Aug. 3, 1926. 1,594,957

F. A. HOWARD ET AL

STEAM DISTILLATION

Filed March 8, 1920 2 Sheets-Sheet 1

Fig. 1.

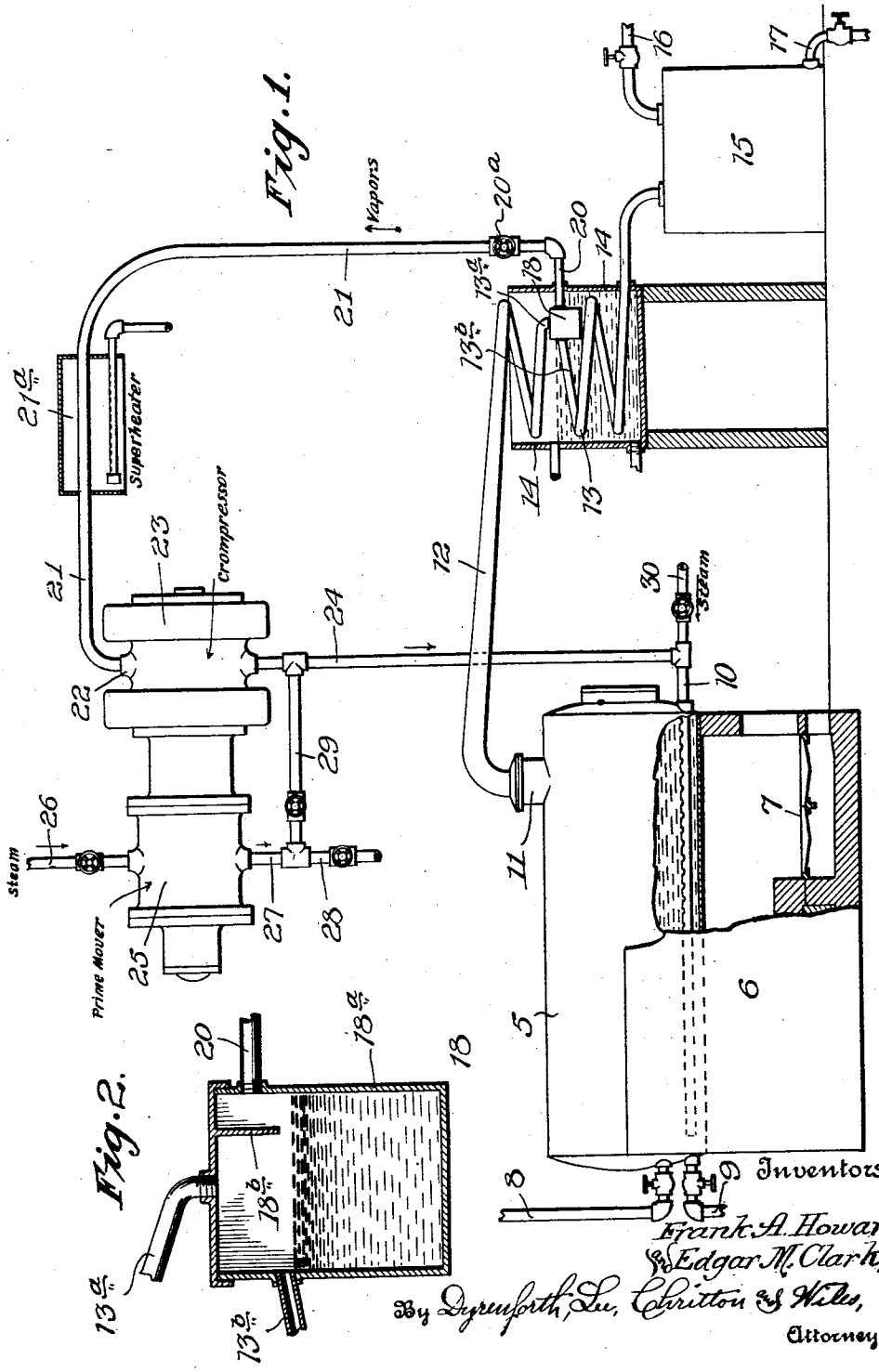


Fig. 2.

