May 30, 1933. J. MARUHN ET AL 1,911,909

HYDROGENATING APPARATUS

Filed Sept. 22, 1931 3 Sheets-Sheet 1

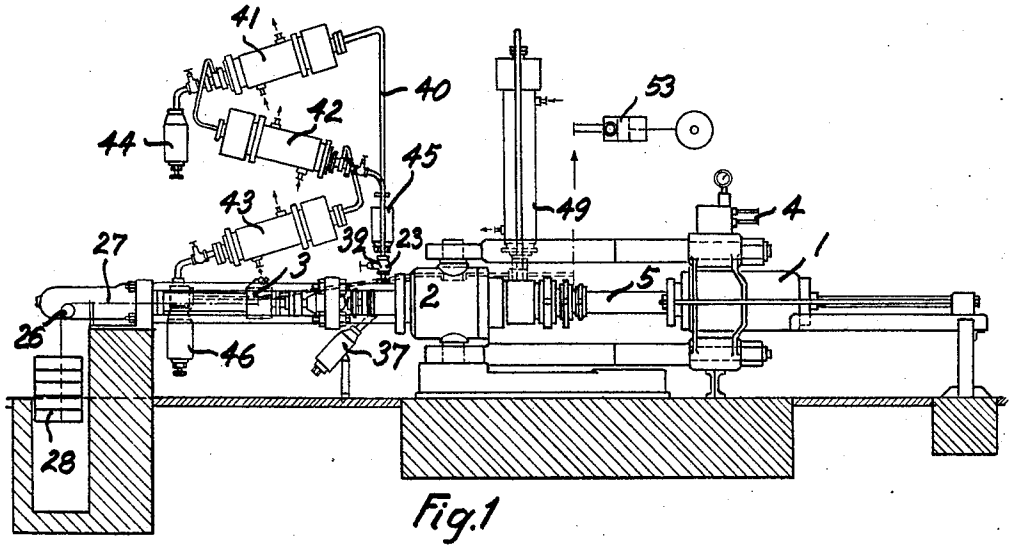


Fig.1

