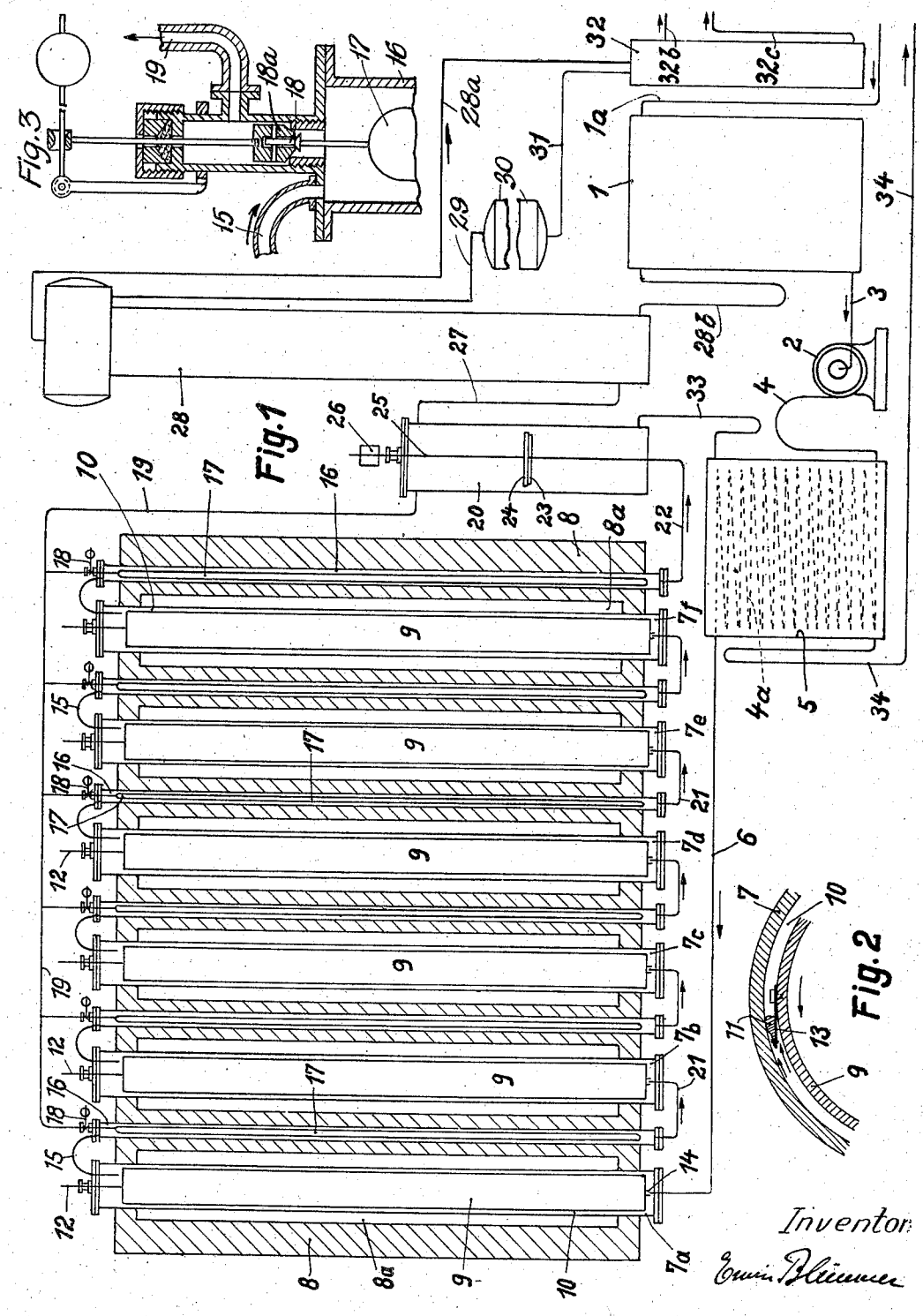
Jan. 17, 1939. E. BLÜMNER 2,144,178

APPARATUS FOR THE PRODUCTION OF TRUE COLLOIDAL FUEL

Original Filed Jan. 18, 1936



Patented Jan. 17, 1939 2,144,178

UNITED STATES PATENT OFFICE

2,144,178

APPARATUS FOR THE PRODUCTION OF TRUE COLLOIDAL FUEL

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Original application January 18, 1936, Serial No. 59,753. Divided and this application February 11, 1937, Serial No. 125,329. In Great Britain January 21, 1935

4 Claims. (Cl. 44—2)

The present application is a division of application filed on January 18, 1936, Serial No. 59,753.

This invention relates to an apparatus for the production of true colloidal fuel and low boiling-point hydrocarbons from solid bituminous fuels, more particularly coal, and provides a plant or an apparatus for subjecting suspensions of such solid fuels, in pulverized state, in hydrocarbon oils to heat treatment under pressure, accompanied by mechanical trituration and grinding.

