Feb. 28, 1967 J. A. KLOESEL, JR., ETAL 3,306,379

ROLLER REAMER

Filed March 25, 1965

Fig. 1

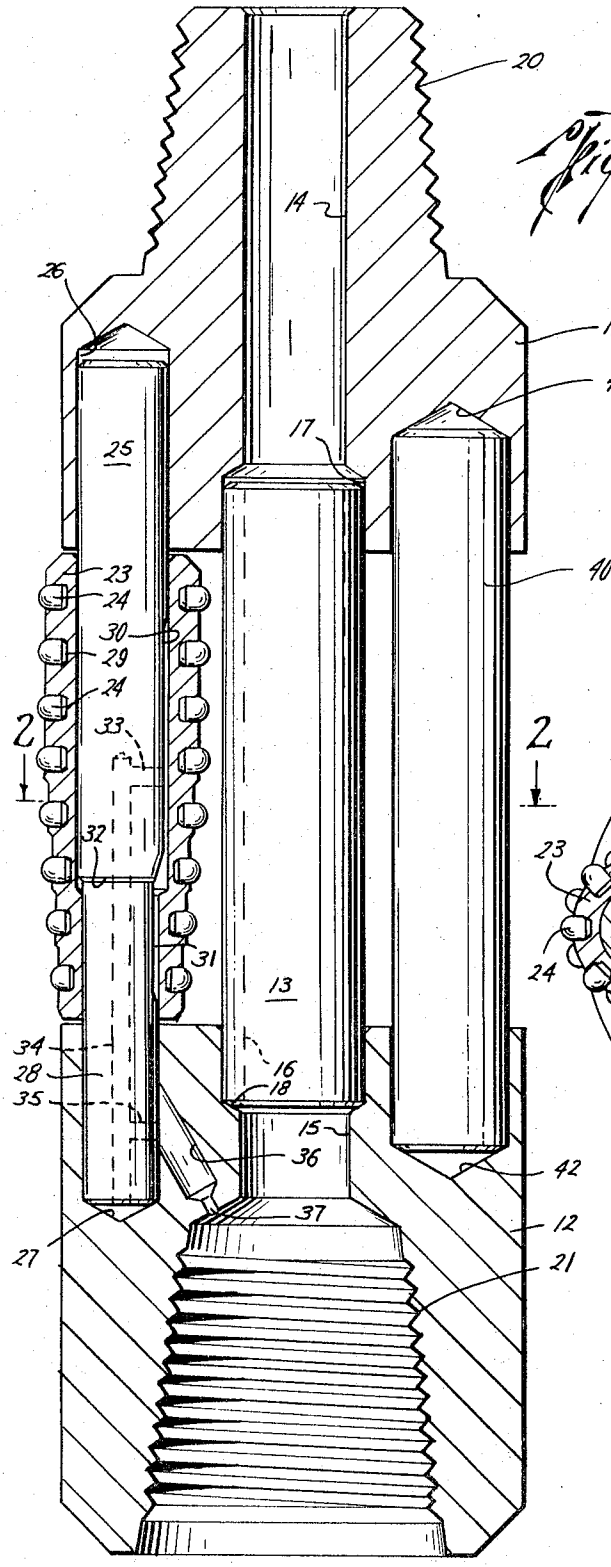
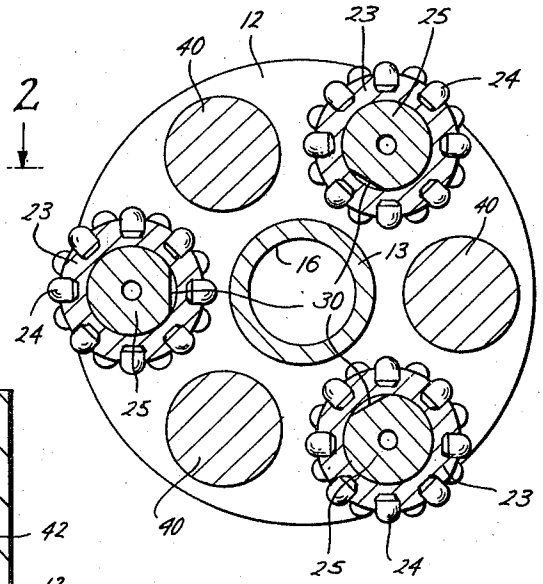


Fig. 2



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ROLLER REAMER

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This invention pertains to earth boring tools and more particularly to a roller type reamer-stabilizer tool especially adapted for air drilling in connection with mining operations although it is also useful in other environments and contains features of general utility.

