

Nov. 19, 1946.

G. W. HALL ET AL

2,411,209

BIT

Filed July 26, 1944

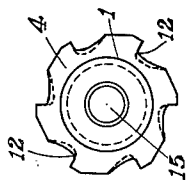


Fig. 3

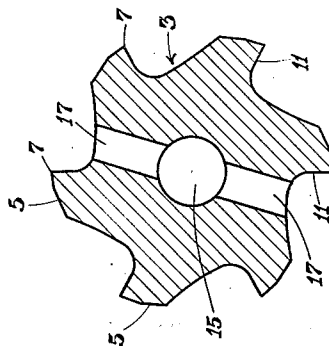


Fig. 6

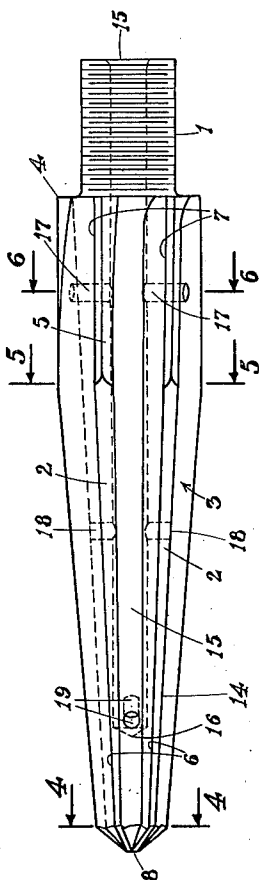


Fig. 1

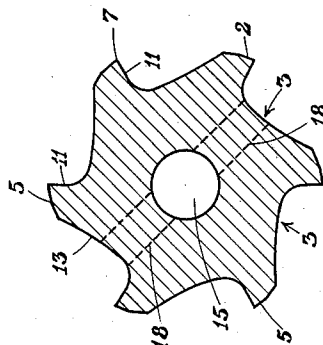


Fig. 5

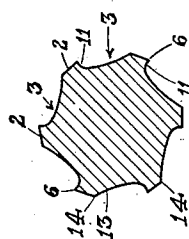


Fig. 4

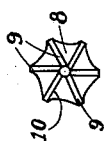


Fig. 2

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2,411,209

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Application July 26, 1944, Serial No. 546,696

3 Claims. (Cl. 15—104.09)

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This invention relates to a drilling bit particularly useful for removing scale from heat exchanger tubes.

It is common practice in the petroleum and other industries to utilize tubular type heat exchangers for cooling, condensing and heating purposes in which water or other liquid is used as a cooling or heating medium. Water deposits scale in the tube, which must be periodically removed in order to maintain the efficiency of the exchanger and to prevent the exchanger from becoming completely clogged. If a liquid such as mineral is used as heating or cooling medium, carbonaceous material may be deposited in the tubes and must be removed.

It is common practice to remove scale from heat exchanger tubes by reaming and/or drilling the tubes with rotary metal bits operated from a power source. Frequent breakage occurs in the use of commercial types of bits and the bits wear out rapidly, necessitating the use of a large number of bits for each cleaning job.

An object of the invention is to provide a drilling bit for cleaning heat exchanger tubes.

An object of the invention is to provide a bit capable of expediting the cleaning of heat exchanger tubes.

A further object of the invention is to provide a drilling and reaming bit capable of longer life than bits heretofore used in drilling and reaming of heat exchanger tubes.

Still another object of the invention is to provide a bit capable of removing scale, carbonaceous or other solid deposits from heat exchanger tubes without injury to the tubes.

A still further object of the invention is to provide a bit for cleaning heat exchanger tubes which requires less manual effort during the drilling operation than is required in connection with the use of known types of bits.

Other objects of the invention will become apparent from the following description and the accompanying drawing of which Figure 1 is a diagrammatic, side-elevational view of the bit; Figure 2 is a front end diagrammatic, front elevational view of the bit; Figure 3 is a diagrammatic, rear elevational view of the bit; Figure 4 is a vertical cross-section of the bit taken along line 4—4 of Figure 1; Figure 5 is a vertical cross-section of the bit taken along the line 5—5 of Figure 1; and Figure 6 is a vertical cross-section of the bit taken along the line 6—6 of Figure 1.

