Nov. 7, 1972 D. H. BEDNAR 3,702,223

HYDRAULICALLY OPERATED SYSTEM FOR SUBSURFACE OPERATIONS

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FIG.1

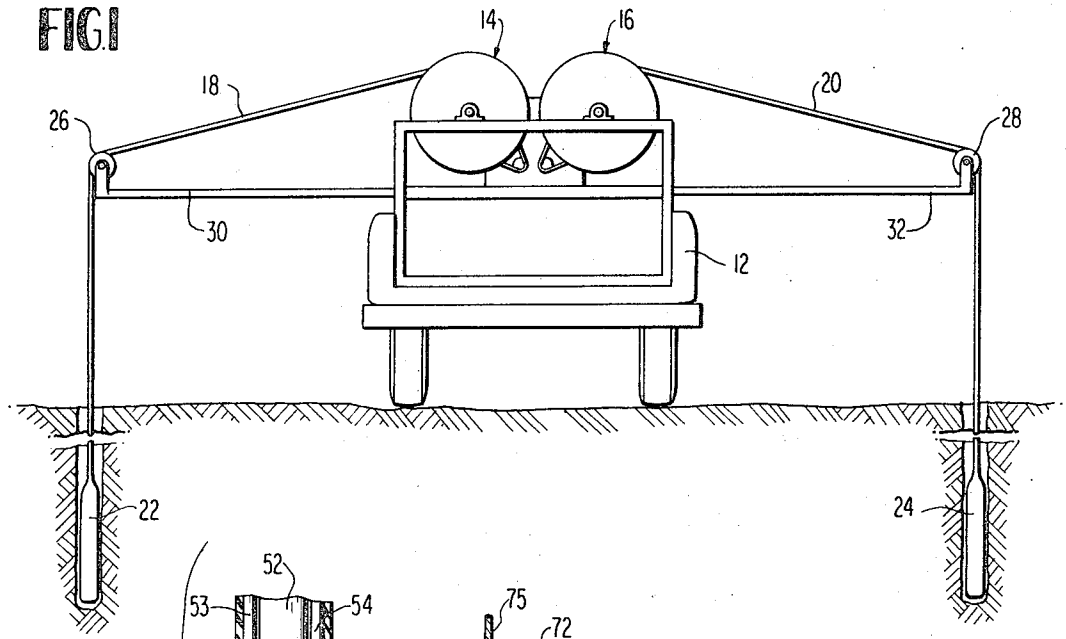
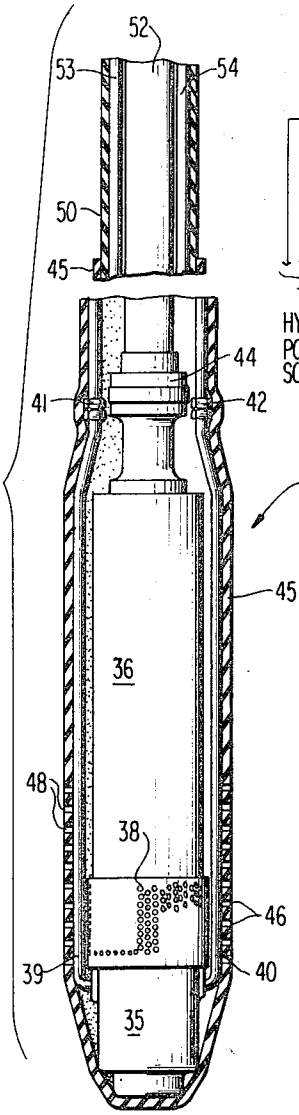