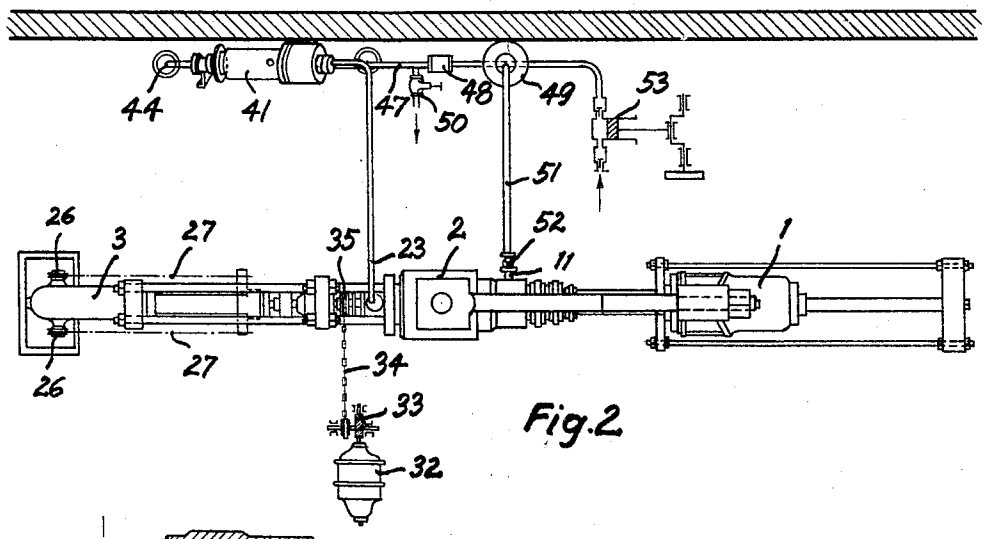


Fig.2

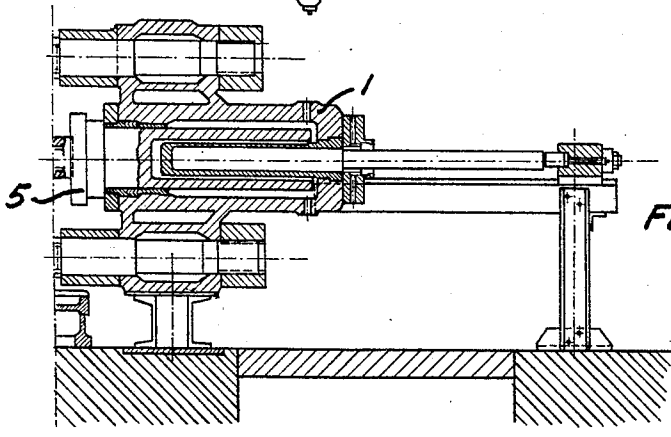


Fig.4

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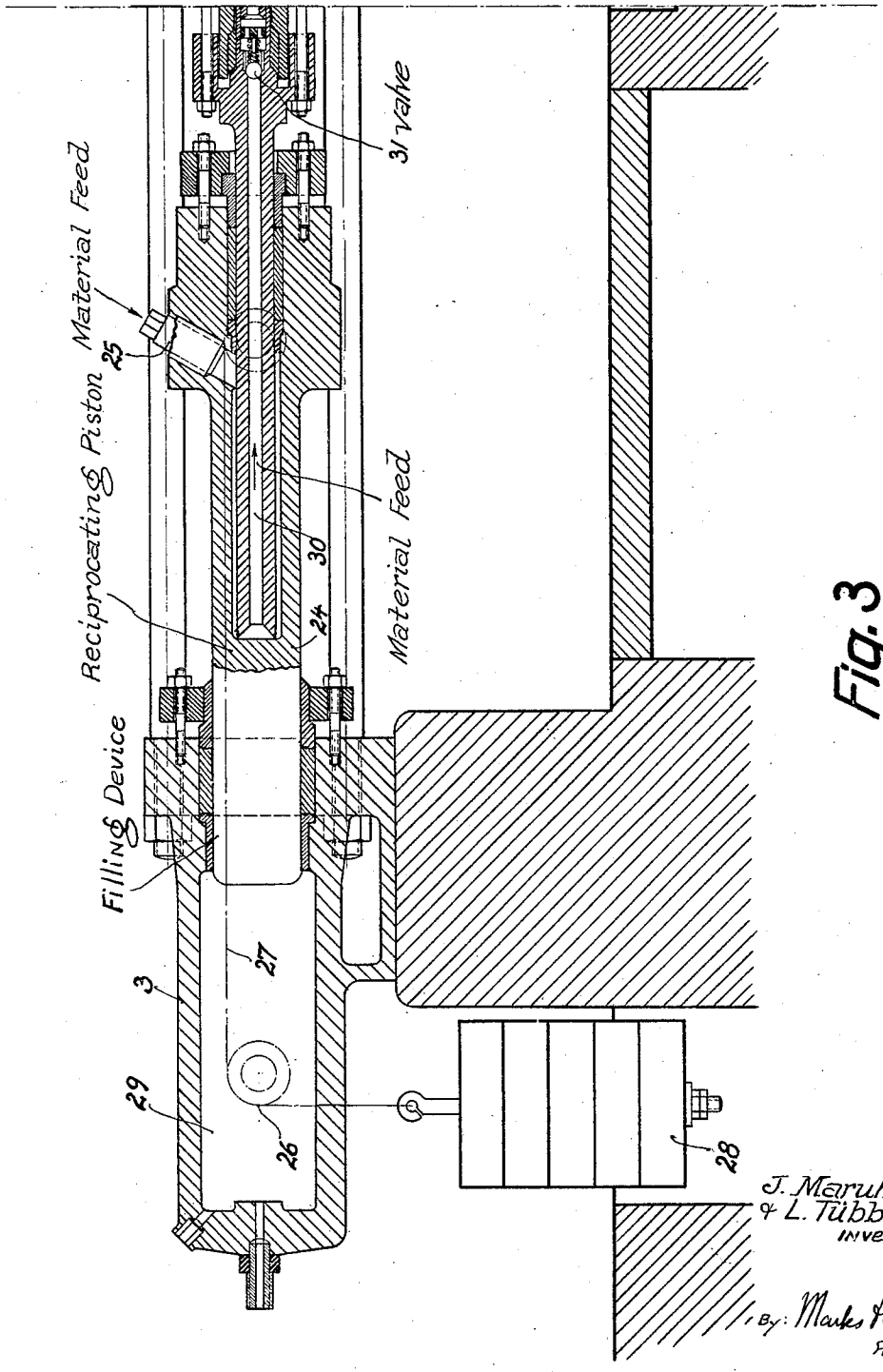