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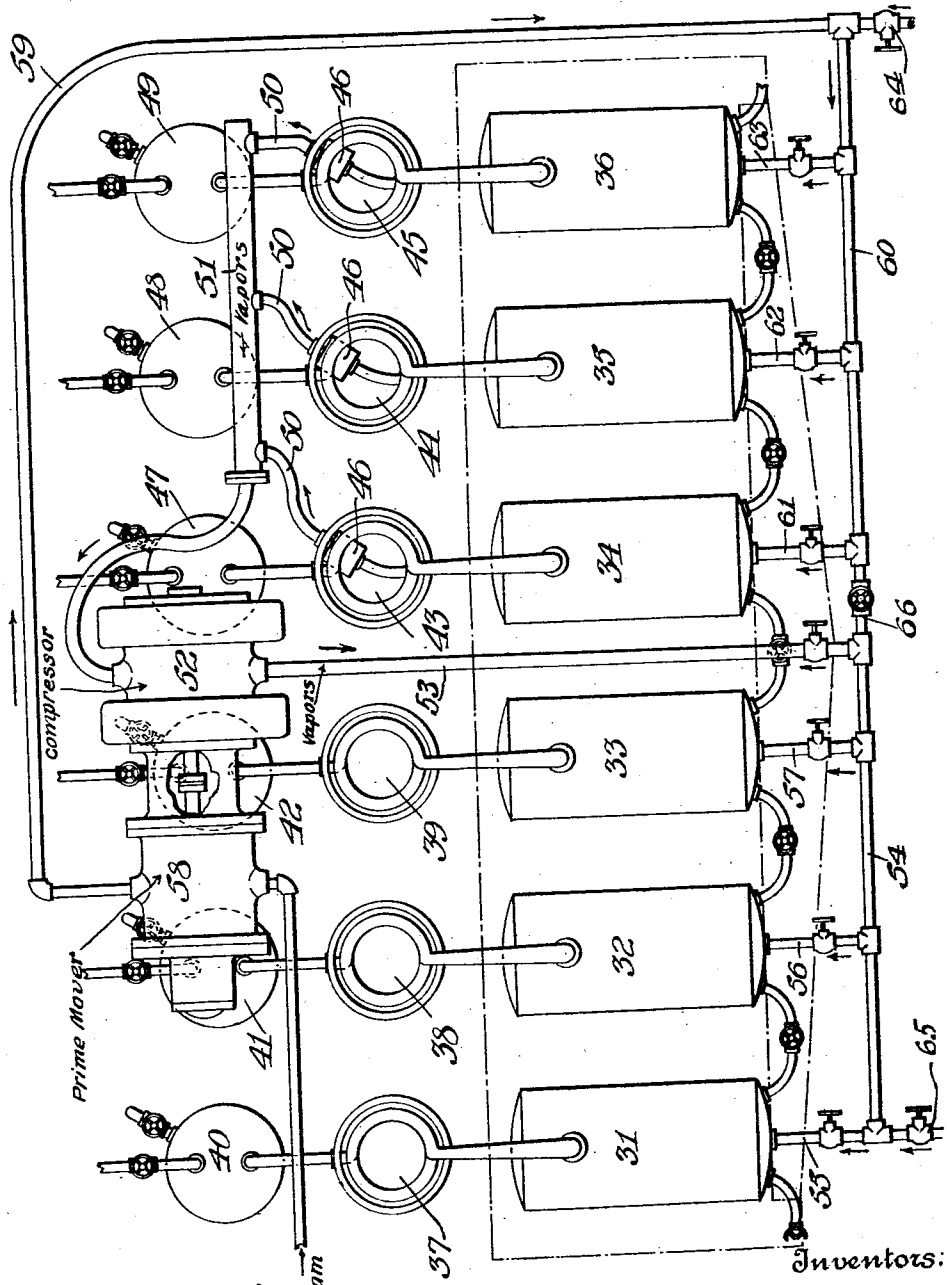


Fig. 3.

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UNITED STATES PATENT OFFICE.

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STEAM DISTILLATION.

Application filed March 8, 1920. Serial No. 364,101.

The present invention relates to improvements in the art of steam distillation, for example, of petroleum or hydrocarbon oils immiscible with water either by steam alone or by steam conjointly with fire or other heat source. It is fully described in the following specification and illustrated in the accompanying drawings, wherein apparatus is shown suitable for carrying out the invention in connection with a single still and likewise in connection with a battery of stills. In the drawings,

Fig. 1 is a view showing somewhat diagrammatically an arrangement of apparatus suitable for carrying out the invention in connection with a single still;

Fig. 2 is a sectional view through the trap inserted in the condenser, and

Fig. 3 is a plan view of an arrangement of apparatus suitable for carrying out the invention in connection with a battery of stills, some of the elements being shown on an exaggerated scale for clearness in illustration.

Referring more particularly to Figs. 1 and 2, the numeral 5 indicates a suitable still of the shell type mounted in a furnace setting 6 provided with a fire box 7 (connections to the stack are not shown). The still is charged and fed through valved pipe 8, the bottoms are discharged through valved pipe 9 and steam is introduced through pipe 10 which extends along the still near its bottom and is provided within the still with perforations for the distribution of the steam.