FIG.2



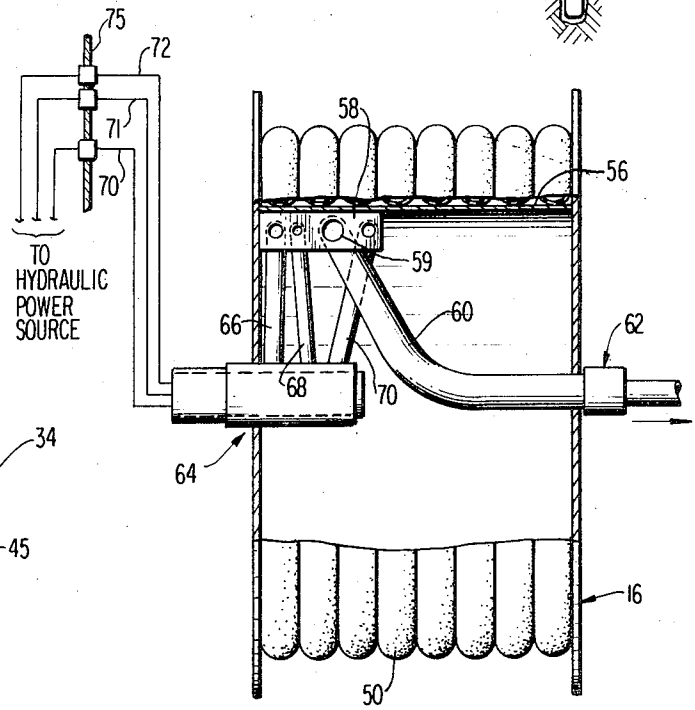


FIG3

INVENTOR
DAVID H. BEDNAR

BY Shanley & O'Neil

ATTORNEYS

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HYDRAULICALLY OPERATED SYSTEM FOR SUBSURFACE OPERATIONS

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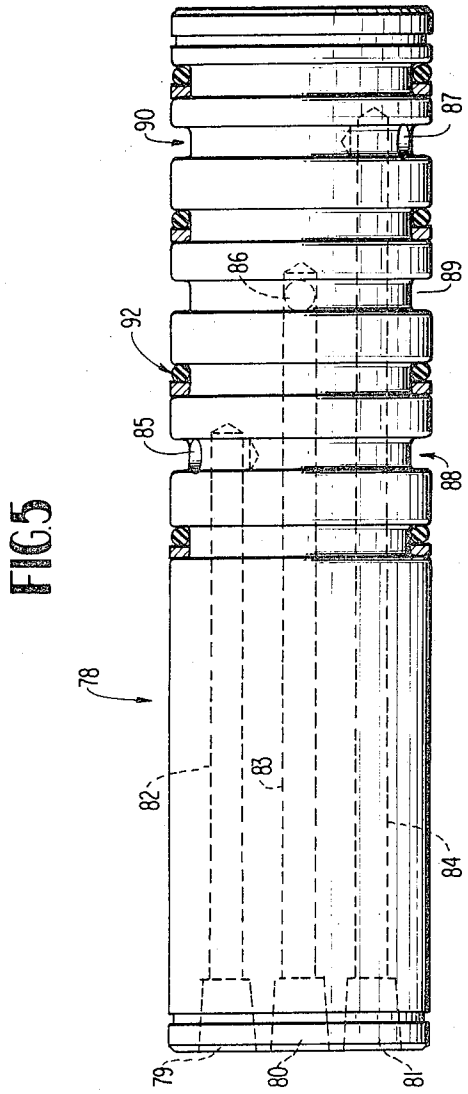