In the air drilling of earth formations, especially formations that are not completely consolidated such as iron ore and copper ore, it has been found that the bodies of replaceable roller type reamer-stabilizer tools are subject to excessive wear. It is a principal object of the invention to overcome this problem.

Was the wear due to erosion by large cuttings carried over the surface of the tool body by the air flow? Although some wear occurs at circumferential bevels adjacent the box at the bottom of the tool, it was found that the wear occurs primarily around longitudinally extending pockets or irregularities in the circumference of the tool body, above and below the level of the rollers, such as extensions of the recesses in which mounting blocks for the roller axles are received, and the slot allowing positioning of a tool to drive the axle in and out of position.

Was the wear due to cuttings too large to be carried away by air flow and tumbling in the longitudinal pockets? It was discovered that the same wear occurred when the tool was used in upside down drilling, that is, in drilling from a lower horizontal mine shaft to an upper shaft wherein gravity insured complete removal of substantially all large cuttings.

It seems likely that the wear is due to large chunks broken loose from the side of the hole, too large to pass between the tool body and the side of the hole and moving radially in and out as the circumferential irregularities in the tool body rotate past. According to the invention there is provided a tool body that is circumferentially smooth thereby preventing the radial motion of the loose chunks and eliminating the wear.

Provisions of a circumferentially smooth body presents a problem of its own if the rollers are to be field replaceable. According to the invention this problem is overcome by providing a tool body that is so inexpensive to manufacture that it can be discarded when the rollers are worn out, thereby eliminating the need for field replacement. The resulting lessened requirement for long life of the tool body also reduces the problem of unduly rapid wear on the body when air drilling in poorly consolidated formations. The provision of an inexpensive tool body thus is a primary object of the invention.

A tool embodying the invention may be called a life balanced tool in that the body and rollers have more nearly equal life expectancies. Briefly described the tool body includes upper and lower large outer diameter cylindrical members, each having a fluid passage therethrough, spaced apart and connected by a small outer diameter cylindrical intermediate member having a fluid passage therethrough communicating at its ends with the fluid passages in the large members. The tool body is thus circumferentially smooth, that is, all sections perpendicular to its axis are circles. In the annular space around the small member and between the large members are mounted the rollers. The rollers are mounted on axle pins whose ends are fitted into sockets in the large members. The rollers are of the tungsten carbide insert type

providing maximum roller life to approach as near as may be the life of the discardable body.

Depending on various factors such as the size of tool sole reliance for transmission of mechanical forces between the large upper and lower body members may be placed on the small intermediate body member and the axles on which the rollers are mounted, or one or more bars may be provided connecting the upper and lower members, the bars being disposed in between the rollers. Although the bars depart from the concept of circumferential smoothness of the tool body, it will be recalled that the wear problem was concentrated at levels above and below the rollers. Apparently the rollers protect the body at the roller level. If bars are used, they may be heat treated for mechanical strength and the axle pins may be heat treated for hardness and the intermediate body member may be left soft and ground smooth.

Other objects and advantages of the invention will become apparent from the following more detailed description of a preferred embodiment of the invention wherein.

FIGURE 1 is an axial section through a tool embodying the invention, and

FIGURE 2 is a transverse section taken on the plane indicated at 2—2 in FIGURE 1.

The tool shown in FIGURES 1 and 2 includes upper and lower steel body members **11** and **12** and intermediate steel body member **13**. All three body members **11–13** have cylindrical outer peripheries. The three members **11–13** are each provided with an axial fluid passage therethrough as indicated at **14–16**. The outer diameters of upper and lower members **11** and **12** are equal and are larger than the outer diameter of intermediate body member **13**. The ends of intermediate body member **13** are received in sockets **17** and **18** in the upper and lower body members with an interference fit such as a press fit. A shrink fit or other mode of connection may be may be used, e.g. a threaded or welded connection. One end of intermediate member **13** may be made integral with either the upper or lower member **11** or **12**. The inner diameters of body members **11–13** are equal and their fluid passages **14–16** are coaxial with the outer peripheries of the members and coaxial with each other forming a continuous fluid passage means through the tool from the upper end of the upper member **11** to the lower end of the lower member **12**.

The upper end of upper body member **11** is provided with a threaded pin **20** and the lower end of lower body member **12** is provided with a threaded socket **21**, the threads of the pin **20** and socket **21** being coaxial with the fluid passages **14** and **15**.

