

PATENT SPECIFICATION

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(54) IMPROVED PRESSURE RELIEF MEANS FOR EARTH PENETRATING TOOLS

(71) We, HUGHES TOOL COMPANY, a company organized and existing under the laws of the State of Texas, United States of America, having a place of business at 5425 Polk Avenue, Houston, Texas, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates in general to improvements in lubricant pressure relief valves for use in the lubrication systems of earth penetrating tools.

Earth penetrating tools, including the rotatable cutter type earth boring drill bit, commonly utilize bearing lubrication systems. The successful lubrication of drill bit bearings was made practicable with the development of a seal capable of operating in the detrimental environment and conditions associated with earth boring. One of the most commercially successful seals is described in the U.S. Patent Specification No. 3,075,781. Improvements to such seals are disclosed in the U.S. Patent Specification Nos. 3,137,508 and 3,313,552. The o-ring type seal has been successfully used in earth boring drill bits as described in U.S. Patent Specification No. 3,397,928.

A successful lubrication system for an earth boring drill bit generally includes in addition to a successful seal a compensator system that limits the pressure differential across the seal. One such compensator may be seen for example in the U.S. Patent Specification No. 3,007,751, and others in the U.S. Patent Specifications Nos. 3,007,750 and 3,137,508.

In addition to a successful compensator system, it is advantageous to include a pressure relief valve to relieve the lubrication system from excessive pressure relief valve to relieve the lubrication system from excessive pressures caused by thermally induced expansion, or by the creation

of gaseous hydrocarbons or other phenomenon. A successful pressure relief valve is disclosed in British Patent Specification No. 1,238,666.

While the pressure relief valve in the latter specification operates successfully in most instances, it has the disadvantage that foreign matter sometimes enters the valve region and by jamming its components prevents successful operation.

According to the invention there is provided a lubricant pressure relief valve comprising: a housing having an opening formed in one end thereof, for communication with a lubricant-containing passage, and at least one outlet port; a tube secured within the housing and having one end in communication with said opening and the other end in communication with said outlet port; a coil spring located within the tube; a valve stem passing through the tube and biased by the coil spring towards said opening in the housing; a resilient member fixedly connected to the valve stem beyond said other end of the tube so as to be biased by the coil spring against said other end of the tube; and elastic means carried by the housing and normally covering said outlet port and being yieldable to release lubricant through the outlet port from within the housing while preventing the entrance of exterior matter into the housing through said outlet port; said elastic means being yieldable to release lubricant at a pressure lower than the pressure required to overcome said coil spring and move said resilient member away from said other end of the tube.

The following is a more detailed description of various embodiments of the invention, reference being made to the accompanying drawings in which:

Fig. 1 is a perspective view, partially in section, of an earth boring drill bit having a lubrication system of the prior art, but which includes the improved pressure relief valve of the present invention.

Fig. 2 is a side elevation view, partially in longitudinal section, of a housing which in this case forms a secondary relief valve or protective means that protects a prior art, primary pressure relief valve.

Fig. 3 is an end view of an unsectioned secondary relief valve of Fig. 2.

Fig. 4 is a side elevation view, partially in longitudinal section, of an alternative form of the invention.

Fig. 5 is a perspective view of the apparatus shown in Fig. 2.

Fig. 6 is a perspective view of the apparatus shown in Fig. 4.

The numeral 11 in Fig. 1 of the drawing designates a lubricated, rotatable cutter type earth boring drill bit having a body 13 formed in three sections that each support a rotatable cutter 15 having earth disintegrating teeth 17. A prior art compensator system 19 in each section is adapted to help provide lubricant through passage 18 to the bearing means 21 between the cutter and supporting shaft, and to limit (preferably eliminate) the pressure differential across the seal 23. The bearing means 21, nozzles 22, lubrication system 19 and seal 23 may be of the previously cited prior art configurations and thus will not be described in further detail. A passage 25 communicates with the lubricant in the system and includes a recess 26 for the pressure relief means to be described hereinafter. As seen in Fig. 1, a pressure relief means is retained in position within each of the sections that supports a rotatable cutter by a threaded plug 27 having an aperture 29 to permit occasional egress of lubricant as will be apparent hereinafter.

