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TOOL FOR IMPINGING LIQUID AGAINST INNER WALLS OF CHAMBERS

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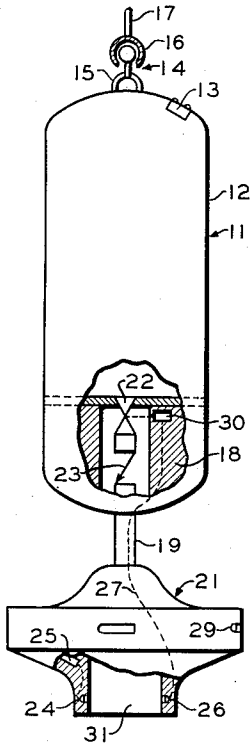


FIG. 1

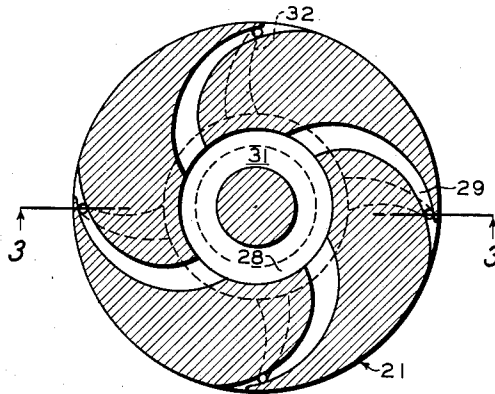


FIG. 2

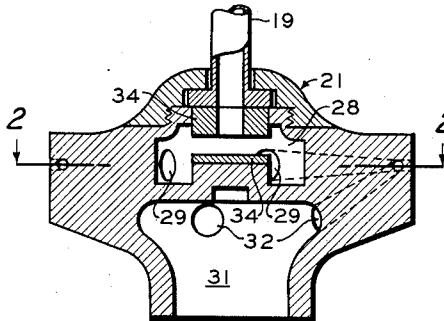


FIG. 3

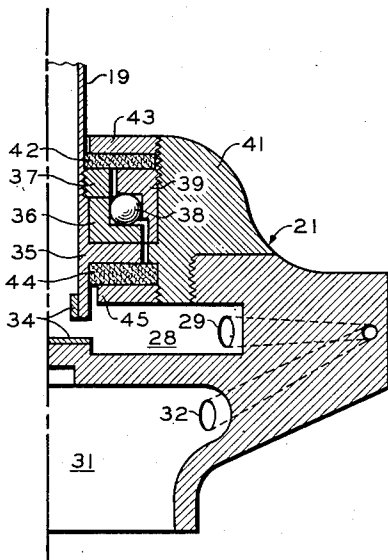


FIG. 4

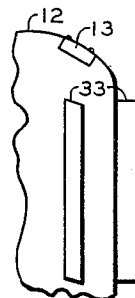


FIG. 5

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TOOL FOR IMPINGING LIQUID AGAINST
INNER WALLS OF CHAMBERSPaul G. Carpenter, Bartlesville, Okla., assignor
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9 Claims. (Cl. 166—20)

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This invention relates to the impingement of liquid against inner walls of a chamber. In one of its more specific aspects it relates to the treatment of well bores. In another of its more specific aspects it relates to an apparatus for treating well bores. In another of its more specific aspects it relates to a method for cleaning or acidizing oil wells.

In order to facilitate recovery of hydrocarbon fluids from oil and gas wells, formations containing such hydrocarbon fluids are often treated with acids or other chemicals. It is common practice in acidizing oil and gas wells to inject a quantity of acid solution into the formation surrounding the well bore where the acid solution reacts with the formation, increasing the size of the pores of the formation and after the acid has reacted to retrieve the solution of "spent" acid and dissolved chemicals from the formation. Under certain operating conditions it is expedient to impinge the acid solution against the wall of the well bore with great force in order to thoroughly cleanse or break down the formation adjacent to the well bore.