In the annular space around intermediate body member **13** in between upper and lower body members **11** and **12** are disposed rotatably mounted rollers, preferably three in number. Each roller includes a steel sleeve **23** having tungsten carbide pellets **24** inserted in the outer periphery thereof and slightly protruding therefrom as shown, the drawing being to scale, the scale being full scale. The pellets are preferably disposed in annular rows or rings with the rings at the upper ends of the sleeves being of larger diameter than those below and the radius from the tool axis to the tip of the outermost pellets in the upper rings being nearly or substantially full gage of the hole being drilled, e.g. 1/16 inch under gage for an eight inch diameter hole.[1] Full gage reaming is not required since in mining operations it is usually unnecessary to change bits during the drilling of a hole. The reaming is desired to keep the hole wall smooth to facilitate removal

[1] For a fuller description of rollers with carbide inserts suitable for use herein see application S.N. 330,715 filed December 16, 1963, by William Robert Garrett entitled, Well Apparatus.

of the bit and in some cases to allow a tube of explosive to be lowered easily into the hole after the bit is withdrawn. The primary function of the rollers is to stabilize the bit so that a straight hole may be drilled, and the carbide pellets protect the rollers from too rapid wear. The tool is thus a combination stabilizer-reamer.

Each roller sleeve **23** is rotatably mounted on an axle pin **25**. The upper and lower ends of each axle pin **25** are received in sockets **26** in the upper body member **11** and in sockets **27** in the lower body member **12**. Pins **25** are preferably press fitted in sockets **26, 27**, although other interference fits such as a shrink fit may be used, or the ends of the pins may be in other manner connected to the upper and lower members **11, 12**.

The lower portion **28** of each pin **25** is of smaller diameter than the upper portion thereof. This provides adequate wall thickness at the bottom **29** of the sockets for the lowermost, smaller radius, rings of pellets **24**. The larger diameter upper portion of each pin **25** provides additional strength.

On the surface of the upper portion of pin **25** there is formed an air duct **30**. As best shown in FIGURE 2, each duct **30** is a flat extending longitudinally along one side of the axle pin **25**. A similar duct **31** is formed along the side of the lower portion **28** of each pin **25**, ducts **31** being aligned with ducts **30** and communicating therewith at their ends adjacent shoulder **32**. Additional ducts **33, 34, 35** formed in the axle pins place each duct **30** in communication with large duct **36** in lower body member **12** which in turn communicates through small duct **37** with the air flow passage **15** in the lower body member **12**. Small duct **37** serves as a choke to determine the quantity of air supplied through the ducts **33–36** to ducts **30, 32**. The air thus bled off the main air stream flowing down through the tool when in use provides means to blow out undesirable material from the space between each roller sleeve **23** and its axle pin **25**. This feature is more fully described and claimed in the copending joint application of Joseph A. Kloesel, Jr. and James W. Dixon, Serial No. 369,801, filed May 25, 1964, and entitled, Air Vented Reamer.

The axle pins **25** are preferably equally spaced apart azimuthally with respect to the tool axis, and in the spaces therebetween are disposed bars **40**, preferably equal in number to the number of axle pins. The bars are preferably cylindrical on their outer surfaces. The upper and lower ends of each bar are received in sockets **41, 42** in the upper body member **11** and lower body member **12**, respectively. Preferably bars **40** are press fitted in sockets **41, 42**, although other interference fits such as a shrink fit may be used, or any other suitable mode of connection may be employed, including for example brazing or welding or a threaded connection.

In use of the above described tool, it may be connected at its lower end to a drill bit and at its upper end to the lower end of a string of drill pipe. As the drill string is rotated with the drill bit against the bottom of the hole, air under pressure is admitted to the upper end of the string of drill pipe and flows down through the pipe to the stabilizer-reamer tool and the drill bit and thence out into the hole and back up the annulus between pipe and hole to the surface. The air flowing in the annulus carries the cuttings from the bit and the reamer-stabilizer tool out of the hole. The rollers on the reamer-stabilizer tool keep the bit centered in the hole so that it drills straight ahead. Also, the rollers keep the pipe immediately above the bit from bending and loading the bit nonuniformly which would tend to wear it out more quickly. The rollers also ream the hole smooth, the tungsten carbide pellets crushing any material protruding any great distance into the hole. There being no circumferential irregularities on the surface of the upper, lower and intermediate body members of the tool, they are protected against undue wear because there is no tendency for partly freed chunks in the side of the hole to be moved radially in and out against these body members of the tool. The bars **40**, being themselves round and set back from the outer periphery of the tool and being adjacent the rollers **23, 24** are also protected against rapid wear. When the rollers wear out, the whole tool may be thrown away because the cost of the body is relatively inexpensive compared to the bodies of tools whose rollers are intended to be replaced in the field, e.g. ⅓ the cost.