Referring now to Fig. 2, the improved pressure relief valve includes a housing 31 having an axially extending opening 33. Further, the housing includes one or more radial ports 35 extending from opening 33 to an exterior annular groove 37 formed near the outer end region of the housing. A primary pressure relief valve 39 of the type described in British Patent Specification No. 1,238,666 is confined within the opening by a retainer 41, and adapted to release excessive fluid pressure from the lubricant system as described in said specification. In general a valve stem 40 in this valve moves against a spring 42 to separate a resilient member fixedly connected to the valve stem 40 by a rigid shoulder 44 from the end of a tube 46 when the pressure of the lubricant inside the lubrication system exceeds a selected value. This expels lubricant from the system, thereby lowering or relieving the fluid pressure of the lubricant in the system.

In the preferred embodiment of Fig. 2 another annular groove 43 receives an o-ring 45 and prevents the flow of fluid past the

exterior cylindrical surface of the housing. The outer end region 47 of the housing is cut away as indicated by the numeral 49 in Fig. 3 to expose the end surface of an elastomeric sleeve 51 inserted within and confined in the annular, circumferential groove 37. This sleeve covers the port or ports 35 to release lubricant when a selected lubricant pressure inside the housing is exceeded while simultaneously excluding the entrance of exterior matter such as drilling fluid and entrained sand particles.

An alternative embodiment is illustrated in Figs. 4 and 6 which show housing 31 having the same configuration as the embodiments of Figs. 2 and 3 except a circumferential groove 53 receives and confines a torus shaped elastic o-ring 55 that covers the port or ports 35 to release lubricant but exclude exterior matter.

In operation one of the embodiments described above is inserted within a relief valve recess in each passage 25 of the drill bit and retained in that position by the threaded retainer or plug 27 which has an aperture 29 to permit lubricant flow to the exterior of the bit. When the pressure inside the lubricant system exceeds a value sufficient to actuate the primary pressure relief valve 39, the valve stem 40 moves against the force of the spring 42 to separate the resilient member 44 from the end of tube 46. Lubricant is therefore released within the opening 33 of the housing 31 and ultimately through the radial ports 35. When the pressure of the lubricant in the port 35 reaches a selected level, it will deform the elastic sleeve 51 in the vicinity of the ports 35 and permit lubricant to leak past the sleeve and the housing. The selected pressure level is lower than the pressure required to open the primary relief valve 39. The cut away portion 49 as shown in Fig. 3 limits excessive outward deformation of the sleeve by providing an easier escape route for the lubricant. The embodiment illustrated in Fig. 4 operates in the same general manner as that described in connection with Fig. 2.

Thus, it may be seen that the invention has the advantage of excluding any foreign matter from the interior of the housing and from the primary pressure relief valve, which therefore can function without failure. The invention may be used as a complete replacement for the primary pressure relief valve, since it also may function alone as a pressure release means to prevent the excessive build-up of pressure in the lubrication system.

While the invention has been shown in only two of its forms, it should be apparent to those skilled in the art that it is not so limited but is susceptible to various changes and modifications.



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WHAT WE CLAIM IS:—

1. A lubricant pressure relief valve comprising: a housing having an opening formed in one end thereof, for communication with a lubricant-containing passage, and at least one outlet port; a tube secured within the housing and having one end in communication with said opening and the other end in communication with said outlet port; a coil spring located within the tube; a valve stem passing through the tube and biased by the coil spring towards said opening in the housing; a resilient member fixedly connected to the valve stem beyond said other end of the tube so as to be biased by the coil spring against said other end of the tube; and elastic means carried by the housing and normally covering said outlet port and being yieldable to release lubricant through the outlet port from within the housing while preventing the entrance of exterior matter into the housing through said outlet port; said elastic means being yieldable to release lubricant at a pressure lower than the pressure required to overcome said coil spring and move said resilient member away from said other end of the tube.
2. A lubricant pressure relief valve according to claim 1 wherein said housing is

cylindrical and said outlet port extends substantially radially from the interior of the housing and communicates with an external annular groove formed circumferentially around the housing, said elastic means comprising an elastic sleeve disposed in said groove and normally covering said outlet port.

3. A lubricant pressure relief valve according to claim 2 wherein a part of the housing adjacent said groove is cut away to expose part of one end surface of the sleeve.

4. A lubricant pressure relief valve according to claim 2 or claim 3 wherein the elastic sleeve is in the general shape of a torus.

5. A lubricant pressure relief valve substantially as hereinbefore described with reference to Figures 2, 3, and 5, or Figures 4 and 6 of the accompanying drawings.

6. A lubricated rotatable cutter earth-boring drill bit having a lubricant-containing passage in communication with a lubricant pressure relief valve according to any of claims 1 to 5.

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