Referring to the drawing, the numeral 1 represents the threaded shank end of the bit, adapted to be screwed into a threaded pipe (not shown)

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which in turn is adapted to be rotated by power means. The length and diameter of the shank end will depend on the size of the bit. In a bit, the overall length of which is approximately $4\frac{1}{8}$ " and the greatest diameter of which is approximately $\frac{3}{4}$ ", the shank end may be approximately $\frac{3}{4}$ " in length and approximately $\frac{1}{2}$ " outside diameter. The shank end is preferably protected by an insulating coating so that during the heat treatment of the bit, maximum hardness is not obtained at or near the point where the shank is joined to the main body of the bit. It is important to reduce the hardness of the shank end below the hardness of the cutting surface and to increase the toughness of the shank end at the point of juncture of the shank with the main body of the bit, because breakage most commonly occurs at the point where the shank is joined to the main body of the bit during drilling and/or reaming operations.

The main body of the bit has an outer surface composed of a series of spaced cutting surfaces 2 with intervening flutes 3 located between the cutting surfaces. As is apparent from the drawing, the diameter of the bit gradually increases from a minimum along the line 4—4 of Figure 1 to a maximum along the line 5—5 of Figure 1 and the bit is of uniform diameter from the line 5—5 to the rear end 4 of the body. In a bit having an overall length of approximately $4\frac{1}{8}$ ", the diameter along the line 4—4 of the bit will be approximately $\frac{25}{64}$ of an inch and the diameter along the line 5—5 would be approximately $\frac{3}{4}$ of an inch. The width of the cutting surfaces 2 on a bit of this size will gradually increase from $\frac{3}{64}$ of an inch along the line 4—4 to $\frac{3}{32}$ of an inch along the line 5—5. From the point extending from the line 5—5 to the rear end 4, the surfaces 5, instead of being flat with a sharp cutting edge 6, as they are between the lines 4—4 and 5—5, are bevelled as shown in Figures 5 and 6, so that the edges 7 are not as sharp as the edges 6 between the line 4—4 and the line 5—5. The bevelled surfaces 5 are wider than the cutting surfaces 2, increasing in width from the line 5—5 to the end 4, and are designed to act as a guide to keep the bit properly centered in the tube. The edges 6 of the cutting surfaces between the lines 4—4 and 5—5 are sharp and are designed to cut scale from the inner wall of the tube.

As will be seen from Figures 1 and 2, the front end 8 of the bit is conical in shape and is provided with radial cutting surfaces 9 joining cutting surfaces 2 along the line 4—4. The edges 10 of the cutting surfaces 9 are sharp and are designed to

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drill scale from tubing which is completely or substantially completely clogged. The bit is preferably provided with six cutting surfaces around its perimeter, the cutting surfaces being equally spaced 60° apart.

The flutes or depressions 3 between the cutting surfaces must be of sufficient width and depth to permit sufficient flow of water or other liquid through the bit and to provide adequate space to allow sufficient liquid to flow through and around the bit to cool it and to remove and wash away the scale which is cut from the inside of a tube. As is apparent from Figures 4 to 6, the flutes 3 have a comparatively steep side 11 adjacent the cutting edges 7 so that the side 11 of the flute makes an angle of slightly less than 90° with the cutting surfaces 2, and the flutes extend to a depth such that the distance from the innermost point 12 of one flute to the innermost point 12 of the opposite flute is somewhat greater than the diameter of the threaded shank. For example, where the outside diameter of the shank is approximately $\frac{1}{2}$ ", the distance between the innermost point of one flute and the innermost point of the opposite flute will be approximately $\frac{5}{8}$ of an inch at the point where the body portion of the bit joins the shank and about $\frac{1}{8}$ of an inch at the line 4-4.

As is apparent from the drawing, the surface 13 of the flute extending from the lowest point 12 thereof to the back edge 14 of the cutting surface is relatively long as compared to the portion 11, and makes an oblique angle with the cutting surface 2. Because of the gradually increasing diameter of the bit from the line 4-4 to the line 5-5, the flutes increase in both depth and width from the line 4-4 to the line 5-5.

By constructing the bit in the manner described, the thickness of the cutting blades at the bottom of the flutes is considerably greater than the thickness of the blades at the cutting surfaces, thereby giving the blades greater strength at the bottom and preventing the blades from being broken when running in hard scale. Moreover, bits constructed in accordance with our invention have a greater amount of cutting surface than conventional type bits, thereby increasing the cutting life of the bit.

The bits should be made from high-speed tool steel, such as Rex AA high-speed tool steel, and heat treated to harden the cutting surfaces. Bits can be satisfactorily treated by heating to 1500° F. slowly, then raising the temperature quickly to 2300° F., quenching in oil at about 600° F., and then drawing at 600° F.