FIG 5

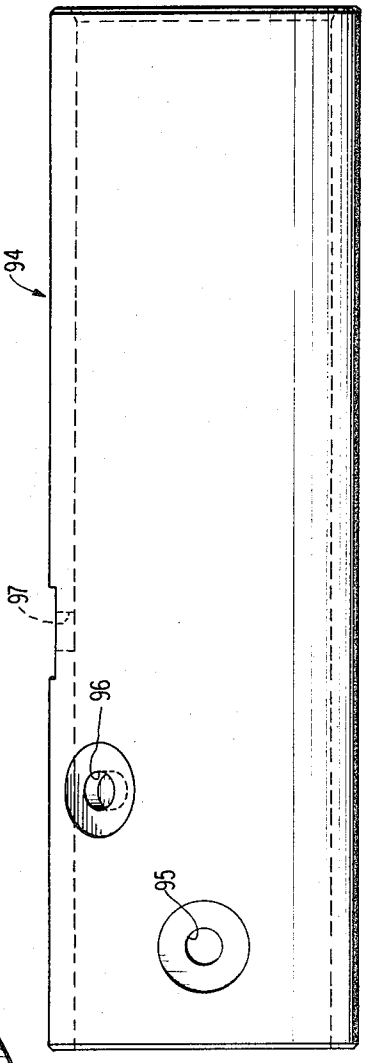


FIG 6

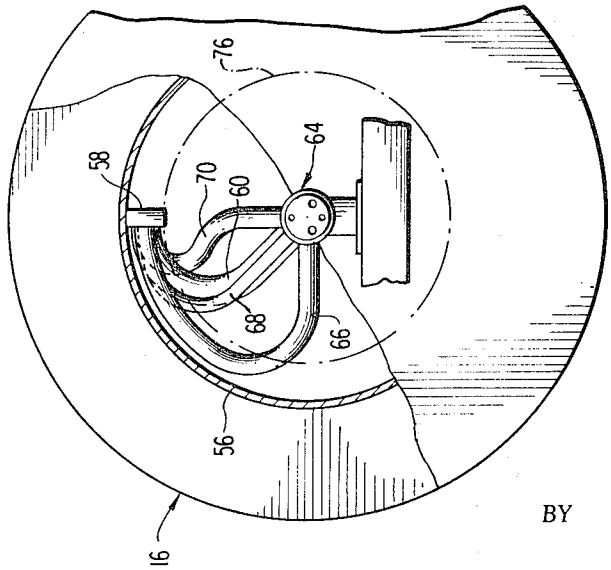


FIG 4

INVENTOR
DAVID H. BEDNAR

BY Shanley & O'Neil

ATTORNEYS

Nov. 7, 1972 D. H. BEDNAR 3,702,223

HYDRAULICALLY OPERATED SYSTEM FOR SUBSURFACE OPERATIONS

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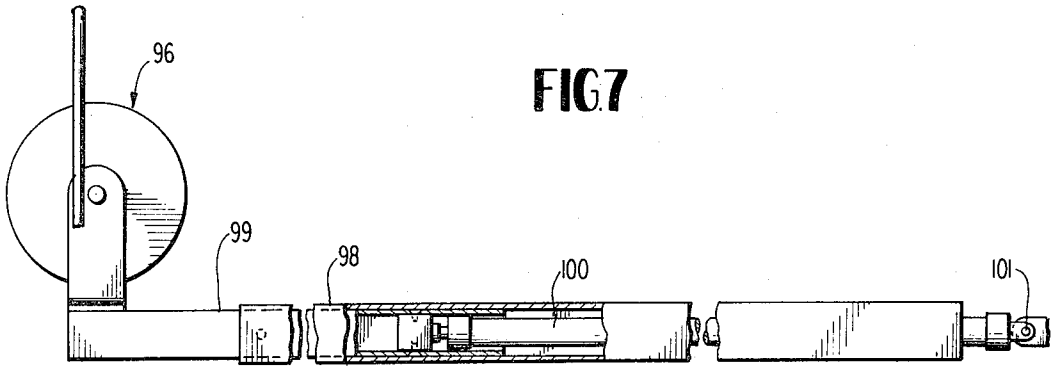