Fig. 3

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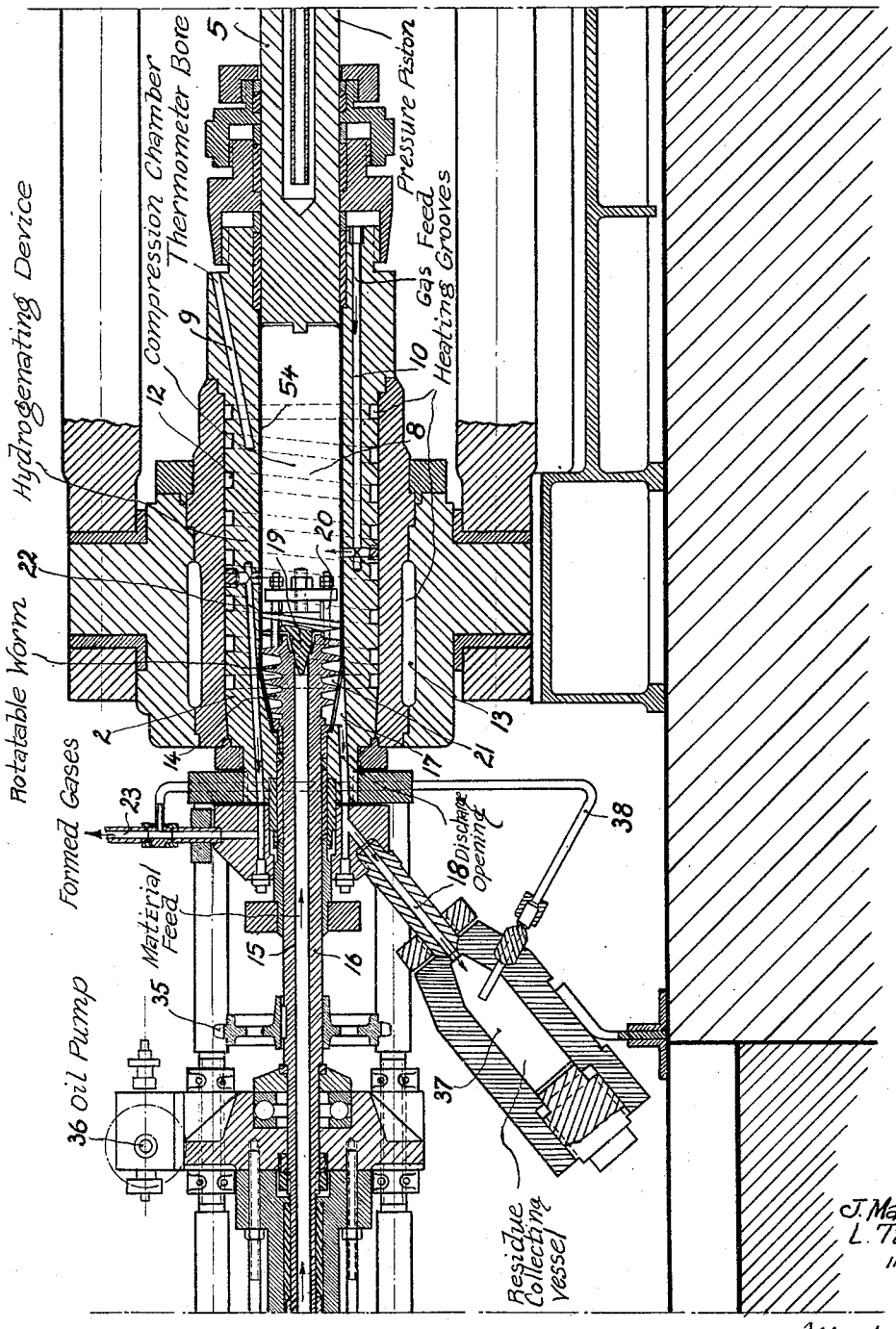


