main at high temperature and to use these high temperature gases leaving the main for distilling tar. The tar may be one rich in low boiling constituents, such as the tarry oils ordinarily obtained from the condensers of a coke oven plant.

More particularly the invention relates to the distillation of tar or tarry oils in the collector main of a coke oven battery, whereby pitch is produced in the collector main, and high boiling constituents present in the gases as they leave the ovens as well as high boiling constituents distilled from the tar are carried over from the main and recovered as oils in the condensers.

The tarry material used may be tar collected from the collector mains or condensers, or collector mains and condensers which are operated by the usual methods, or tar from an outside source. It may also comprise tarry oils which may be collected in the condensers connected with the collector main or mains operated by the methods of the present invention.

If clean oils containing a percentage of heavy components higher than normal are desired, the heavier tars from the collector mains may be used to advantage.

It is common practice in many coke oven plants to circulate a mixture of tar and ammonia liquor thru the collector main to prevent the formation of hard pitch deposits in the main, and sufficient ammonia liquor is admixed with the tar which is used in the collector main to prevent any substantial distillation of the tar so used. According to the present invention, the tar circulated

thru the collector main may contain a small amount of ammonia liquor as it enters the main, but the amount of ammonia liquor is small and readily volatilized so that the tar is heated sufficiently in its passage thru the main to cause the volatilization of lower boiling constituents, and higher boiling constituents may be volatilized when desired.

The invention does not contemplate admitting a small amount of tar to the main and passing it thru the main at such a rate that in one passage thru the main the tar will be distilled to pitch. According to this invention, the tar is caused to flow thru the main at a considerable velocity, such as to cause erosion and solution of hard pitch deposits which may result from temporary localized over-distillation. The stream of tar or partially distilled tar or pitch flowing thru the main is sufficient to prevent the accumulation of hard deposits in the bottom of the main. The flow is such that the surface of the stream is continuously changing and there is considerable distillation from the surface of the tar so that in one passage of the tar thru the main a considerable quantity of the volatile constituents of the tar are vaporized and pass off from the main as vapors carried by the gases. By recirculating a considerable portion of this partially distilled tar or pitch thru the main together with fresh tar further distillation takes place and the amount recirculated is so regulated as to produce the desired distillation. The main may be insulated to prevent excessive condensation of such vapors before they pass out of the collector main.

Coke oven plants equipped with a collector main of the usual type which drain toward a center-box from which the gases pass thru the cross-over main may readily be adapted to the carrying out of this invention. In such a case, a stream of tar may advantageously be pumped to each end of the main and in passing thru the main to the collector box, it will be distilled and the partially distilled tar or pitch will be withdrawn from the collector main thru the center box. By recirculating this partially distilled tar or pitch, adding fresh tar thereto and bleeding off from the system a quantity of pitch of the desired melting point corresponding with the amount of fresh tar admitted to the main, a continous process will result in which tar is continually admitted to the main and pitch is gradually produced with continuous recirculation of a portion of the material withdrawn from the main.

A coke oven plant in which the collector main slopes gradually toward each end of the battery, may be readily equipped for carrying out this invention by admitting the pitch and fresh tar to the mid-portion of the main and withdrawing pitch from either end of the main and recirculating the greater portion of the pitch thus withdrawn by adding it to the main at the mid-point.

Where a battery is equipped with a collector main which gradually slopes in one direction from one end to the other or where the collector main is practically horizontal, the pitch and fresh tar may readily be admitted to one end of the main, withdrawn from the other, and a portion, which may be the greater portion of the material which is withdrawn, may be recirculated by admitting it to the opposite end of the main.

Any process of recirculation in the main, which may involve adding the flushing medium to one end of the main and withdrawing it from the other, or admitting it to the middle and withdrawing a portion from each end or vice versa, or any suitable method of recirculation of the flushing medium in the main may be employed according to this invention.

A coke oven battery which is equipped with a plurality of collector mains, such as a coke oven battery equipped with two collector mains for the separate collection of rich and lean gases, may readily be adapted for carrying out this invention. For example, where both collector mains are approximately horizontal and both mains are located at one side of the battery, the partially distilled tar may be drawn off one end of one main and recirculated thru the adjacent end of the other main, and a similar operation may also be carried out at the opposite ends of the two mains and means provided for withdrawal of pitch and the admission of the fresh tar. Other methods of recirculating the flushing medium thru the mains may be employed as where more than two mains are employed, or where the mains are located on opposite sides of the block of ovens.