FIG.7

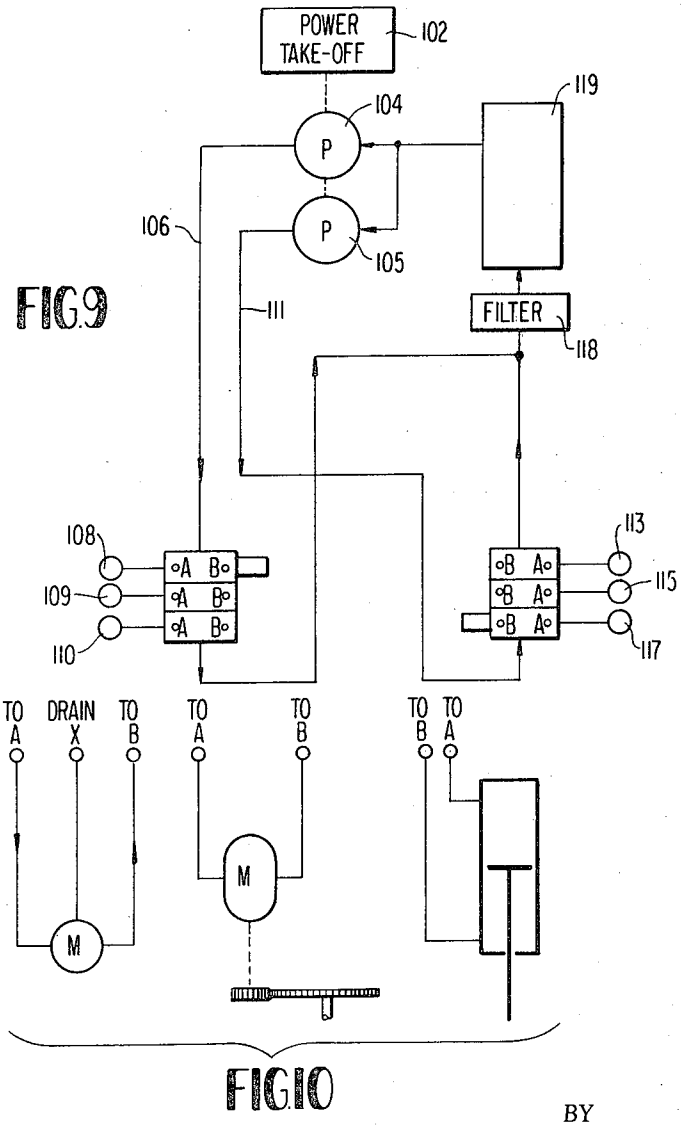


FIG.9

FIG.10

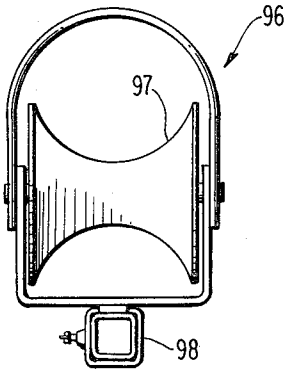


FIG.8

INVENTOR
DAVID H. BEDNAR

BY Shanley & O'Neil

ATTORNEYS

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HYDRAULICALLY OPERATED SYSTEM FOR SUBSURFACE OPERATIONS

David H. Bednar, Mountain Iron, Minn., assignor to Viking Explosives & Supply Inc.

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U.S. Cl. 417—375 15 Claims

ABSTRACT OF THE DISCLOSURE

Provision is made for removal of blast hole liquids hydraulically thus avoiding safety hazards of electrically operated apparatus in blasting holes. Hydraulically driven submersible pump means are protected within electrically insulating boot means and connected through an abrasion resistant, electrically non-conductive sheathing cable which houses supply and discharge conduits. Reeling means at the surface provide for lowering, raising, and suspending of the submersible apparatus with novel junction block and connector means providing above ground connection for the conduit means without inhibiting of reeling of the sheathing cable and housed conduits.

This invention is concerned with subsurface operations such as blast hole or other type of bore hole dewatering.

Blast holes are generally drilled by air drilling of jet piercing methods. In air drilling, water is commonly used for dust control and in jet piercing, water is an integral part of the drilling method. Ground water is also present in most areas. Because of these factors most drill holes will contain and hold water after completion.

Such conditions have in the past required the use of explosives which are substantially unaffected by water. Any such product however, is considerably more costly than an ammonium nitrate-fuel oil mixture, or other types of dry explosive products, which, because of the present invention, are now practical for use in blast holes. These dry type explosives also have other advantages, such as an explosive coupling effect, unavailable with waterproof cartridges. As a result the dry type explosive can be more effective.

There have been concerted effects in recent years to develop suitable methods and equipment for dewatering wet blast holes. Any of the systems commerically available at the time of this invention have a number of disadvantages. Centrifugal pumps, e.g., are limited to a pumping depth of approximately 22 feet. In another approach, water can be blown from the holes by air devices or small explosives but usually it returns before desired operations can be completed. Also, some holes can be dewatered by sealing and applying pressure, but this is a time consuming and often ineffective method especially where fractures exist above the water level.

Another approach would be use of an electrically operated submersible pump. However, use of electric apparatus in blasting holes is dangerous because most blasting holes already contain some explosives or explosive devices. Consequently there is an inherent hazard in placing electrically operated apparatus within a hole containing explosives. Also it is necessary to have an electrical power source or a generator of such size that the operation becomes unduly expensive in addition to being dangerous.

The present invention eliminates these problems of the prior art by providing a self-contained blast hole dewatering system free of any electrically operated apparatus which could possibly be a hazard to safety. In brief, a safe, economic system providing improved operations permitting use of dry type explosives in blast holes is provided.

Novel concepts of the invention are presented more

specifically in describing the embodiment shown in the accompanying drawings. In these drawings:

FIG. 1 is a schematic general arrangement showing an elevational view of the non-electrical system of the present invention.