It is a disadvantage of the conventional methods and conventional apparatus used for the purpose of cleaning and acidizing well bores that the activity of the acids or chemicals is not completely utilized. Considerable waste of materials is encountered during such a cleaning or acidization operation. Broadly speaking, this invention comprises supplying acids or chemicals to a chamber, drawing those acids or chemicals through a jetting tool and jetting those materials against the inner walls of such a chamber and recirculating the materials through the jetting tool. By means of such a process and apparatus it is possible to utilize the activity of the acids and chemicals to the greatest possible extent.

An object of this invention is to provide improved means for jetting a liquid against the inner walls of a chamber. Another object of the invention is to provide improved means for acidizing well bores. Another object of the invention is to provide improved means for cleaning well bores. Another object of the invention is to provide means for circulating liquid in a chamber. Another object of the invention is to provide an improved method for impinging liquid against the inner walls of a chamber. Other and further objects and advantages will be apparent to those skilled in the art upon study of the accompanying disclosure and the drawings.

Figure 1 of the drawings is an elevation, partly

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in section, of the jetting tool of this invention. Figure 2 is a horizontal cross-section of a motor head, taken along line 2—2 of Figure 3. Figure 3 is a schematic view of a vertical section of a modification of the motor head, taken along line 3—3 of Figure 2. Figure 4 is a partial vertical section of a modified motor head similar to that of Figure 3 but shown in more complete detail. Figure 5 is a partial section of the device shown in Figure 1 showing a modification of the invention.

Referring particularly to Figure 1 of the drawings, jetting tool 11 comprises a pressurizing chamber 12 which is provided in its upper portion with closure member 13 which is capable of closing the upper portion of chamber 12 to prevent the escape of gaseous materials there-through. Suspension means 14 comprises a fastener member 15 which may, as is shown in the drawings, be a U-fastener which retains a ball and socket joint 16. The ball and socket joint 16 is suspended on a line 17 which maintains jetting tool 11 in position within a given chamber. The lower portion of jetting tool 11 is preferably provided with a weighted portion 18 which causes the jetting tool to maintain a tension upon line 17 and causes the lower end of the jetting tool 11 to be submerged in a liquid within a given chamber. Conduit 19 extends downwardly from pressurizing chamber 12 and extends downwardly through the weighted portion of jetting tool 11. Motor head 21 is rigidly affixed to the lower end of conduit 19. A flow control valve 22 is provided in conduit 19 at a point near the upper end of that conduit. A back-flow check valve 23 is provided in conduit 19 downstream of control valve 22. The flow control valve 22 opens and closes the fluid passage in conduit 19 and back-flow check valve 23 permits flow downwardly and closes to prevent upward flow in conduit 19. Actuator member 30 may be a solenoid or a clock which is provided with operative communication with control valve 22. Any number of means may be utilized to actuate the solenoid. Electrical means may be provided from the top of the chamber or a photoelectric cell may be placed in the lower portion of the motor head 21 and a light source also provided in the lower portion of that member so that as the motor head is submerged in a liquid the intensity of the light beam from the light source which is directed upon the photoelectric cell is diminished. Upon the decrease in the intensity of the light source upon the photoelectric cell the photoelectric cell provides an impulse to solenoid 30 which actu-

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ates control valve 22. The position of the light source and photoelectric cell will be better understood upon reference to the cutaway portion in the lower section of Figure 1 of the drawings in which light source 24 is connected to an electrical source 25, such as a battery. Photoelectric cell 26 is disposed at a point opposite the light source and within the beam of that light source in the lower portion of the motor head. Cell 26 is operatively connected to the actuator member 30 by means of line 27. Conduit 19 opens into conduit 28 which is shown in the horizontal cross-section of Figure 2 of the drawings. A plurality of conduits 29 extend outwardly as arcs from conduit 28 to the periphery of motor head member 21 in common lateral directions. Conduit 31 provides liquid communication from a point outside and below the motor head to a point within the motor head. Conduit 31 is shown in Figure 2 of the drawings by dotted lines therein. A plurality of conduits 32 extend upwardly and outwardly from conduit 31 to points within a restricted portion of each conduit 29. Conduits 32 preferably extend upwardly and outwardly as arcs in substantially the same direction taken by conduits 29.