The bit is provided with an axial passageway 15 running through the bit from the shank end to a point 16 adjacent the front end of the bit. In a bit of the size hereinabove described, the point 16 may be approximately $\frac{3}{8}$ of an inch from the line 4-4 and the diameter of the passageway may be approximately $\frac{3}{8}$ of an inch. A hole 17 is drilled from the bottom of one flute to the bottom of the opposite flute at a point approximately half way between the line 5-5 and the rear end 4 of the bit body. The hole 17 connects with passageway 15. The hole 17 in a bit of the size hereinabove described may be approximately $\frac{3}{8}$ of an inch in diameter. Although in the bit shown in the drawing, one hole 17 is drilled through two opposite flutes, additional holes may be made if desired. Another hole 18 is drilled from the bottom of a different flute to the bottom of the opposite flute at a point approximately half way between the point

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8 and the rear-end 4 of the body of the bit. These holes may be approximately $\frac{3}{8}$ of an inch in diameter. Two additional holes 19 are drilled from the bottoms of the remaining two opposite flutes diagonally into the front end of the passage-way 15. These holes, likewise, may be approximately $\frac{3}{8}$ of an inch in diameter.

The bit as described contains six holes each connecting the bottom of a flute to the passageway 15. Additional holes may be drilled in order to increase the flow of cooling liquid through the bit.

In order to set forth the size relationships between the various parts of the bit, a bit of particular size has been described. The bit hereinabove described is adapted for cleaning tubes of 1 inch O. D. No. 12, P. W. G. It should be understood, however, that the bit will vary in size in accordance with the size of the tube which it is desired to clean, but we have found that the proportions herein above set forth are the optimum conditions to be maintained in a bit of any size in order to obtain the best results.

During a drilling operation the bit is screwed into a hollow pipe threaded to receive the shank end of the bit, which pipe is provided with means to circulate water or other liquid into the passageway 15 from which it escapes through the holes 17, 18, and 19 to maintain the bit sufficiently cool and to wash away through the flutes the scale or other solid cuttings removed from the tube. The bit will be rotated in clockwise direction.

In actual operation we have been able to drill in excess of 1500 tubes with one bit without interruption or breakage; whereas, with the bits formerly used in this service, it was common to wear out or break a bit in drilling anywhere from 1 to 20 tubes. The saving in time effected by the use of our novel bit in cleaning scale, carbon or other solid deposits from heat exchanger tubes has materially shortened the down time of petroleum cracking and distillation units, thereby increasing the yearly through-put of petroleum through these units.

We claim:

1. An elongated bit comprising a main body portion, a shank and a front end, said body portion gradually increasing in diameter from the front end to a point adjacent the rear end thereof and having a plurality of substantially straight longitudinal spaced cutting surfaces around the periphery thereof running along the length of the body to said point adjacent the rear end of said body portion, said cutting surfaces having intervening flutes, the rear end of said body portion having a plurality of spaced guiding surfaces with intervening flutes, said rear end being of uniform diameter throughout, said front end having a plurality of spaced cutting surfaces terminating at a point in line with the midline of said bit.

2. An elongated bit comprising a main body portion and a shank, a plurality of equally spaced straight ribs running longitudinally of said body portion with elongated recesses therebetween, the outer edges of said ribs lying in the circumference of circles gradually increasing in circumference from front to a point adjacent the rear end of said body portion, said ribs having cutting edges extending from the front end of the body portion to said point adjacent the rear end thereof, the rear end portion of said ribs being parallel to each other and devoid of sharp cutting edges and the outer edges of the ribs in said rear end portion having a surface substantially wider than that of the remaining portion of said ribs.

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3. An elongated bit comprising a main body portion, a front end and a threaded shank, a plurality of equally spaced straight ribs running longitudinally of said body portion with elongated recesses therebetween said ribs sloping from the front end of said body portion to a point adjacent the rear end of said body portion so that the main body portion of said bit gradually increases in circumference from front end to said point, said ribs having cutting edges extending from the front end of the body portion to said point, the rear end

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portion of said ribs being parallel to each other and devoid of sharp cutting edges and the outer edges of said ribs in said rear portion having a surface substantially wider than that of the remaining portion of said ribs; the front end of said bit being conical with a plurality of radially disposed cutting ribs terminating in a point along the midline of said bit.

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