Feb. 23, 1965 A. ARUTUNOFF 3,170,520

DUAL-FLOW TRANSFER ASSEMBLY

Filed Aug. 28, 1962 4 Sheets-Sheet 1

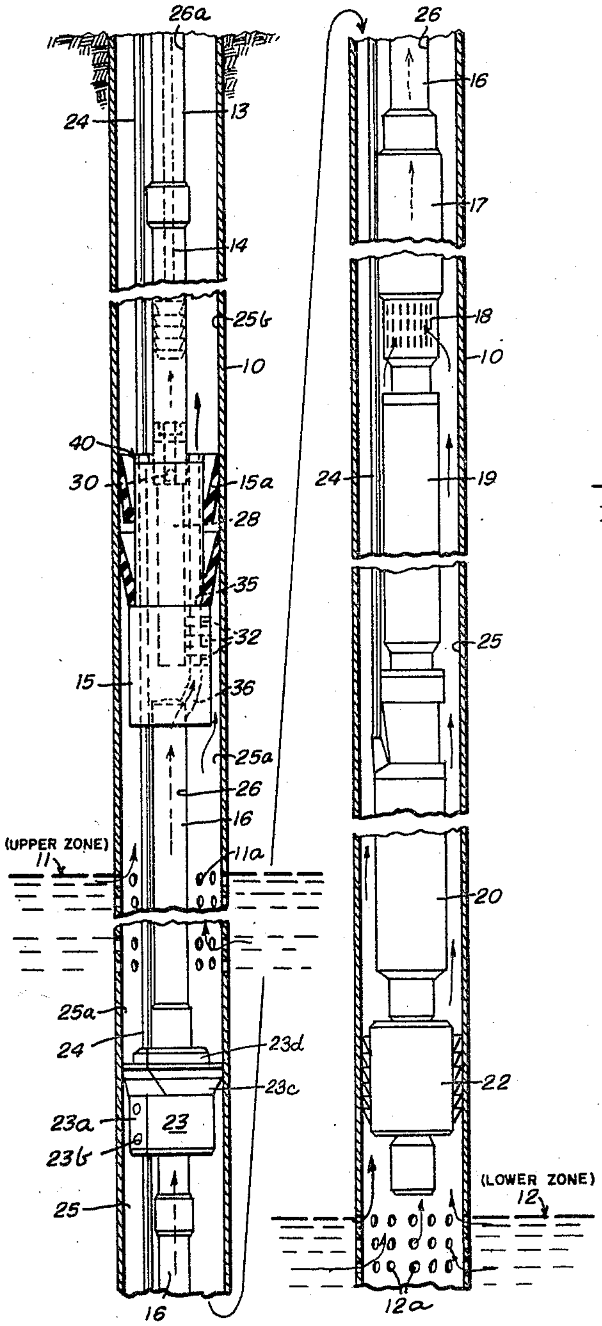

FIG. 1a FIG. 1b

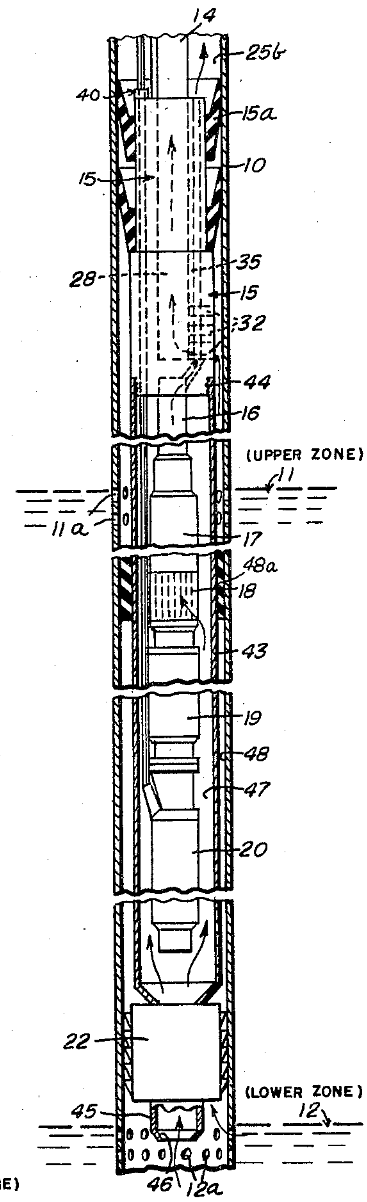

FIG. 7
(ALT. FORM)