According to the present invention, solid bituminous fuel, such as bituminous coal, which is pulverized so as to be capable of passing through a 150- to 200-mesh screen, is suspended in crude oil, fuel oil or other high-boiling hydrocarbon oils, and is then heated up to about 450° C., under a pressure exceeding 20 atmospheres, under which treatment the bituminous constituents of the fuel undergo conversion between 270° and 400° C. This change is accompanied by the formation of gas and the evolution of steam and at the same time the viscosity of the mass increases, but diminishes again as the temperature continues to rise, and finally falls to a level that is below that of the original solid fuel oil suspension.

During the process the suspension is temporarily emulsified, the reaction products of the bitumen passing into solution in the oil and even the finest pores and channels in the residual carbonaceous mass becoming filled with oil instead of with bitumen, thus forming a soft and readily triturable mass which, if sufficiently manipulated, assumes such a finely divided condition that a colloidal solution of carbonaceous matter in oil is obtained. By this means bituminous fuels, such as bituminous coal, can be converted into the colloidal condition in a relatively simple manner without high working costs, an operation which cannot be economically effected by mechanical means alone.

A point of special importance in carrying out the process is that the mechanical treatment of the solid fuel oil suspension should be performed simultaneously with the progressive conversion due to the heat treatment under pressure; firstly, in order to produce a most intimate emulsification of the carbonaceous substance with the oil, and secondly, to effect extreme disintegration and grinding of the residual carbonaceous skeleton to colloidal fineness, immediately after the emulsification phase.

Simple though the herein described operations may seem, the phenomena of molecular conversion occurring during said process are, nevertheless, exceedingly complex. The reaction products of the coal bitumen, for example, are not low-temperature tars and, in any event, are comparable only with tars obtained by steam distillation in vacuo. The finely divided residual carbon dispersed in the oil is not coke, but a carbonaceous substance—containing the ash constituents, of course—which is comparable, to some extent, with the residues from the extraction of coal, though this latter process, being usually performed with solvents of low boiling point, does not—nor can it—ever lead to the complete extraction of the bitumen.

In the final heating state of about 400 to 450° C., the solution of bitumen in oil which also contains the colloidal carbonaceous matter is subjected to a moderate cracking treatment, accompanied by continuous trituration. During this treatment, as yet unidentified molecular reactions and migration of hydrogen between the oil and the coal hydrocarbons occur. It has been ascertained that the bituminous matter in coal for example, furnishes considerably larger yields of benzine when treated in accordance with the present invention than when treated by itself, even when allowance is naturally made for the benzine attributable to the oil vehicle itself.

The apparatus designed for carrying out the improved process is illustrated diagrammatically and by way of example in the accompanying drawing in which—

Figure 1 is a diagrammatic view of the apparatus, certain portions being shown in vertical section and other portions in side elevation.

Figure 2 is a horizontal sectional view upon an enlarged scale taken horizontally through a fragment of one of the vertical cylinders of the apparatus.

Figure 3 is a sectional view taken vertically through the upper portion of one of the intermediate cylinders and illustrating the construction of one of the float controlled needle valves.

On the drawing, 1 denotes a storage vessel or receptacle for the coal-oil suspension which enters into the vessel 1 through a tube 1*a* and which is pumped by means of a high-pressure pump 2 from the vessel 1 and through pipes 3 and 4 into the serpentine tube 4*a* in the interior of a heat-exchanger 5 from which said suspension passes through a pipe 6 into a vertical cylindrical heating vessel 7*a* in which the suspension is heated to about 100° C. There are a plurality of such vessels (six in the example shown, viz 7*a*, 7*b*, 7*c*, 7*d*, 7*e*, 7*f*) assembled in a masonry-furnace 8 having flues 8*a* in which said vessels

are located and through which heating gases, may be furnace gases or waste gases, (for example coming from the gas-tube 28*a*) are conducted so as to heat the said vessels to about the temperature stated. All vessels 7 . . . are of equal construction. Each comprises, besides the vessel 7 . . . proper, a cylindrical rotary insertion 9 filling the vessel to such an extent that only a narrow tubular passage 10 remains through which the suspension must pass. Each insertion 9 is firmly connected with an upper shaft 12 turned by any suitable means so as to rotate in turn the insertion 9.

The tubular space or passage between the stationary vessel 7*a* and the rotary insertion 9 is subdivided into a plurality of parallel compartments, say six, by vertical members 11 (Fig. 2) of about shoe-like transverse section which contact with the inner surface of the respective vessel 7 and are secured to elastic strips 13 affixed to the outer surface of the appertaining member 9. The suspension forced through the tubular passage flows now not only vertically, but is also rotated on its way through said passage, and owing to the suitably chosen shape of the members 11 the particles contained in the suspension are very finely triturated.

14 denotes a foot-bearing for the rotary insertion 9. There is, of course, provided a foot bearing 14 for every insertion.