In the operation of the jetting tool 11 a pressurizing material, such as carbon dioxide in a non-gaseous form, i. e., liquid or solid, or hydrogen peroxide is supplied to pressurizing chamber 12 through an opening in the upper portion of that chamber. Closure member 13 is then fastened so as to maintain the upper portion of pressurizing chamber 12 in a gas-tight condition. Control valve 22 is also closed so as to maintain the pressurizing material within a sealed chamber. A liquid material, such as acids or other chemicals, is supplied to a chamber, such as a well bore. Jetting tool 11 is lowered into the chamber until motor head 21 is submerged within a body of the liquid previously supplied to the chamber. Control valve 22 is then actuated by actuator member 30 which may be a clock member adapted to actuate control valve 22 at a specified time or a solenoid valve adapted to actuate valve 22 in response to an electrical impulse from the top of the chamber or from photoelectric cell 26. When control valve 22 is open it allows the pressurizing material from chamber 12 to pass downwardly through conduit 19. The non-gaseous carbon dioxide vaporizes and passes downwardly through conduit 19 and outwardly through conduits 29 which form aspirating zones within motor head 21. The flow of gas through conduits 29 pass with sufficient force therefrom to rotate motor head 21 by the jet action of the gases. The flow of gas through conduits 29 also acts with an aspirating effect to draw liquid through conduit 31 and through conduits 32 into the restricted portion of conduits 29. The liquid is jetted from conduits 29 against the walls of the chamber surrounding jetting tool 11 and impinges the liquid against those walls with sufficient force to materially increase the effect of the liquid upon the chamber walls. The liquid collects in the body of liquid in which motor head 21 is immersed and is recirculated through motor head 21 against the walls of the chamber.

In the device shown as Figure 1 of the drawings, motor head 21 is rigidly affixed to conduit 19 and thus to pressurizing chamber 12. The jet action of the gas and liquid from conduits 29 therefore, rotates jetting tool 11 on the ball and socket joint 16. At times the effect of the liquid upon the walls of the chamber is better when the

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speed of rotation of jetting tool 11 is maintained at a relatively low rate. The rate of rotation of jetting tool 11 is materially reduced by providing fins 33 to the outer surface of pressurizing chamber 12 as shown in Figure 5 of the drawings.

In a preferred modification of the drawings, motor head 21 is rotatably mounted upon the lower end of conduit 19 as shown in Figure 3 of the drawings. Conduit 19 opens into conduit 28 which in turn opens into conduits 29. A layer of catalyst material 34 is provided in conduit 28 in such a manner as to provide a catalyst chamber at the outlet of conduit 19. The catalyst material is a decomposition catalyst utilized for the decomposition of hydrogen peroxide when hydrogen peroxide is provided as the pressurizing material within pressurizing chamber 12. Conduit 31 provides an opening through the bottom of motor head 21 upwardly thereto and communicates by means of conduits 32 with a constricted portion of conduits 29. More complete structure of motor head 21 showing the motor head as being adapted for rotation on conduit 19 is found in Figure 4 of the drawings. Conduit 19 is provided with a protruding collar 35 upon which sleeve member 36 is allowed to rest. Sleeve member 36 is replaceably retained in place by a nut 37 which is affixed by threads to conduit 19. Ball bearings 38 are maintained in a race provided between the lips of sleeve member 36 and support sleeve member 39. Sleeve member 39 depends downwardly over sleeve member 36 and an inwardly extending lip provides the upper surface of the race, which bears upon bearings 38. Sleeve member 39 is replaceably affixed to collar member 41 by means of threads. Packing material 42 closes the upper end of the space formed between sleeve members 36 and 39. Packing material 42 is maintained in place by follower member 43 which is also maintained in place by means of threads communicating with collar member 41. Packing material 44 closes the lower end of the space formed between sleeve members 36 and 39 and between shoulder member 35 and collar 41. Packing material 44 is maintained in place by means of follower member 45 which is replaceably affixed by means of threads to collar member 41. The body portion of motor head 21 is replaceably affixed by means of threads to the lower portion of collar member 41 and is thus provided with an efficient bearing means for rotating upon conduit 19. The pressure of the pressurizing material is such that a slow seepage of that material is encountered through packing material 44 and 42 and the problem of corrosion of sleeves 36 and 39 and bearings 38 from contact with acid or other chemicals is substantially eliminated.