FIG. 2 is an elevational view, partly in section, showing submersible apparatus and the special protective means of the present invention,

FIG. 3 is a schematic view, partly in section, of reeling drum means and conduit connector means of the present invention,

FIG. 4 is a schematic side elevation, partially in section, of the reeling drum means and conduit connector means of FIG. 3,

FIG. 5 is a side view of the fixed connector for the swivel means for the present invention with subsurface conduit shown in dotted lines,

FIG. 6 is a side view of the rotatable sleeve housing for the swivel connector means of FIG. 5,

FIGS. 7 and 8 are schematic side view and end views, respectively, of the guide assembly forming part of the present invention,

FIG. 9 is a schematic hydraulic circuit diagram of parallel hydraulic power systems for the dual probe embodiment disclosed, and

FIG. 10 is a hydraulic circuit schematic for the hydraulic power drives of the present invention.

The invention provides a self-contained unit which can be made operative in remote areas utilizing only the power take-off of a mechanized vehicle. In the specific embodiment of FIG. 1, truck body **12** supports rotatable reel means **14** and **16**. Through the teachings of the invention, drum portions of such reel means can be used to control cables **18** and **20** for lowering, raising, and suspending submersible apparatus **22** and **24**. Also, provision is made for supporting cables **18** and **20** in various spaced positions by sheaves **26** and **28**, carried by extensible booms **30** and **32**. Further, provision is made for hydraulically operating such equipment with the hydraulic power means being driven from the power-take-off of the truck.

This invention provides a blast hole dewatering system which avoids completely the hazards inherent in use of electrical apparatus. Yet the inventive system is without the limitations of the other non-electrical systems available in the art since blast hole liquid is rapidly removed from the blasting hole and from the area of the blasting hole.

In the novel system, a narrow diameter, high capacity, submersible pump is powered by a hydraulic motor having a maximum diameter approximating that of the pump. As shown in FIG. 2, submersible apparatus **34** includes hydraulic motor **35** situated below submersible pump **36**. The submersible pump draws fluid through the inlet surface **38**.

Hydraulic lines **39** and **40** are connected to hydraulic motor **35** and extend along the surface of the pump **36**. Coupling means **41** and **42** are provided at the upper ends of lines **39** and **40**. The liquid discharge end of the submersible pump **36** is provided with coupling means **44**.

An important aspect of the invention insulates the entire submersible apparatus **34** with a special boot **45**, made of a resilient electrically insulating material, such as rubber. This prevents damage to the pump and also prevents detonating any fuse, or shorting of blasting cap electrical leads, which may already be present in the blasting hole.

Boot **45** defines an apertured surface **46** which is contiguous to and provides direct communication with the apertured surface **38** at the fluid inlet end of the submersible pump **36**.

Because of heavy slurries encountered within blasting holes, especially at the bottom of such holes where blast-

ing agents may already exist, it has been discovered that a water diluting action greatly aids pumping. For this purpose boot **45** is provided with a series of enlarged apertures in a circumferential surface **48** above the fluid inlet surface of the submersible pump. If the pump inlet is submerged in a blasting agent gel at the bottom of a blasting hole, water entering at the surface **48**, above the pump inlet, and traveling downwardly within boot **45** mixes with the intake at surface **46** reducing the viscosity of the fluid being pumped and aids in the pumping operation.

An important contribution of the invention for handling and protection purposes is the provision of sheathing cable means. At the upper end of submersible apparatus **34**, the boot **45** is joined to non-conductive sheathing cable **50** which houses the water discharge conduit **52** and hydraulic fluid power lines such as **53** and **54**. Sheathing cable **50**, and its protected conduits, extend to the surface and provides movement control, for example, by reeling on the drum of reel means **16**.

In practice, this sheathing cable can take the form of an abrasion-resistant cover hose, which is not electrically conductive. In the preferred embodiment, sheathing cable **50** is made from an electrically insulating material such as rubber. The sheathing cable may be two to three inches in diameter to permit encasing high pressure polyurethane hydraulic conduits, for example two ⅜" ID hoses for supply and discharge of hydraulic fluid lines and an additional ¼" drain hose for relieving pressure on the seal of the hydraulic motor. In such embodiment, water discharge conduit **52** can have a diameter of approximately one inch. The overall diameter of the submersible pump and hydraulic motor will be approximately three to four inches for a sixty gallon per minute coupling unit. The sheathing cable means is used to lower, raise, or suspend the dewatering apparatus **34** at the desired height. Winding and unwinding of the sheathing cable means and encased conduits are carried out by reel means supported at the surface. Specific apparatus for this purpose is shown and described in relation to FIGS. 3 through 6.