It is not essential in carrying out the present invention that collector mains of the ordinary type be employed. Novel collector mains, such as mains which provide for the circulation of a flushing medium around a central partition with means for withdrawing pitch and admitting fresh tar to the circulating stream may be employed.

The enriched gases leaving the collector main may be condensed in the ordinary way to produce a total condensate or they may be fractionally condensed to produce desired fractions. Before condensing, the gases may be cleaned in an electrical precipitator or other detarring device such as a suitable scrubbing device and by carrying out the cleaning operation at a high temperature, clean oils comprising high boiling constituents may be obtained directly from the gases.

The gases passing from the ovens thru the collector main to the condensers, according to the present invention, are not subjected to cooling in the collector main to the same extent that coke oven gases are ordinarily cooled in the collector main with the result that a larger portion than usual of the oils originally contained in the gases as they leave the ovens pass from the collector main to the condenser. The oils recovered in the condensers under such conditions contain in considerable proportion higher boiling constituents usually thrown down in the collector main. The oils recovered in the condensers comprise not only the oils originally present in the gases, but oils distilled from the tar added to the pitch circulated thru the collector main. By proper selection of the tar thus distilled in the collector main and control of the operation so that the distillation of pitch within the main is carried to a desired extent to remove oils of a desired boiling range from the flushing medium, the composition of the oils obtained in the condensing system can be controlled so that a greater or less proportion of higher boiling constituents will be drawn off into the condensers.

Where desirable, a small amount of water or ammonia liquor may be sprayed into the gases passing thru the collector main in order to regulate the temperature of the gases and in this manner the distillation of the pitch within the main and the composition of the oils obtained in

the condensers can be controlled. The amount of water or ammonia liquor sprayed into the gases is small and not comparable with the amount ordinarily sprayed into the gases in a Semet-Solvay system in which the gases are suddenly cooled and in which large quantities of oils are condensed from the gases and ammonia liquor is withdrawn from the collector main together with the tar thrown down from the gases.

The invention is described in the accompanying drawings more particularly as applied to the operation of a coke over battery, but it is to be understood that the invention is not limited by the drawings.

Fig. 1 is a plan view of an ordinary collector main with a center-box and cross-over main, and by-product recovery system equipped for carrying out this invention;

Fig. 2 shows a modification involving a two-main system;

Fig. 3 shows a modified collector main;

Fig. 4 is a cross-section thru the main;

Fig. 5 shows still another form of a modified collector main;

Fig. 6 is a section thru the main;

Fig. 7 is an elevation of modified apparatus adapted for producing clean oils by passing the gases from the collector main thru an electrical precipitator;

Fig. 8 is a cross-section of the precipitator shown in Fig. 7; and

Fig. 9 shows a scrubber for removing entrained impurities from the gases after they leave the collector main.

Referring to the drawings, 5 represents a coke oven battery equipped in the usual way with uptake pipes 6 which convey the gases to a collector main 7. The opposite ends of the collector main drain towards the center-box 8 and the gases pass off from the center-box 8 thru the cross-over main 9 to condensers 10. Ammonia liquor and condensate from the cross-over main and the condensers 10 drain thru the pipes 11, 12 and 13 into the decanter 14 from which tarry oils condensed from the gases are collected in the tarry oil storage tank 15. An exhauster 16 is provided to draw the gases thru the system, and means for the recovery of ammonia liquor and light oils (not shown) are located beyond the exhauster 16.

