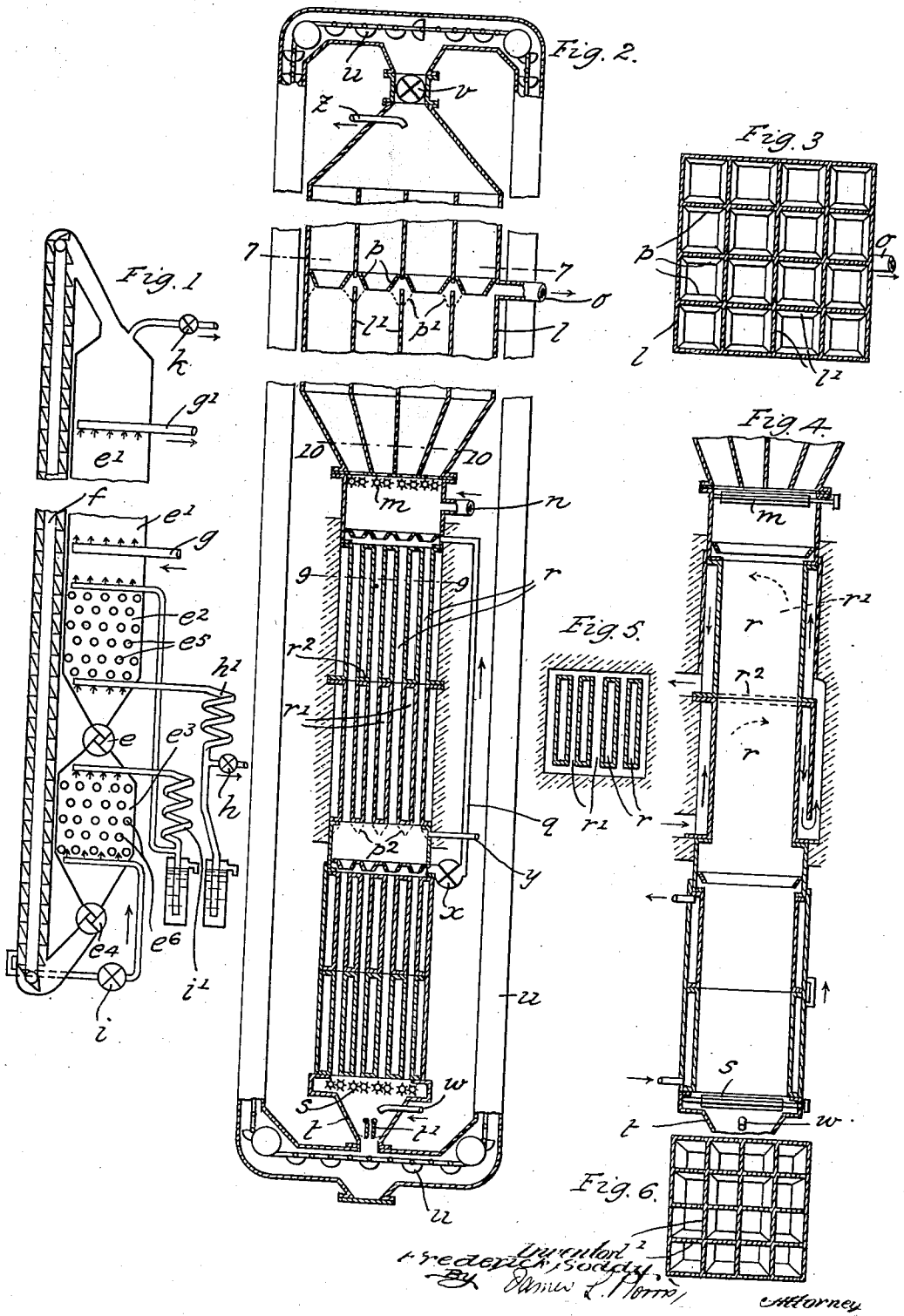
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APPARATUS FOR PURIFYING COAL GAS.

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UNITED STATES PATENT OFFICE.

FREDERICK SODDY, OF OXFORD, ENGLAND.

APPARATUS FOR PURIFYING COAL GAS.

1,422,608. Specification of Letters Patent. Patented July 4, 1922.

Application filed August 6, 1920. Serial No. 401,696.

To all whom it may concern:

Be it known that I, FREDERICK SODDY, a subject of the King of Great Britain, formerly residing in Aberdeen, Scotland, but now residing in Oxford, England, have invented a certain new and useful Improvement in Apparatus for Purifying Coal Gas, of which the following is a specification.

This invention relates to apparatus suitable for applying the process described in my application for United States Letters Patent Serial No. 289,352 dated 11th April 1919.