The still 5 is provided with a dome 11, to which the vapor line 12 is connected, which, in turn, communicates with the condenser coil 13 in the water bath 14. The condenser discharges into a drum 15, which is provided with a gas discharge pipe 16 and a liquid discharge pipe 17.

The condenser coil is provided at an intermediate point with a trap 18, shown in section on a relatively enlarged scale in Fig. 2. The condenser coil inlet into the trap 18 is shown at 13^a and the condenser coil outlet at 13^b, serving also as an overflow for the liquid condensate which collects in the body 18^a of the trap. A vapor outlet 20 is arranged above the liquid level in the trap and is protected by a baffle 18^b which projects downwardly from the top of the trap almost to the liquid level and prevents to a great extent the entrainment of liquid issuing from the condenser coil inlet 13^a in the current of vapors passing out of the vapor outlet.

The vapor outlet 20 communicates through pipe 21 with the intake 22 of a compressor 23, the discharge of which communicates through pipe 24 with the steam pipe 10 leading into the still. The compressor 23 is driven by any suitable means, for example, by the reciprocating steam engine 25, into which steam is admitted through pipe 26 and exhausted through pipe 27. The exhaust steam may pass out through pipe 28 to a condenser (not shown), if desired. It is prefered, however, that the steam be exhausted from engine 25 at the same pressure as that discharged from compressor 23, in which case the exhaust steam from the engine is passed through pipe 29 into pipe 24, joining the steam issuing from compressor 23 and passing into pipe 10 leading into the still.

The cooling of the condenser coil is so controlled that the greater portion (at least 50% by weight) of the vapors issuing from trap 18 through pipe 20 shall be steam. This can readily be determined for any particular oil by withdrawing a sample of the vapors through pipe 20, cooling to condense the same, and measuring the relative quantities of condensed water and oil. For operation under ordinary conditions, that is, with an average pressure in the still and condenser but slightly above atmospheric (about 1 lb. gauge) the temperature of the vapors in the trap 18 should be at least 215° F.

The steam trapped from the condenser, which may be at a pressure of, for example, 1 lb. gauge, is compressed to a suitable pressure for introduction into the still, for example, 10 lbs. gauge, and passes out of the compressor through pipe 24 at this pressure. The engine operating the compressor may be driven by steam at, say, 80 lbs. gauge, exhausting at 10 lbs. gauge, the exhausted steam being passed into the line 24, joining the steam issuing from the compressor. With reasonable efficiency of operation under these conditions of operation the quantities of steam delivered into the line 24 by the compressor and the engine exhaust will be approximately equal. A super-heater 21^a may be utilized to super-heat the steam before it enters the still, if desired.

A suitable stock, preferably one vaporizing above 212° F. (for example, an oil of 28 to 30° Bé.) is charged into still 5, which is then fired and steam is forced into it through pipe 10 at the pressure prevailing therein, which is, in the instance described, 10 lbs. gauge. If desired the steam may be superheated by means of the super-heater 21ª to a temperature equal to or greater than the internal temperature of the still, say 525° F. In case the steam is super-heated, the direct firing of the still may be proportionately diminished or may be entirely omitted. The distillation is continued until the desired distillates or bottoms have been produced. In continuous operation fresh stock may be charged through pipe 8 and bottoms removed through pipe 9. The hydrocarbon vapors drawn off at the trap with the steam, which in the case of a heavy oil may form less than 10% of the total vapors, are returned to the still together with the compressed steam and are hence not lost. The withdrawal of steam from the trap may be discontinued by closing the steam outlet 20 therefrom by means of valve 20ª and stopping the engine and compressor steam may then be supplied from steam line 30 at any desired pressure.

In the batch distillation of oils containing fractions vaporizing below the boiling point of water, e. g. crude oils, the vapor outlet of the trap is closed until these fractions have been removed and the composition of the vapors at the trap is at least 50% steam, when the vapor outlet of the trap may be reopened and the distillation continued as above described. During the early part of such a batch distillation, fresh steam is preferably utilized, although steam containing vapors of heavy fractions may be employed, if desired.