The operation of jetting tool 11 as modified in Figures 3 and 4 of the drawings is substantially the same as that described in connection with Figures 1 and 2 of the drawings. The main difference in operation between the device as first described and the modification of Figures 3 and 4 is that motor head 21 is allowed to rotate without rotating the entire device which includes the pressurizing chamber 12 and the weighted portion 18. This modification is particularly advantageous when it is desirable to rotate motor head 21 at relatively high rates. Considerable quantities of energy are consumed by overcoming friction in the ball and socket joint 16 of Figure 1 of the drawings, the friction being due in part to the considerable weight of the pressurizing

chamber 12 and the weighted portion 18. Much of that friction is removed with the device shown in Figures 3 and 4 of the drawings.

When hydrogen peroxide is utilized as the pressurizing material it is quite advantageous to utilize a decomposition catalyst in connection therewith which facilitates the decomposition of the hydrogen peroxide. Such decomposition of the hydrogen peroxide is exothermic in nature and the heat which is released by the reaction is used to increase the activity of the acid which is impinged upon the walls of the enclosing chamber. Catalysts which are suitable for such a decomposition of hydrogen peroxide include finely divided silver, finely divided platinum, alkali metal permanganates, alkaline earth permanganates, and manganese dioxide. The decomposition of the hydrogen peroxide provides a considerable volume of gas which is utilized for the purpose of aspirating the liquid through the jetting tool. Although the catalyst chamber has been specifically shown only in Figures 3 and 4, the same type of catalyst chamber is also utilized in the device shown as Figure 1 of the drawings.

The length of the pressurizing chamber which is utilized is generally dependent upon the length of time over which the jetting of the liquid against the walls of the chamber is desired. The length of the reservoir generally varies between 2 and 20 feet and preferably between 4 and 10 feet. Although this invention has been primarily described in connection with the use of non-gaseous carbon dioxide or hydrogen peroxide as the pressurizing materials, it is within the scope of this invention to utilize any gaseous or liquid materials which may be compressed and which, upon release, will expand to provide the gaseous volume desired for aspirating the liquid through the motor head where all or any one of a mixture of the normally gaseous hydrocarbons may be utilized as the pressurizing materials.

When non-gaseous carbon dioxide is utilized as the pressurizing medium a considerable amount of cooling is encountered during the vaporization of the material. A great deal of heat is supplied to the jetting tool by the circulating liquid. In situations in which additional amounts of heat are required, heat is supplied by providing electrical communication with the top of the chamber and passing an electrical current through a resistance coil, not shown, in the jetting tool. The speed of rotation of the tool is controlled by varying the electrical input to the resistance coil.

Other and further modifications of the invention will be apparent to those skilled in the art upon study of the accompanying discussion and the drawings. It is believed that such modifications are within the spirit and the scope of the discussion and the drawings.

I claim:

1. A tool for jetting liquid against inner walls of chambers, which comprises in combination a pressurizing chamber; a first conduit communicating with and extending longitudinally from said pressurizing chamber; a flow control valve in said first conduit; a motor head attached to said first conduit; second conduits in said motor head extending outwardly as arcs in common lateral directions from said first conduit to the periphery of said motor head and communicating therebetween; and a third conduit extending upwardly and outwardly from and communicating between the bottom exterior of the motor head

and each second conduit at a point in each second conduit near the outer terminus thereof.