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Feb. 23, 1965 A. ARUTUNOFF 3,170,520

DUAL-FLOW TRANSFER ASSEMBLY

Filed Aug. 28, 1962 4 Sheets-Sheet 2

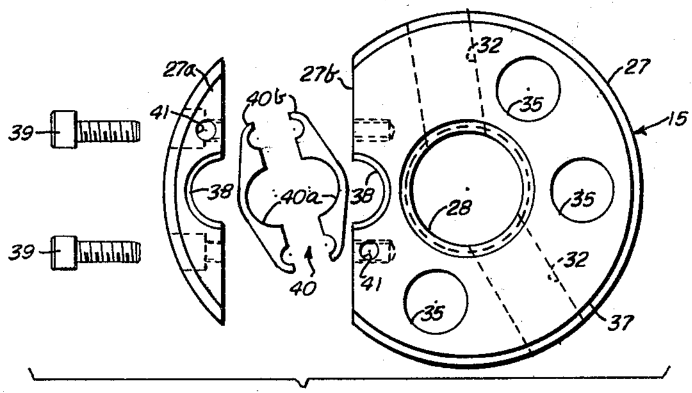

FIG. 4

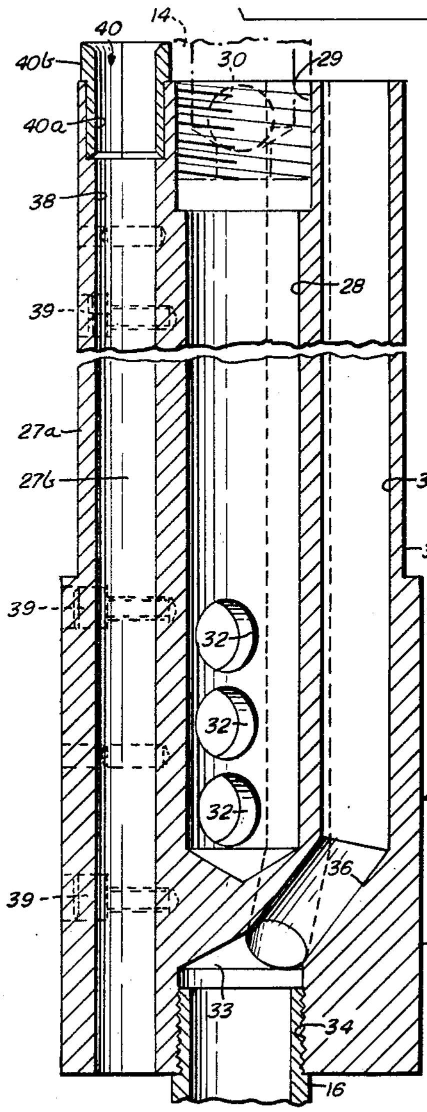

FIG. 2

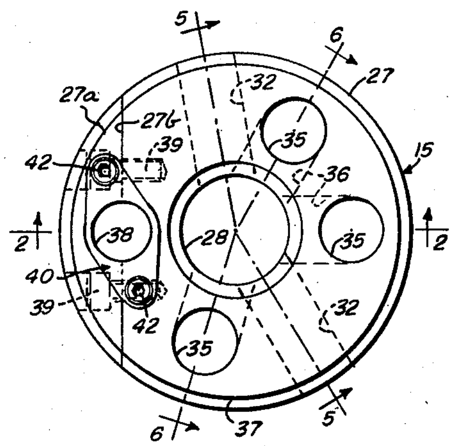

FIG. 3