To prevent the accumulation of hard pitch and coke in the collector main, the collector main is flushed with tar or pitch. By recirculation of the tar or pitch thru the main, light oils contained therein are volatilized and a pitch of higher melting point is obtained. The volatilized constituents are carried off from the collector main with the gases thru the cross-over main and on cooling in the condensers are obtained as constituents of the tarry oils collected in 15. The pitch formed within the collector main is drawn off of the center-box thru the line 17 into the pitch container 18 and there a portion of it is withdrawn, preferably continuously, thru the draw-off 19 into the pitch storage tank 20. The pitch is maintained in a heated condition within the tank 18 by a steam coil or other means (not shown) and recirculated therefrom thru the pump 21 and pipes 22 and 23 into the ends of the collector main. Fresh tar, which may be dehydrated or may contain a small amount of ammonia liquor, is also added to the ends of the main, as thru the lines 22 and 23. The fresh tar, which may be ordinary coke oven tar or tarry oil from the collector main or condensers of a coke oven battery or any other suitable tar or low melting point pitch from any source, such as the container 24, is shown in the drawings as being supplied by the pump 25 thru the line 26 into the lines 22 and 23, although the pitch from the tank 18 and the tar supplied thru the line 26 may advantageously be mixed in a proper mixing box before being supplied to the lines 22 and 23 to provide for even distribution of the fresh tar and the recirculated pitch. Instead of being supplied to the collector mains with the recirculated pitch, the fresh tar may be added to the collector main thru separate delivery pipes at the ends of the mains. As the recirculated pitch and the admixed fresh tar circulate thru the main, they are distilled, and the gases entering the collector main from the ovens thru the uptake pipes 6 are enriched in volatile constituents which are carried off from the collector main thru the cross-over main 9.

In Fig. 1 the uptake pipes 6 and cross-over main 7 are equipped with spray pipes 27 and 28, which may be of the usual type, although a fewer number are necessary, and when used, they are used to spray only a small amount of water or ammonia liquor into the hot gases passing thru the main to regulate the temperature of the gases and thereby regulate the distillation of the tar or pitch flowing thru the bottom of the main.

As a further means of controlling the extent of cooling of the hot gases and the extent of distillation of the tar or pitch in the collector main, tarry oil from the condensers 10 connected with the collector main thru the usual cross-over main may be added to the recirculating pitch in regulated amounts and by the heat absorbed by its distillation the distillation of the pitch flowing thru the main can be controlled so as to produce a pitch of desired melting point.

Fig. 2 shows a different system for carrying out the invention and it may be readily applied to a coke oven battery or bench of gas retorts equipped with a rich and lean gas main in the usual way. Each of the coke ovens may be connected with each of the mains as in an ordinary system equipped with rich and lean gas mains, or for the purpose of carrying out this invention, alternate ovens may be connected with each main so that the flow of gases thru each of the mains is relatively constant and the temperature of the gases passing thru each main is relatively uniform.

The mains may be connected at their mid-point so that, for example, the gases collected in the main 60 may pass thru the connecting main 61 into the collector main 62 and thence into the cross-over main 63 which connects the collector mains with the condensers 64, which may be of the indirect type, or the direct type as here indicated. An exhauster 65 is provided and means for the recovery of ammonia and light oils may be provided beyond the exhauster. The usual means for recovering the oils from the condenser is provided.

The collector mains are flushed with tar or pitch which is recirculated from the tank 66 by means of the pump 67 and the line 68 into one end of the collector main 60 and withdrawn from the opposite end of this collector main thru the trap 69 and passed on by the pump 70 thru the line 71 into the adjacent end of the other collector main 62. The collector mains shown may be level or the mains 60 and 62 may drain in opposite directions. The pitch is removed from the main 62 thru the trap 63' and returned to the pitch receiver 66. From this receiver the finished

product is withdrawn, preferably continuously, into the pitch storage tank 72. Fresh tar or a low melting point pitch from the tar storage tank 73 or any other suitable source is added to the recirculated pitch in limited amount by means of the pump 74 thru the line 75. The fresh tar is supplied in an amount corresponding to the finished pitch which is withdrawn to the pitch storage 72.

Pitch may be continuously withdrawn and tar may be continuously added to the recycled pitch, or pitch may be withdrawn intermittently and tar supplied intermittently. The volatile constituents distilled by the hot gases from the tar or pitch in the bottom of the collector mains together with vapors carried by the gases from the ovens into the mains pass over thru the cross-over main 63 into the condensers 64.