In Fig. 3 of the drawings there is illustrated a mode of application of the invention to a battery of continuous stills, there being six in the battery illustrated. The oil is introduced into the first still 31 of the battery, and after treatment there, flows successively into and out of the remaining stills 32, 33, 34, 35, 36 and 37, being subjected in each still to steam or fire and steam distillation at successively higher temperatures. Thus, the temperature of the oil in still 31 may be 200–210° F., and may increase by removal of lighter boiling fractions in each still to approximately 700° in the last stills of the battery, the increase in temperature between stills being approximately equal. The first three stills of the battery are connected by vapor lines to condenser 37, 38 and 39, respectively, which in turn communicate with the receiving drums 40, 41, and 42. The last three stills of the battery, that is, those stills wherein the oil treated has a boiling point above 400° F., are connected by their vapor lines to condensers 43, 44 and 45, respectively, each of which is provided with a steam trap 46, operating as in the case of the single still hereinbefore described. The temperature of the condensers is controlled in such manner that the vapor temperature in the trap will be at least 215° F. and not above the temperature at which 50% of the vapors withdrawn from the trap will be oil vapors. A temperature of approximately 230° F. is satisfactory for the operation of the trap. The discharge from the condensers pass into receiving drums 47, 48 and 49. The vapor outlets 50 from the steam traps lead into a manifold 51, from which the steam is drawn at the pressure prevailing in the stills (about 1 lb. gauge) into compressor 52. Here the steam is compressed to a suitable pressure for introduction into the stills, (about 10 lbs. gauge) and is discharged through pipe 53 into manifold 54, from which it is passed through pipes 55, 56 and 57 into the stills 31, 32 and 33, in which the lower boiling point fractions are removed. Any heavy hydrocarbon vapors carried by the steam are here absorbed by the oil, light vapors being condensed with the distillate from the still.

The compressor may suitably be driven by a steam engine 58, for example, of the reciprocating type, which may receive steam, for example, at 80 lbs. and exhaust it at a pressure suitable for introduction into the stills (for example, 10 lbs. gauge.) The exhaust steam passes through pipe 59 into manifold 60, from which it is led through pipes 61, 62 and 63 into the stills 34, 35 and 36, which treat the oil from which the lower boiling fractions have been removed and the condensers of which are provided with steam traps. As has previously been stated, with reasonable efficiency of operation under these conditions, approximately equal quantities of steam are delivered through the exhaust of the engine and the discharge of the compressor. It is hence apparent that with an equal number of stills fed by the engine exhaust and by the compressor discharge, the engine exhaust will furnish substantially all of the steam required by the battery. If desired, the steam from the engine exhaust may be supplemented or replaced in whole or in part by steam from an independent line 64, and that from the compressor by steam from line 65.

A connection 66 may be provided between the manifolds 54 and 60, which may be opened if it is desired to supply a mixture of compressed distillation steam and exhaust steam to all of the stills, this mixture having, of course, a less proportion of oil vapors than the compressed distillation steam. This mode of operation may readi-

ly be utilized in continuous distillation operations, such as the reduction of crudes to heavy residues, as described in the copending application Serial No. 308,645, filed July 3rd, 1919, of one of the present inventors.

It is clearly apparent that the processes and apparatus whereby the present invention may be carried into effect may be widely varied and that compressors and prime movers therefore of other types than those herein illustrated may be utilized. It is hence, not intended that the details of apparatus or process, such as specific temperatures and pressure, shall be regarded as limitations upon the invention, except as included in the accompanying claims.

We claim:

1. The process of distilling liquid hydrocarbons or like substances immiscible with water which consists in passing the same progressively through a plurality of stills in which successively heavier fractions are removed in successive stills, introducing steam into the stills in which the heavier fractions are removed, removing and cooling the vapors evolved in such stills, withdrawing therefrom vapors containing at least 50% of steam, compressing said vapors and introducing the compressed vapors into stills in which lighter fractions are removed, and removing and condensing the vapors from said last mentioned stills.

2. The process of distilling crude petroleum oil which consists in passing the same successively through a plurality of stills in which successively heavier fractions are removed in successive stills, some of said stills being at a temperature below 500° F. and some of said stills at a temperature of above 500° F. introducing steam into the stills which are at a temperature above 500° F., removing and cooling the vapors evolved in said stills, withdrawing therefrom vapors containing at least 50% of steam, compressing said vapors and introducing the compressed vapors into stills at a temperature below 500° F. and removing and condensing the vapors from said last mentioned stills.

3. Steam distillation apparatus comprising a still, a condenser, and means for withdrawing vapors from the condenser and means for forcing them into the still comprising a compressor having its intake connected with the condenser and its discharge leading into the still, a steam-driven prime mover operating said compressor, the exhaust from said prime mover being connected with the discharge from the compressor.

4. Steam distillation apparatus comprising a plurality of stills maintained at successively higher temperatures, and each provided with a condenser for evolving vapors, means for passing oils progressively through said stills in the order of their temperatures, a compressor, a steam-driven prime mover for operating said compressor, means for introducing the exhaust from said prime mover into the stills at or above a predetermined temperature, means connecting the condensers of these stills with the intake of the compressor, and means for conducting the discharge from the compressor into the stills below the predetermined temperature.

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