Between each two vessels 7 is located in the furnace 8 a narrow cylinder 16, the upper end of which is connected with one of the adjacent vessels 7*a* by means of a bent pipe 15 by which the contents of the vessels 7*a* treated therein is conducted into the second vessel (7*b*). The cylinder 16 is not located in a flue and, therefore, not heated by hot gases. The cylinder 16 receives the entire contents of the vessel 7*a*, i. e., the liquid, the vapor and the gas, which components of the suspension are separated in the said cylinder.

In each cylinder 16 is a long vertical float 17 connected at its upper end with an outer automatically acting needle valve 18 regulating the height of the level in the respective cylinder, independent of the pressure in the cylinder. If the formation of gas increases and, therefore, the level of the liquid in the cylinder is forced downwardly below a certain normal height, the float 17 moves downwardly with the liquid and the head of the needle valve will be moved off of the valve seat 18*a* to the opened position shown in Figure 3, whereupon the gas and the vapor escape into a pipe 19 through which they pass to an expansion vessel 20. When then the liquid in the cylinder 16 again rises, the float 17 is lifted by it and the valve 18 is closed.

It is a very important condition and a high advantage of my new apparatus, that there comes gas free coal-oil fluid only from one heated cylinder 7 to the next one over the cylinders 16 through the pipes 15 and 21.

All cylinders 16 are connected up in parallel to the vessel 20, but the vessels 7 (7*a*—7*f*) are connected up in series, and the last of these vessels (7*f*) is connected with the vessel 20 by the intermediary of the last cylinder 16 and by a pipe 22 extending into the vessel 20 through the bottom thereof to about the middle portion of said vessel where it is attached to a so-called expansion colloidal mill comprising a stationary disk 23 firmly connected with the pipe 22, and a rotary disk 24 connected with a vertical shaft 25 by which it is rotated. The two disks are polished and are made of a specially selected kind of steel. The shaft 25 is provided with a weight 26 so as to exert a corresponding pressure upon the shaft 25, or upon the two disks 23 and 24 and the composition entering between them and being acted on between them. The object of said weight is mainly to maintain the pressure in the system, or to regulate the pressure exerted by the pump 2. The supply of heat to the heating chambers in the masonry-furnace 8 is so regulated that the highest heat is in the first flue (8*a*) and the lowest temperature is in the last flue containing the vessel 7*f*. Owing to a certain reduction of pressure in the mill 23, 24 another fall of temperature takes place in the chamber or vessel 20, the final temperature of the product being about 260° C., whereas the initial temperature amounted to 450° C.

All hydrocarbons evaporating below 260° C. distill through the pipe 27 into the fractional distillation column 28. The benzines are withdrawn through the pipe 29 and are condensed in the condenser 30, wherefrom the condensed benzine is conducted through the pipe 31 into a separator 32 in which water and gas are separated from the benzine, and from which the benzine flows through the tube 32*b* to a not shown benzine storage vessel and the water is conducted away through the tube 32*c*, as indicated. The gas-tube 32*a* is connected with the gas-tube 28*a* of the distillation column 28 of the plant.

The hot, true colloidal fuel collecting on the bottom of the vessel 20 passes through a pipe 33 into the heat-exchanger 5 containing the serpentine tube 4*a* and flows from the heat-exchanger 5, through a pipe 34 into a collecting tank (not shown).

I claim:

1. In an apparatus of the character described a furnace having a series of vertical heating chambers spaced transversely from each other and gas separating chambers in alternating relation to the heating chambers, means being provided for heating the heating chambers, a rotary insert extending longitudinally in each said heating chambers and each mounted to turn about a vertical axis and spaced from walls of the chamber to provide an annular passage through the heating chamber about the insert, upper and lower transfer pipes extending between ends of the heating chambers and the gas separating chambers and connecting the chambers in series, a gas main having branch pipes each leading from a gas separating chamber, and pressure controlled valves in said separating chambers for controlling escape of gas through the branch pipes adjusted to be opened by pressure of accumulated gas in the separating chambers.

2. The structure of claim 1 wherein each insert is of cylindrical formation and carries longitudinally extending partitions dividing the annular space about the insert into a plurality of longitudinally extending sections and moving with the rotary insert to impart whirling motion to fluid flowing through the said space.

3. The structure of claim 1 wherein each insert is of cylindrical formation, partitioning strips extending longitudinally through space between the insert and walls of the heating chambers and dividing the space into sections, and resilient mounting members for said strips fixed to the insert and yieldably holding the strips against walls of the chambers.

4. The structure of claim 1 wherein partitions

are provided between each expansion chamber and the cooperating branch pipes of the gas main and each formed with a passage produced by a valve seat and a float in each expansion chamber having a stem extending upwardly therefrom and carrying a valve head for seating against the valve seat of the cooperating partition to confine fluid in the expansion chamber, pressure of gas in the said chamber being adapted to depress the float and move the valve to an open position.

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