The general principle involved in the process for which the apparatus is intended, is the continuous travel of charcoal first through a cool chamber in which it is exposed to the current of gas at ordinary temperature, and then through a heated chamber in which it is cut off from the gas current, the expelled illuminants being suitably withdrawn. This principle is applied in such a manner that a certain fractionation of the illuminants from the non-illuminants is attained, whereby a more concentrated product may be continuously obtained than is possible by known methods of absorbing and recovering.

The invention is illustrated by the accompanying drawing in which Fig. 1 shows in diagrammatic vertical section an apparatus for the continuous treatment of coal gas by means of charcoal; Fig. 2 is a diagrammatic sectional elevation of a modified form of the apparatus; Fig. 3 is a cross section on line 7—7 of Fig. 2; Fig. 4 is a vertical section in a plane at right angles to that of Fig. 2, and Figs. 5 and 6 are respectively sections on lines 9—9 and 10—10 of Fig. 2.

Fig. 1 represents a tower subdivided into two chambers by a valve e. The upper part e' of the upper chamber is the absorber, the lower part e^2 (containing heating pipes e^5) is the heater, while the lower chamber e^3 (containing cooling pipes e^6) is the cooler and has a valve e^4 at its lower part.

These valves e, e^4 are of any known type for transferring a solid while checking passage of gas; they need not in this case be completely gas-tight so long as they effectively check gaseous flow. The charcoal descends the tower by gravity and is again raised by a conveyor f working in a gas-tight casing. The main stream of coal gas enters at g and leaves at g', substantially stripped by the charcoal descending the tower, and consisting essentially of hydrogen, methane, carbon monoxide and nitrogen, the ethylene, ethane and their homologues being absorbed by the charcoal, together with the liquid illuminants if these have not been removed in a previous scrubbing. As the charcoal passes among the heating pipes e^5 it loses its absorbed gases and vapours, some of which are withdrawn by pump h through a condenser h' while the rest ascend to join the gas entering at g. The part of the expelled gas so ascending is subjected to the fractionating action hereinbefore mentioned. It consists of the gas expelled in the initial stages of the heating of the charcoal, which in passing over successively cooler layers of charcoal is deprived of its excess of illuminants by the charcoal and gains from the charcoal a part of the non-illuminants previously absorbed by the charcoal before it was heated. The gases withdrawn by the pump h through the condenser h', consist of the part of the absorbed gases expelled in the later stages of the heating. They consist of the illuminants in the coal-gas in a highly concentrated condition, the removal of which from the coal-gas is the object of the invention. The gas so removed is the richer in illuminants the less of it that is so withdrawn. The volume withdrawn must not be less than the volume of the total illuminants in the gas passed through and may, in general, be somewhat greater than this volume.

For washing the charcoal descending among the pipes e^6, stripped gas is withdrawn in determined amount from the top of the tower, passing down the casing of the elevator, by pump i and is caused to pass through the cooler so as to carry the illuminants from the charcoal therein (through a condenser i' if necessary), into the upper chamber at a place above the heating tubes e^5. The volume of gas so used for washing may be somewhat greater than, for example, from two to four times as great as, the volume of charcoal passing down the tower. A pump k may withdraw a gas rich in hydrogen from the upper part of the tower.

By this means a small part of the stripped gas, which otherwise would leave by the exit pipe g', is caused to pass through a relatively large mass of fresh charcoal at ordinary temperature which has not yet absorbed any gas and, in consequence, the methane and carbon monoxide are absorbed preferentially

and the content in hydrogen of the part not absorbed thereby increased.

It will be understood that the washing of the charcoal with stripped gas with the double object of preventing the accumulation in it of the less volatile and more difficultly removed constitutents and the recovery of the small and relatively unimportant part of the illuminants it carries along with it in its pores, and also the withdrawal of a small part of the total gas richer in hydrogen than the main quantity of stripped gas, are subsidiary to and not essential to the main process which can be operated without them. In this case the pump i, condenser i' with their connecting pipes, and the pump k may be dispensed with, and the exit pipe g' taken from the top of the tower.

To construct an apparatus thus diagrammatically represented, regard must be had to the conditions under which charcoal will flow under gravity. Lumps which will pass through a 1 inch sieve will flow through a pipe of circular cross-section 6 inches in diameter but will bridge in a pipe 4 inches in diameter. It will flow through a rectangular slot 3 inches wide, but 4 inches is a safer dimension. Its angle of repose is about 45° and the sides of a hopper through which it is to flow without bridging should make an angle of not less than 50° with the horizontal.

Referring now to Figs, 2–6, the interior of the absorber l is subdivided by vertical plates l' in planes at right angles to each other into elongated cells down which the charcoal descends. The descent is regulated and made uniform over the cross sectional area of the tower by means of the grooved rollers m rotated by suitable mechanism. The coal-gas enters the absorber at n and leaves it at o (Fig. 2), consisting essentially of hydrogen, methane, carbon monoxide and nitrogen. To ensure a uniform withdrawal of the gas over the cross section of the tower, at the plane of the exit o there are fixed in the cells rectangular funnels p and the vertical partitions are perforated at the places which are behind these funnels (Fig. 3). The charcoal descending through the funnels assumes the angle of repose indicated by dotted lines p', leaving spaces which are all in communication with each other and with the exit o through the said perforations. A like construction is provided at the ends of the by-pass q referred to below, and the charcoal also takes up its natural angle of repose, indicated by p^2 at the line of the exit y.