Fig. 5.

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UNITED STATES PATENT OFFICE

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HYDROGENATING APPARATUS

Application filed September 22, 1931, Serial No. 564,408, and in Germany June 25, 1931.

This invention relates to an apparatus for the hydrogenation of pulverized coal-oil-paste or heavy oil. It concerns a further improvement and partial modification of the hydraulic hydrogenating press described in the Patent 1,807,122 dated May 26, 1931.

The details of the invention are hereinafter described and claimed and also shown in the accompanying drawings, in which:

Figure 1 is a side elevation of the apparatus;

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

Figures 3 and 4 represent together a longitudinal section along the center line of Fig. 2 through the apparatus on a larger scale;

Figure 5 is a fragmentary longitudinal section on a still larger scale through the hydrogenating chamber and the delivery screw along the center line of Fig. 2.

The complete apparatus comprises the hydraulic press 1, the hydrogenating device 2 proper and the filling device 3 for the latter. The hydraulic press, shown in section in Figure 4, is of a known type and provided with forward and return stroke pistons. The hydraulic pipes are designated 4 in Figure 1. During the pressure stroke, the piston 5 is moved forward to the left of the drawing. Owing to the resulting high heating, the piston is provided with water cooling means and with the cooling water pipes 6 and 7. The part 54 indicates a lining of the cylinder 80 with chrome-nickel steel.

As advantages it may be stated that a great resistance of the cylinder to wear and tear is thereby obtained and that chrome-nickel steel also exerts a catalytic effect or action during the chemical process.

During the pressure stroke, the volume of the cylindrical chamber 8, wherein the supplied gases are led, is reduced and the requisite high pressure is thereby produced. The cylinder 80 provided with the chamber 8 has a drilled recess 9 for a measuring thermometer and a channel 10 for feeding the gases; this channel communicates with the pipe 11 (Fig. 2). The compression chamber is surrounded by grooves 12 and 13 through which steam or hot gases or liquids are led for heating the reaction chamber. A hollow worm 14 is provided opposite the piston 5 in the compression chamber and is mounted on a pipe 16 having a bore 15; the heavy oil or the coal-oil-paste is fed through the said bore and since the front part 19 of the worm 14 is movable and is guided against the bolts 20 whose nuts serve as an abutment, the said oil is pressed between the helices of the screw that is to say, into the intermediate spaces 21 which form the reaction chamber proper. The movable part 19 of the screw or worm is designed as a valve cone which bears on a suitable valve seat provided in the worm 14. The reaction of the combustibles and the hydrogenating gases contained between the helices of the screw takes place under the action of the compressed gases and the high temperature. During the rotation of the worm 14, the residues are pressed into the opening 17 and thence to the pipe 18. The passage 22 which extends to the pipe 23 is adapted for the discharge of the gases. The stuffing boxes, bearings and so forth as shown in the drawings may be of any known type adapted for high pressures and temperatures. By means of a cylindrical bore in the piston 24 Fig. 3 the coal-oil-paste or the heavy oil or a mixture of both is fed through the opening 25 when the piston 24 is in the left end position. By means of the ropes or the chains 27 passing over the rollers 26 cooperating with the weight 28, the piston 24 is drawn into the left end position. The piston is forced back into the right end position shown in Figure 3 by introducing water under pressure into the cylinder 29. The coal or the oil is thereby forced into the bore of a stationary pipe 30 tightened by a packing and passes through the back pressure valve 31 designed as a ball valve and thence into the bore 15. The coal or the oil now passes in the manner described above between the helices of the screw 14 into the intermediate spaces 21. The worm 14 is driven by the motor 32, a reducing gear 33 Fig. 2, the chain 34 and the sprocket wheel 35. The axial thrust of the screw or worm is absorbed by a ball bearing. An oil pump for the lubrication of the various stuffing