Figs. 3 and 5 show modified collector mains which provide means for recirculating the tar or pitch within the mains. Fig. 3 shows a main 80 with a partition 81 which runs almost the entire length of the main dividing it into two portions. The partition may extend the whole height of the main but is preferably a short diaphragm as shown in Fig. 4, which merely separates the pitch flow which is in opposite directions on opposite sides of the diaphragm. Pitch from the receiver 82 together with fresh tar from 83 are pumped into the main 80 thru the pipe 84 and pass down one side of the main around the partition 81 and back thru the other side of the main and are withdrawn thru the trap 85 to the pitch receiver 82. The finished pitch is withdrawn into the pitch storage 86. The arrangement of the diaphragm or partition 81 within the main may be altered to suit conditions. The end of the main at which the flow of the pitch is reversed is preferably rounded to prevent the accumulation of pitch within the corners, and other variations from the usual collector main construction may be made to promote the circulation of the pitch within the main without localized overheating.

The main 90 shown in Fig. 5 is of somewhat different construction and comprises a partition or diaphragm 91 passing thru the middle of the main but allowing for passage of pitch around each end of the diaphragm or partition within the main. The diaphragm is shown as extending the whole height of the main, altho a lower diaphragm, such as that shown in Fig. 4, may be employed. Propellers 93 driven by suitable means, such as electric motors (which are not shown) may be employed to promote the circulation of the pitch within the main. A small amount of pitch is continuously withdrawn from the main into the pitch storage tank 94 and fresh tar or pitch is added from the tar storage tank 95 by means of the pump 96 and the line 97.

In Fig. 5 the uptake pipes 98 are connected with the collector mains so that alternate uptake pipes discharge gases on opposite sides of the partition. Various arrangements of the diaphragm and uptake pipes may be employed to suit various conditions and obtain desired results. In each of Figs. 3–6, the arrangement shown may be altered within the scope of the invention to accomplish certain desired results. In each case a suitable trap is advantageously utilized at the pitch draw-off from the main to remove any small amount of coke or solids which may form within the main. Rodding holes of the usual type are provided and the usual scrapers or other equipment may be employed to free the mains of any small amount of coke which may form.

Where clean oil products are desired, the gases leaving the collector main enriched in constituents volatilized from the tar or pitch circulated thru the main may be cleaned in an electrical precipitator or other suitable cleaning device, and where the cleaning takes place at a high temperature, clean oil products which contain high boiling constituents, will be recovered directly from the gases on cooling them. The gases and vapors may be cooled fractionally to produce clean oil fractions directly.

Fig. 7 shows a collector main, such as the collector main 7 of Fig. 1, with an electrical precipitator located in the hottest portion of the cross-over main 9. Cleaning means may equally well be employed with the arrangements shown in the other figures. The short gas main 100 which connects the precipitator with the collector main may advantageously be insulated to prevent or reduce loss of heat due to radiation. The gases enter the bottom of the precipitator and pass up thru the tubes 101 and thru the cross-over main 9. In passing up thru the tubes, the gases are subjected to a silent electrical discharge from the electrodes 103. These electrodes are suspended from a bus-bar 104 which is supported by insulators 105 in the chambers 106. The electrical precipitator is advantageously insulated to prevent heat loss, or a heating jacket may be provided between the heads 107 and 108 around the tubes, thru which a heating medium may be recirculated by means of the connections 109. Heavy tar or pitch which is thrown out from the gases onto the collecting electrodes 101 drains into the bottom of the precipitator and is drawn off to suitable storage means thru the swivel arm 110 leading off from the trap 110'. By adjusting the position of the swivel arm the height of the pitch in the bottom of the precipitator may be regulated. This type of trap and pitch draw-off is shown in the other figures.

Instead of cleaning the gases in an electrical precipitator, entrained particles may be removed from the hot gases by any suitable type of hot tar or pitch scrubber. In Fig. 9 a scrubber 115 is shown connected with the collector main 7 of Fig. 1. The gases enter the bottom of the scrubber at 116 and are scrubbed with tar or pitch by means of suitable spraying or atomizing means 117 which are supplied with tar or pitch thru the line 118. The tar or pitch is preferably preheated in the preheater 119. Although any suitable scrubbing medium may be employed, the scrubbing means is here shown as adapted for spraying the gases with pitch of the same composition as the pitch which is removed from the gases during the scrubbing operation. The pitch which is sprayed into the gases together with the pitch removed from the gases during the scrubbing operation are drained from the scrubber thru the line 120 into the tank 121. This pitch is recirculated thru the scrubber by means of the pump 122 and pipe 118 into the sprays 117 and is preferably preheated in the preheater 119 to compensate for the loss of heat due to radiation in the tank 121 and the pipe 118. Pitch may be recirculated directly from the bottom of the scrubber instead of from the tank. Accumulations of excess pitch are drawn off from the tank thru the line 123.