Referring to FIG. 3, sheathing cable **50** is wound on a cylindrical drum surface **56** of reel means **16**. In order to permit winding and unwinding via a reel means, the invention provides unique connector means. The sheathing cable, at its upper end, is fixedly secured to drum surface **56**. Within the rotatable drum, and carried by drum surface **56** is junction block **58**. Part of the novel contribution of the invention is the provision of means for fixedly securing the conduit from the sheathing cable, that is, the liquid discharge and hydraulic fluid conduits, at the reeling means without inhibiting winding and unwinding of the sheathing cable. These conduits are coupled through junction block **58**.

For discharge of blast hole liquid coupler **59** connects junction block **58** to water discharge pipe **60**. The latter is mounted within the drum. Discharge of liquid is as indicated by the arrow. A rotatable water-tight fitting **62** (located on the axis of the drum) is provided at the discharge end of pipe **60** to permit fluid-tight discharge without inhibiting rotation of the drum.

The hydraulic fluid lines are supplied and discharged from the axially opposite fitting **62** on the reel means. For this purpose junction block **58** is connected to swivel connector means **64** by hydraulic fluid pipes **66**, **68** and **70**. These junction block and swivel structures which permit winding, unwinding, and control of the cable will be described in more detail later. However, note the separate handling of water and hydraulic fluid lines to avoid possible intermixing should leakage in the blast hole liquid conduit occur. Note also that the invention teaches means for a plurality of hydraulic fluid lines to be handled through the same axis.

From the swivel structure **64** hydraulic fluid lines **70**, **71** and **72** extend to bulkhead **75** where they are coupled to corresponding lines extending to the hydraulic power source and controls (not shown). The use of the bulkhead **75** relieves strain on these lines and swivel connector structure and avoids possible leakage due to such strain.

In FIG. 4 the reel means **16** is shown from its side view. The circumferential path defined by junction block **58** during rotation of the drum is shown at **76**.

FIG. 5 shows an enlarged view of the fixed portion of the swivel apparatus **64** comprising an axially-located fixed bearing-connector block **78**. Coupling means **79**, **80** and **81** receive the hydraulic fluid lines coming from the source and connect these lines axially of the reel, through conduits **82**, **83** and **84**, to respective outlet couples **85**, **86** and **87** on the periphery of block **78** within the reel drum.

These outlet couples **85**, **86** and **87** communicate with annular cavities **88**, **89** and **90** respectively which extend around the full periphery of block **78**. O-rings and back-up ring assemblies are included between each annular cavity, as shown at **92**, to maintain pressures.

This fixed swivel block **78** fits within the cylindrically shaped housing sleeve **94** shown in FIG. 6. The outlet coupling means **95**, **96** and **97** in the peripheral surface of rotatable cylindrical sleeve **94** communicate with the respective annular cavities of the fixed swivel block **78**.

FIGS. 7 and 8 present in more detail important placement control apparatus in the form of the sheave and extensible boom for supporting the sheathing cable and subsurface apparatus. Sheave structure **96** includes guide roller **97**. The boom is telescopically operated with the outer sleeve **98** moving on support arm **99**. This boom is moved by hydraulic cylinder **100** and is pivotally mounted at terminal end **101**.

As shown in FIG. 9, power take-off drive **102** supplies pumps **104** and **105** connected in tandem. A parallel system is provided for each reel means and submersible assembly, with pump **104** being connected through line **106** to submersible pump means **108**, to the reel drive **109**, and to the hydraulic cylinder **110** for the boom.

Pump **105** is connected through line **111** to hydraulic cylinder **113** for its extensible boom, reel drive **115**, and submersible pump means **117**. Filter **118** serves both systems before the hydraulic fluid is returned to reservoir **119**.

A schematic showing of the connections for the submersible pump means, reel motor, and boom cylinder (left to right respectively) is shown in FIG. 10. The third line from the submersible pump means designated "Drain" X is for purposes of relieving the pressure on the seal within the pump. The fluid can be conventional hydraulic machine oil.

