

FLUID-POWERED SUBMERSIBLE SAMPLING PUMP

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to submersible, fluid-powered pumps, and more particularly to compact, small diameter pumps useful for obtaining liquid samples from deep subterranean locations via a borehole into which the pump is lowered.

2. Brief Description of the Prior Art

A number of fluid-powered pumps have been heretofore developed which utilize some type of small pilot valve of the spool type. In some of these, the pump is double-acting and includes pump pistons at opposite ends of the pump housing which alternately draw in and discharge a fluid to be pumped. Fluid-powered pumps of this general type include submersible pumps of a type adapted for use in oil wells. Examples of these types of pumps are those illustrated in Charles English U.S. Pat. Nos. 3,135,210; 3,336,941; 3,109,379; 3,024,733; 2,989,005 and 2,983,227.

Another design of pump which utilizes a spool type pilot valve to control the movements of a pair of pump pistons is that which is shown in Netherlands Pat. No. 41635. This patent depicts a fluid pump-motor arrangement in which a pair of main pistons are interconnected for mutual reciprocation, with control of their movement effected by a spool-type pilot valve which periodically shifts a spool-type distribution valve which directs power fluid to one of the cylinders in which the two main pistons are located, and concurrently exhausts spent power fluid from the other of the two main piston cylinders.

I have previously constructed a small diameter piston type pump containing an automatic cycle device and intended for expeditiously obtaining subterranean fluid samples. These pumps were utilized by the U.S. Geological Survey for this purpose. The pump was limited, however, in the operating pressure of the power fluid used to drive the pump, and was limited in the depth from which the fluid sample could be pumped.

These early pumps which I conceived and constructed had a pump housing diameter of 1.8 inches and an overall assembled length of 30 inches and weighed about 12 pounds. The prior pump, however, was difficult to start when it was installed at the end of 1600 feet of tubing bundle required to convey the power fluid to the pump. It contained an automatic cycling device which tended to stall or center when the pump was shut down. When the automatic cycling device was centered, a complicated procedure was then required to start the pump by relocation of the cycling device.

My prior pump was also less than optimum in that several small diameter external tubes or parts were required for construction of that pump, and it was therefore necessary to place a protective sleeve around the external tubes to shield the entire pump from damaging contact, and snagging in the borehole into which it was lowered. Moreover, the types of parts utilized in my earlier pump did not permit interchange of those parts from one pump to another, and therefore field replacement of some of the parts was impossible.

GENERAL DESCRIPTION OF THE PRESENT INVENTION

The present invention provides a compact, small diameter fluid-powered sampling pump useful for collecting a fluid sample from deep subterranean locations.

Broadly described, the sampling pump of the invention includes a cylindrical body assembly which comprises a hollow cylindrical upper motor piston chamber, a hollow cylindrical lower motor piston chamber and a cylinder connector which interconnects the upper and lower motor piston chambers and is positioned therebetween. The cylinder connector is of novel configuration and construction to accommodate, in a compact spatial arrangement, a pilot valve subassembly and a distribution valve subassembly. The pilot valve subassembly is interconnected with the distribution valve subassembly and with a source of pressurized power fluid so that shifting of the valve spool included in the pilot valve subassembly effects shifting of the distribution valve which in turn distributes the power fluid to the motor piston chambers. In a preferred embodiment of the invention, the pump is double acting by reason of the inclusion of two motor piston chambers and a pair of interconnected motor pistons which are slidably mounted therein.

Connected to each of the motor pistons located in the upper and lower motor piston chambers are a pair of pump pistons which move in pump piston chambers connected to the respective motor piston chambers. Each pump piston chamber is associated with a valve subassembly which includes an intake and a discharge valve for taking in the fluid to be sampled during one portion of the reciprocating stroke of one of the motor pistons and its associated pump piston, and discharging such sampled fluid during the reversed stroke of the respective motor piston and associated pump piston. Manifold tubing is laid into recesses provided along the cylindrical body assembly, including the respective pump piston chambers, so that the discharge valves of each of the pump valve subassemblies are manifolded to each other, and convey the sampled fluid to the upper end of the pump where it is passed into flexible tubing extending in a tube bundle to the surface. The recessing of the manifold tubing utilized in the pump into the peripheral external walls of the pump body assures the achievement of maximum reduction in overall diameter of the pump, permitting it to be lowered into small diameter bore holes for sampling purposes. A reel assembly is provided at the surface for the purpose of raising and lowering the pump carried at the lower end of the tube bundle.

An important object of the invention is to provide a compact, small diameter fluid sampling pump which can efficiently sample significant quantities of a subterranean fluid from a deep location in the earth.

A further object of the invention is to provide a fluid sampling pump which utilizes only two fluid conveyance tubes or conduits located external to the pump body, which tubes are recessed into the body to protect them from damaging contact with a borehole in the earth during raising and lowering of the pump.

Another object of the invention is to provide a fluid sampling pump of small diameter which contains interchangeable and quickly replaceable parts so that field repair or replacement of parts can be quickly and easily accomplished.