By omitting cooling sprays in the collector main except for the possible admission of a small amount of water or ammonia liquor sprayed into

the gases to regulate their temperature, the gases pass from the collector main at a high temperature. They are enriched by the distillation of volatile constituents from the medium used for flushing the bottom of the main. The gases are cooled as they leave the main or they may be first cleaned in a suitable cleaning apparatus such as an electrical precipitator and then cooled. The cleaning may be effected by a scrubbing medium such as a pitch of the same composition and temperature as that removed from the gases during the scrubbing operation or a scrubbing medium comprising oils which are volatile under the conditions obtaining in the scrubber may be employed. In the latter case, the lighter constituents will be volatilized and carried over with the gases into the coolers and there condensed.

The regulated treatment of the gases within the collector main with recirculation of the flushing medium and partial distillation of the volatile constituents of this medium afford a method of producing pitch within the collector main, and also provide hot gases enriched to a greater or less extent which may be utilized for various purposes, such as the production of tarry oils by direct condensation, the production of clean oils by first cleaning the gases and then cooling them, or by contacting the hot gases with a material such as tar or tarry oils which comprise constituents volatile at the temperature of the gases leaving the main, the hot gases may be employed for distilling such tar or tarry oil.

Although the invention has been described more particularly as applied to the treatment of hot coke oven gases in the collector main of a coke oven battery, it is to be understood that the invention is applicable to the treatment of other hot coal carbonization gases, such as the hot gases passing thru the hydraulic main of a gas retort plant.

I claim:

1. The method of distilling tar to pitch at a coal distillation plant, the ovens or retorts of which are provided with a pair of parallel collector mains, which comprises collecting hot coal distillation gas simultaneously in the two mains, distilling tar to pitch by circulating a stream of the tar and resulting pitch serially through the two mains in contact with the hot gases therein, the flow of the tar and pitch being in one direction in one of the mains and in the opposite direction in the other main, adding tar to the stream and withdrawing pitch therefrom.

2. The method of operating a two-main coal carbonization plant, the two mains of which are substantially straight and substantially parallel to one another, which comprises circulating tar and pitch from one end of one of the mains to the opposite end of this main then into the adjacent end of the other main, back thru this main in a direction counter-current to the direction of the flow of tar and pitch thru the first-mentioned main and out the opposite end of the main and into the other main, and continually recirculating tar and pitch thru the mains, distilling the tar to pitch therein while withdrawing a portion of the pitch and adding fresh tar to the cycle.

3. In a coal distillation plant two adjacent and parallel gas collector mains, pipes connecting the adjacent ends of the mains and means for circulating tar and pitch thru this closed cycle, means for withdrawing a portion of the pitch from the cycle, and means for adding fresh tar thereto.

4. A gas collector main with a partition therein and means for circulating tar and pitch around thru the main whereby the flow of tar and pitch on each side of the partition is in an opposite direction, and means for withdrawing pitch from the main and means for adding tar thereto.

5. The method of distilling tar to pitch at a coal distillation plant, the ovens or retorts of which are provided with gas-main collecting means including a pair of interconnected longitudinal passages, which method comprises collecting hot coal distillation gases simultaneously in both passages of the gas collecting means, distilling tar to pitch by circulating a stream of the tar and resulting pitch serially through the two passages in contact with the hot gases therein, the flow of tar and pitch being in one direction in one of the passages and in the other direction in the other of the passages, adding tar to the stream and withdrawing pitch therefrom.

6. The method of distilling tar to pitch at a coal distillation plant the ovens or retorts of which are provided with a collector main having a pair of longitudinal passages therein, which comprises collecting hot coal distillation gases simultaneously in the two passages, distilling tar to pitch by circulating a stream of the tar and resulting pitch serially through the two passages of the main in contact with the hot gases therein, the flow of the tar and pitch being in one direction in one passage and in the opposite direction in the other passage, adding tar to the stream and withdawing pitch therefrom.

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