A basic novel concept of the invention is the provision of an hydraulic system for subsurface blast hole dewatering in which hydraulic motor means are operatively connected to submersible pump means with hydraulic fluid lines and a liquid discharge line being housed within a protective sheathing cable permitting lowering, raising, and suspending of such hydraulic apparatus. The above described embodiment exemplifies apparatus for carrying out this concept. Other hydraulic circuits and changes in mechanical structure can be adapted to the conception disclosed without departing from the spirit of the invention. Therefore it is understood that the scope of the invention should be determined from the appended claims.

What is claimed is:

1. Apparatus for removing liquid from a borehole without the hazard of electrically powered apparatus comprising

submersible pump means,

hydraulic motor means operatively connected to drive the submersible pump means to cause intake of a liquid from a borehole and delivery of such liquid under pressure by the submersible pump means,

means for lowering, raising, or suspending the submersible pump means and hydraulic motor means within a borehole including

discharge conduit means for liquid delivered by the submersible pump,

hydraulic fluid conduit means for delivering fluid for operating the hydraulic means, and

sheathing cable means made from non-electrically conductive material encasing such discharge conduit means and hydraulic fluid conduit means.

2. The apparatus of claim 1 additionally comprising

resilient electrically insulating casement means covering the submersible pump means and hydraulic motor means while allowing for entry of borehole liquid responsive to suction action of the submersible pump means.

3. The apparatus of claim 2 wherein such casement means defines aperture means communicating directly with an inlet surface of the submersible pump means and, secondary aperture means spaced longitudinally above such inlet surface for directing diluting liquid toward such inlet surface.

4. The apparatus of claim 2 wherein the sheathing cable means comprises resilient electrically insulating material joined to the casement means to provide protected passage of the hydraulic fluid conduit means and liquid discharge conduit means.

5. The apparatus of claim 1 wherein the means for lowering, raising, and suspending include reel means permitting winding and unwinding of the sheathing cable means, such reel means including a rotatable drum means.

6. The apparatus of claim 5 wherein the reel means includes connector means to permit the hydraulic fluid conduit means and the discharge conduit means to be secured to the reel means during winding and unwinding of the sheathing cable means.

7. The apparatus of claim 6 including hydraulic drive means for rotatably driving the reel means.

8. The apparatus of claim 6 wherein the connector means includes junction block means located contiguous to a winding surface of the rotatable drum means and swivel means centrally located within the rotatable drum means contiguous to its axis of rotation.

9. The apparatus of claim 6 including swivel means comprising

a rotatable sleeve member rigidly mounted to rotate with the rotatable drum means about the rotation axis of the latter, and

a stationary swivel block positioned within the sleeve member along the rotation axis of the rotatable drum means to act as a bearing for the sleeve member,

the stationary swivel block means including a plurality

of separate passageways interconnecting an external axial end of the stationary swivel block and the peripheral surface of the sleeve member within the rotatable drum means.

10. The apparatus of claim 9 including

conduit means interconnecting the passageway means within the fixed swivel member to the hydraulic fluid conduit means within the sheathing cable, such conduit means extending between the peripheral surface of the sleeve member and the rotatable drum surface.

11. The apparatus of claim 10 including

means connecting to the discharge conduit means from the sheathing cable means through the rotatable drum surface to the remaining axial end of the rotatable drum means opposite to the stationary swivel block means.

12. The apparatus of claim 11 including

water-tight coupling means located at the remaining axial end of the rotatable drum means providing for discharge of liquid pumped from the borehole during rotation of the rotatable drum means.

13. The apparatus of claim 5 including

mobile platform means for supporting the reel means.

14. The apparatus of claim 13 including

extensible boom means for supporting the sheathing cable means and submersible pump means in spaced relationship from the mobile platform means.

15. The apparatus of claim 13 including

hydraulic power supply means providing hydraulic circuit means for operating a plurality of reeling means, extensible booms, and submersible pump means.

References Cited

UNITED STATES PATENTS

2,997,120	8/1961	Kendrick	175—103
3,398,694	8/1968	Lerch	417—375 X
2,735,717	2/1956	Harman	242—86.5 R

FOREIGN PATENTS

218,388	7/1924	Great Britain	417—405

CARLTON R. CROYLE, Primary Examiner

R. J. SHER, Assistant Examiner

U.S. Cl. X.R.

166—67; 175—103; 242—86.5 R