2. A tool for jetting liquid against the walls of well bores, which comprises in combination a pressurizing chamber; a suspension swivel attached to the upper end of said pressurizing chamber; a first conduit communicating with and extending downwardly from said pressurizing chamber; a flow control valve in said first conduit; a motor head axially attached to and communicating with said first conduit; second conduits of a Venturi type extending outwardly as arcs in common lateral directions from said first conduit through said motor head to the periphery thereof and communicating therebetween; a liquid inlet in the bottom of said motor head; and a third conduit extending upwardly and outwardly from said liquid inlet to a constricted point in each said second conduit and communicating therebetween.

3. The tool of claim 2, wherein said motor head is rigidly attached to said first conduit.

4. The tool of claim 2, wherein said motor head is rotatably attached to said first conduit.

5. The tool of claim 4, wherein fins are affixed to the outer surface of said pressurizing chamber.

6. The tool of claim 2, wherein a catalyst chamber is provided at the outlet end of said first conduit; and a hydrogen peroxide decomposition catalyst is provided in said catalyst chamber.

7. A tool for jetting liquid against the walls of well bores, which comprises in combination a pressurizing chamber; a suspension swivel attached to the upper end of said pressurizing chamber; a first conduit extending downwardly from said pressurizing chamber and communicating therewith; a flow control valve in said first conduit; a back-flow check valve in said first conduit downstream of said control valve; a motor head axially attached to said first conduit; second conduits of a Venturi type extending outwardly as arcs in common lateral directions from said first conduit through said motor head to the periphery thereof and communicating therebetween; a liquid inlet in the bottom of said motor head; and a third conduit extending upwardly and outwardly from said liquid inlet to a constricted point in each said second conduit and communicating therebetween.

8. A tool for jetting liquid against the walls of well bores, which comprises in combination a pressurizing chamber; a suspension swivel attached to the upper end of said pressurizing chamber; a first conduit extending downwardly from said pressurizing chamber and communicating therewith; a flow control valve in said first conduit; a back-flow check valve in said first conduit downstream of said control valve; a first sleeve, having an outwardly protruding flange, rigidly and replaceably affixed to the lower portion of said first conduit; a second sleeve, having an inwardly protruding flange, closely encircling said first sleeve, said inwardly protruding flange disposed above said outwardly protruding flange; ball bearings resting upon said outwardly protruding flange and supporting said inwardly protruding flange; a collar member encircling and rigidly and removably affixed to said second sleeve; first packing material closing the upper end of the space between said first and second sleeve members; a first follower rigidly and replaceably affixed within the upper portion of said collar member above said first packing, whereby

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said first packing is maintained in place; second packing closing the lower end of the space between said first and second sleeve members; a second follower rigidly and replaceably affixed within the lower portion of said collar member below said second packing, whereby said second packing is maintained in place; and a motor head body rigidly and replaceably affixed to the lower portion of said collar member, said motor head body having second conduits of a Venturi type extending outwardly as arcs in common lateral directions and communicating between said first conduit and the periphery of said motor head, a liquid inlet in the bottom of said motor head, and a third conduit extending upwardly and outwardly from said liquid inlet in the motor head to a constricted point in each said second conduit.

9. A process for jetting a liquid against the inner walls of a chamber, which comprises charging carbon dioxide in a non-gaseous state to a pressure-supply zone of a jetting tool; positioning said jetting tool within a body of liquid within the walls of said chamber; vaporizing said carbon

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dioxide within said pressure zone, whereby said carbon dioxide vapors are placed under pressure; passing said pressurized carbon dioxide through an aspiration zone in said jetting tool; controlling addition of heat to maintain vaporization of said carbon dioxide; drawing a liquid from within said chamber into said aspiration zone by action of said carbon dioxide therein; and jetting said liquid and carbon dioxide from said aspiration zone in a common direction tangential to said jetting tool and against said chamber walls, whereby at least said aspiration zone of said jetting tool is caused to rotate.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,658,697	Weisman	Feb. 7, 1923
1,695,749	Watson	Dec. 18, 1923
2,203,029	Partridge	June 4, 1940
2,382,685	Washburn	Aug. 14, 1945