While a preferred embodiment of the invention has been shown and described, many modifications thereof can be made by one skilled in the art without departing from the spirit of the invention.

That being claimed is:

1. Well tool adapted for connection into a rotary drill string to form one element thereof, comprising,

an upper body member having an upper end and a lower end and a generally cylindrical outer periphery and having means at the upper end thereof for making connection to another drill string element,

a lower body member having an upper end and a lower end a generally cylindrical outer periphery and having means at the lower end thereof for making connection to another drill string element,

an intermediate body member disposed between said upper and lower body members, the intermediate body member having an upper end connected to the lower end of the upper body member, the intermediate member having a lower end connected to the upper end of the lower body member,

said upper and lower body members being coaxial and of larger maximum diameter than the maximum transverse extent of said intermediate body member leaving a space adjacent the intermediate body member between the upper and lower body members,

at least one axle pin in said space having an upper end supported by said upper member and a lower end supported by said lower member and a roller rotatably mounted on said pin within the axis of rotation of the roller eccentric to the axis of said upper and lower body members and the outer periphery of the roller extending in part beyond the outer peripheries of the upper and lower body members,

and fluid passage means extending through said tool from the upper end of the upper body member to the lower end of the lower body member.

2. Combination according to claim **1** wherein all sections through said upper and lower body members perpendicular to the axis of said upper and lower members, exclusive of sections taken through said connection means, are perfectly circular in outer periphery.

3. Combination according to claim **2** wherein said intermediate body member is of perfect cylindrical outer periphery and coaxial with the axis of the upper and lower members.

4. Combination according to claim **3** wherein said fluid passage means is coaxial with the axis of said body members.

5. Combination according to claim **4** including at least one bar in said space between said upper and lower members and having an upper end connected to said upper member and a lower end connected to said lower member.

6. Combination according to claim **5** in which at least one end of each of said intermediate body member and axle and bar is connected to the adjacent one of said upper and lower body members by said one end being telescopically received in a socket in said adjacent one of said upper and lower body members.

7. Combination according to claim **6** wherein each said one end makes an interference fit with its socket.

8. Combination according to claim **1** wherein at least one end of each of said intermediate body member and axle pin is connected to the adjacent one of said upper and lower body members by said one end being telescopically received in a socket in said adjacent one of said upper and lower members.

9. Combination according to claim 8 wherein said fluid passage means extends through said intermediate body member.

10. Combination according to claim 9 including at least one bar in said space between said upper and lower body members and having an upper end connected to said upper member and a lower end connected to said lower member, at least one end of said bar being connected to the adjacent one of said upper and lower body members by said one end of the bar being telescopically received in a socket in said adjacent one of said upper and lower members.

11. Combination according to claim 10 wherein said one end of each of said intermediate member and axle pin and bar makes an interference press fit with its socket.

12. Combination according to claim 11 wherein said at least one bar is steel heat treated for toughness and strength and said at least one axle pin is steel heat treated for hardness.

13. Combination according to claim 12 wherein said intermediate member is of cylindrical outer periphery and is steel ground smooth on its outer periphery.

14. Combination according to claim 13 wherein each said roller is made of steel and is provided with tungsten carbide means at its outer periphery and each said bar is set inwardly from the outer peripheries of said upper and lower members.

15. Combination according to claim 14 in which said intermediate body member is coaxial with said upper and lower body members, said axle pins are three in number equally azimuthally spaced around the axis of said intermediate body member, and said bars are three in

number equally azimuthally spaced around said intermediate body member disposed symmetrically in between said axle pins.

16. Combination according to claim 15 in which the bars are of cylindrical outer periphery and of larger diameter than the axle pins.

17. Combination according to claim 16 in which there is air duct means extending from said fluid passage means to the space between each roller and its axle pin, said air duct means including air ducts in one of said upper and lower body members connecting to sockets therein in which the axle pins are received and further ducts in said axle pins connecting from said first said ducts to the outer periphery of said axle pins adjacent the rollers thereon.

18. Combination according to claim 17 wherein all sections through said upper and lower body members perpendicular to the axis of said body member, exclusive of sections taken through said connection means, are perfectly circular in outer periphery.

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