boxes is provided at 36 in the known manner. The residue forced out by the worm 14 passes into the residue collecting vessel 37 which for the purpose of relieving pressure communicates through the pipe 38 with the gas outlet 23. The gases produced after the reaction pass through the pipe 23, the valve 39 and the pipe 40 (Figs. 1 and 2) into the condensers 41, 42 and 43 where they are preferably subjected in known manner to a fractional condensation. The resulting condensate passes from the condensers into the corresponding collecting vessels 44, 45 and 46. The non-condensable gases are led through the pipe 47 and the valve 50 to a collecting vessel or they pass through the back pressure valve 48 into the heating vessel 49. They are then led through the pipe 51, the valve 52, the pipe 11 and the channel 10 into the compression chamber of the hydrogenating cylinder. The gases, chiefly hydrogen, compressed by the compressor 53 also pass into the same chamber and are supplied anew to the process.

The apparatus operates in the following manner: The hydrogenating chamber is filled when the piston 5 has reached its right end position as seen in the drawings and a reduction of pressure has therefore taken place. The valve 52 is then opened so that the gases produced pass into the condensers 41, 42, 43 whence the condensate that is formed passes into the collecting vessels 44, 45, 46. The non-condensable gases are led through the pipe 47 and the back pressure valve 48 to the heater 49. The pressure in the press has now dropped to 200 atmospheres or less. The material to be hydrogenated is forced against the said pressure by means of the piston 24 through the opening 25, bore of the pipe 30, back pressure valve 31, bore 15 and the valve space of the front part (also designed as a back pressure valve) of the worm 14 into the space 21 between the helices of the screw. The gases which are heated in the pre-heater 49 and other gases, mainly hydrogen, pass into the same space 21 and the cylinder chamber 8 and are compressed by the compressor 53 to such an extent that a pressure of 400 atmospheres or more is produced in the hydrogenating chamber. Gases in excess may be led through the valve 50 to a collecting vessel (gasometer) which is not shown in the drawings. The piston 5 is now moved forward to the left as seen in the drawings and a pressure of 1000 atmospheres or more is produced. The piston remains in the end position according to the pressure and temperature for several minutes and preferably under pressure while the reaction is taking place. The process is then continued as described above.

It is obvious that the known details including stuffing boxes, bearings, reinforcing members, etc., which are not fully described and the other details which are described above and shown in the drawings may be modified without departing from the spirit of the invention.

Regarding the operation of the apparatus the following is stated: the valves are first operated by hand, which cannot be otherwise in connection with an experimental apparatus. The hydraulic pump is driven by an electromotor, that is to say, the large pump for moving the hydrogenating piston as well as the small pump for operating the plunger of the filling device.

It is obvious that the residue can only be discharged from the spaces 21 if the cylinder receives a corresponding recess at 17. The liquid material is conveyed backward constantly by the worm so that it cannot enter the space between the worm and the hydrogenating plunger. The gaseous products can be readily led away through the channels 22 and 23. The hydrogenating products are prevented from entering the space between the worm and the plunger by the worm itself. The piston 5 passes into the zone 8 to the extent of its stroke but not to such an extent that it comes in contact with the worm or covers the gas outlet channel 22.