The charcoal having left the absorber descends the heater which is also of cellular structure, but the cells r alternate with heating flues r' divided into an upper and a lower set by horizontal partitions r^2. They may in addition be subdivided by transverse partitions in planes parallel to the paper (Fig. 2). As shown in Fig. 4 heating gases circulate first through the lower heating flues and then through the upper, so that the lower part of the heater is the more strongly heated and the heat is used economically. Having left the heater the charcoal descends through the cooler which is similarly constructed with upper and lower flues for circulation of cooling gases or liquid as indicated in Fig. 4. In passage through the heater and cooler the relative movement that occurs among the pieces of charcoal decreases the time required for heating and cooling the charcoal. At the bottom of the cooler are grooved rollers s to regulate the descent, driven by any suitable mechanism. From the cooler the charcoal travels through a hopper t, having a suitable device, such as two flaps t', which is so geared to the conveyor u that it permits passage of charcoal only when there is a bucket of the conveyor beneath the discharge opening. For instance, flaps t' may assume the position shown each time a conveyor bucket is beneath the discharge opening of the hopper and may be turned into the position to close the hopper as soon as the bucket has passed. The conveyor discharges the charcoal to the rotating bucket valve v at the top of the absorber.

As in the case of Fig. 1, stripped gas, which may be taken from the main stream of stripped gas delivered in regulated amount through a pipe w into the lower part of the cooler and a corresponding amount is withdrawn by pump x from the upper part and passed through by-pass q to the upper part of the heater. The illuminants are withdrawn at y. Gas rich in hydrogen may be withdrawn at z, or in the event of this not being required, the main stream of stripped gas may leave at z instead of at o. The meters or pumps controlling the flow of gases through the pipes w and q are driven at a constant relative speed found, by trial, best to prevent intermixture of the illuminants with the gas used for washing the charcoal, which in this form of apparatus serves also to prevent the gases expelled in the heater from being reabsorbed in the cooler, and is kept as small in volume as is found by trial to be effective for this purpose.

The fractionating effects in the part of the expelled gases passing upwards in the heater to rejoin the main stream at n and in the part of the gas passing upward above the exit o to the exit z, are precisely similar to those already described in the case of Fig. 1.

Having thus described the nature of the said invention and the best means I know of carrying the same into practical effect, I claim:—

1. Apparatus for treating coal-gas to sep-

arate the non-illuminant hydrocarbon and other gases from the illuminants, comprising a container, a heated chamber, a cooled chamber and a chamber which is neither heated nor cooled in the said container, means for circulating charcoal successively through the heated chamber, the cooled chamber and the chamber which is neither heated nor cooled, means for passing coal-gas through the last-named chamber in counter-current to the charcoal and means for withdrawing gas from the heated chamber.

2. Apparatus for treating coal-gas to separate the non-illuminant hydrocarbon and other gases from the illuminants, comprising a container, a heated chamber, a cooled chamber and a chamber which is neither heated nor cooled in the said container, means for circulating charcoal successively through the heated chamber, the cooled chamber and the chamber which is neither heated nor cooled, means for passing coal-gas through the last-named chamber in counter-current to the charcoal, means for withdrawing gas from the heated chamber, means between the heated chamber and the cooled chamber adapted to permit passage of charcoal while hindering passage of gas, means for withdrawing gas from the chamber which is neither heated nor cooled and introducing it into the cooled chamber, and means for withdrawing gas from the cooled chamber and passing it into the chamber which is neither heated nor cooled.

3. Apparatus for treating coal-gas to separate the non-illuminant hydrocarbon and other gases from the illuminants, comprising a container, a heated chamber, a cooled chamber and a chamber which is neither heated nor cooled in said container, means for circulating charcoal successively through the heated chamber, the cooled chamber and the chamber which is neither heated nor cooled, means for passing coal-gas through the last-named chamber in counter-current to the charcoal, means for withdrawing gas from the heated chamber, means between the heated chamber and the cooled chamber adapted to permit passage of charcoal while hindering passage of gas, means for withdrawing gas from the chamber which is neither heated nor cooled and introducing it into the cooled chamber, means for withdrawing gas from the cooled chamber and passing it into the chamber which is neither heated nor cooled, and means for withdrawing gas from the last-named chamber at a point passed by the charcoal before it passes the point at which the main portion of gas leaves the chamber.

In testimony whereof I have signed my name to this specification.

FREDERICK SODDY.