The following should be noted. The supplied material, preferably coal-oil paste or heavy oil, passes only into the intermediate spaces 21 but not into the space 8. The worm 14 is rotated during the supply of the material and material is only supplied until the helical spaces 21 of the worm are filled. The spaces 21 form the actual reaction chamber which communicates with the compression chamber 8.

What we claim is:

1. An apparatus for hydrogenating material consisting of coal-oil paste and heavy oils; comprising a compression chamber, a compression piston adapted to reciprocate in said chamber, a worm revoluble in the compression chamber and adapted to force out material contained in its helical spaces, said helical spaces forming part of the compression chamber, means for feeding the material to be treated into the helical spaces of the worm, means for feeding hydrogenating gas into the compression chamber and means for carrying off the vapors and gases produced in the compression chamber.

2. An apparatus for hydrogenating material consisting of coal-oil paste and heavy oils; comprising a compression chamber, a compression piston adapted to reciprocate in said chamber, a worm revoluble in the compression chamber and adapted to force out material contained in its helical spaces, the worm having a rearwardly extending shank with a central bore, means for feeding the material to be treated into said bore, a pressure actuated closure member for said bore

adapted to control the passing of the material from the bore into the helical spaces of the worm, said helical spaces forming part of the compression chamber, means for revolving the worm, means for feeding hydrogenating gas into the compression chamber and means for carrying off the vapors and gases produced in the compression chamber.

3. An apparatus for hydrogenating material consisting of coal-oil paste and heavy oils; comprising a compression chamber, a compression piston adapted to reciprocate in said chamber, a worm revoluble in the compression chamber and adapted to force out material contained in its helical spaces, the worm having a shank extension with a central bore, means for feeding the material to be treated into said bore, a pressure actuated closure member for said bore adapted to control the passing of the material from the bore into the helical spaces of the worm, said helical spaces forming part of the compression chamber, a worm gear adapted to revolve said worm for carrying off the material treated, means for feeding hydrogenating gas into the compression chamber and means for carrying off the vapors and gases produced in the compression chamber.

4. An apparatus for hydrogenating material consisting of coal-oil paste and heavy oils; comprising a compression chamber, a compression piston adapted to reciprocate in said chamber, a worm revoluble in the compression chamber and adapted to force out material contained in its helical spaces, the worm having a shank extension with a central bore, a plunger in alignment with the axis of said worm and telescoping with said shank extension, adapted to feed the material to be treated into said bore, a pressure actuated closure member for said bore adapted to control the passing of the material from the bore into the helical spaces of the worm, said helical spaces forming part of the compression chamber, means for revolving the worm, means for feeding hydrogenating gas into the compression chamber and means for carrying off the vapors and gases produced in the compression chamber.

5. An apparatus for hydrogenating material consisting of coal-oil-paste and heavy oils; comprising a compression chamber, a compression piston adapted to reciprocate in said chamber, a worm revoluble in the compression chamber adapted to force out material contained in its helical spaces, the worm having a shank extension with a central bore, a plunger in alignment with the axis of said worm and telescoping with said shank extension, adapted to feed the material to be treated into said bore, a hydraulic power supply device for the feed stroke of said plunger and tension members with a weight adapted to retract the plunger, a pressure actuated closure member for said bore adapted to control the passing of the material from the bore into the helical spaces of the worm, said helical spaces forming part of the compression chamber, means for revolving the worm, means for feeding hydrogenating gas into the compression chamber and means for carrying off the vapors and gases produced in the compression chamber.

6. In an apparatus according to claim 2, a collecting vessel for residues of said material, a conduit between said vessel and said chamber and a pressure relieving valve for the gases in said vessel.

7. In an apparatus according to claim 2, a heating device, condensers and conduits for leading the gases resulting from the reaction from said chamber through the condensers to the heating device and returning them to said chamber.

In testimony whereof we affix our signatures.

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