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DUAL-FLOW TRANSFER ASSEMBLY

Filed Aug. 28, 1962 4 Sheets-Sheet 3

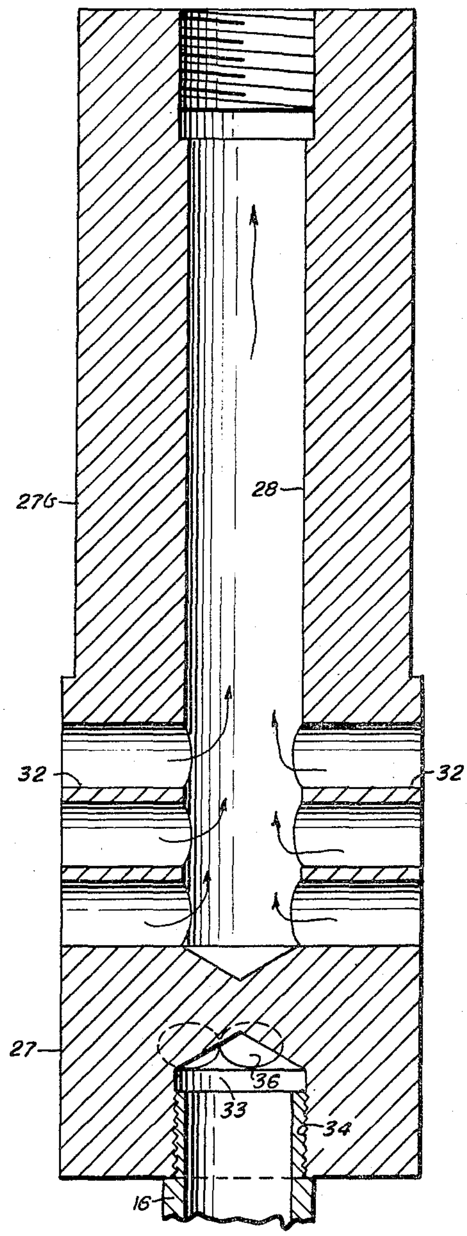

FIG. 5

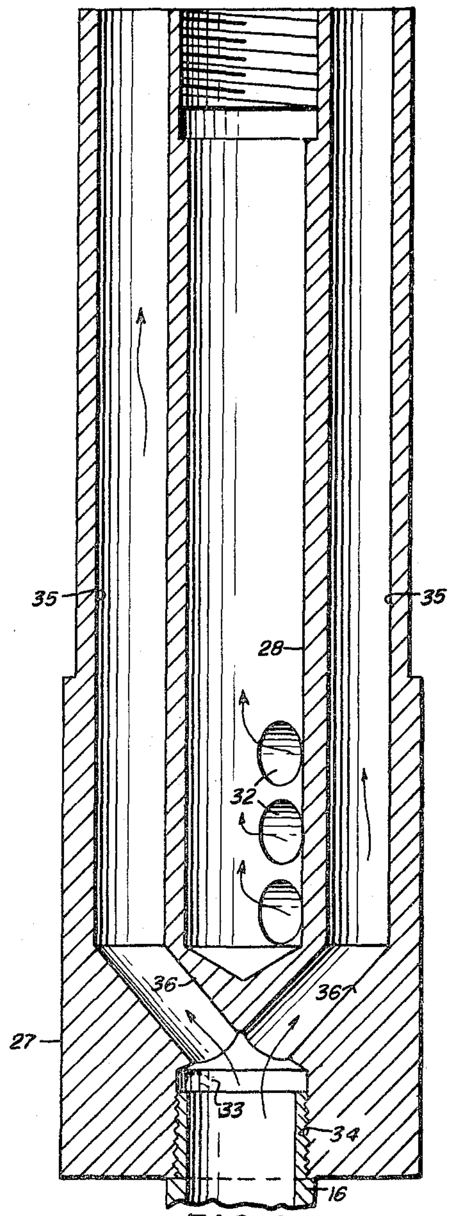

FIG. 6

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Feb. 23, 1965 A. ARUTUNOFF 3,170,520

DUAL-FLOW TRANSFER ASSEMBLY

Filed Aug. 28, 1962 4 Sheets-Sheet 4

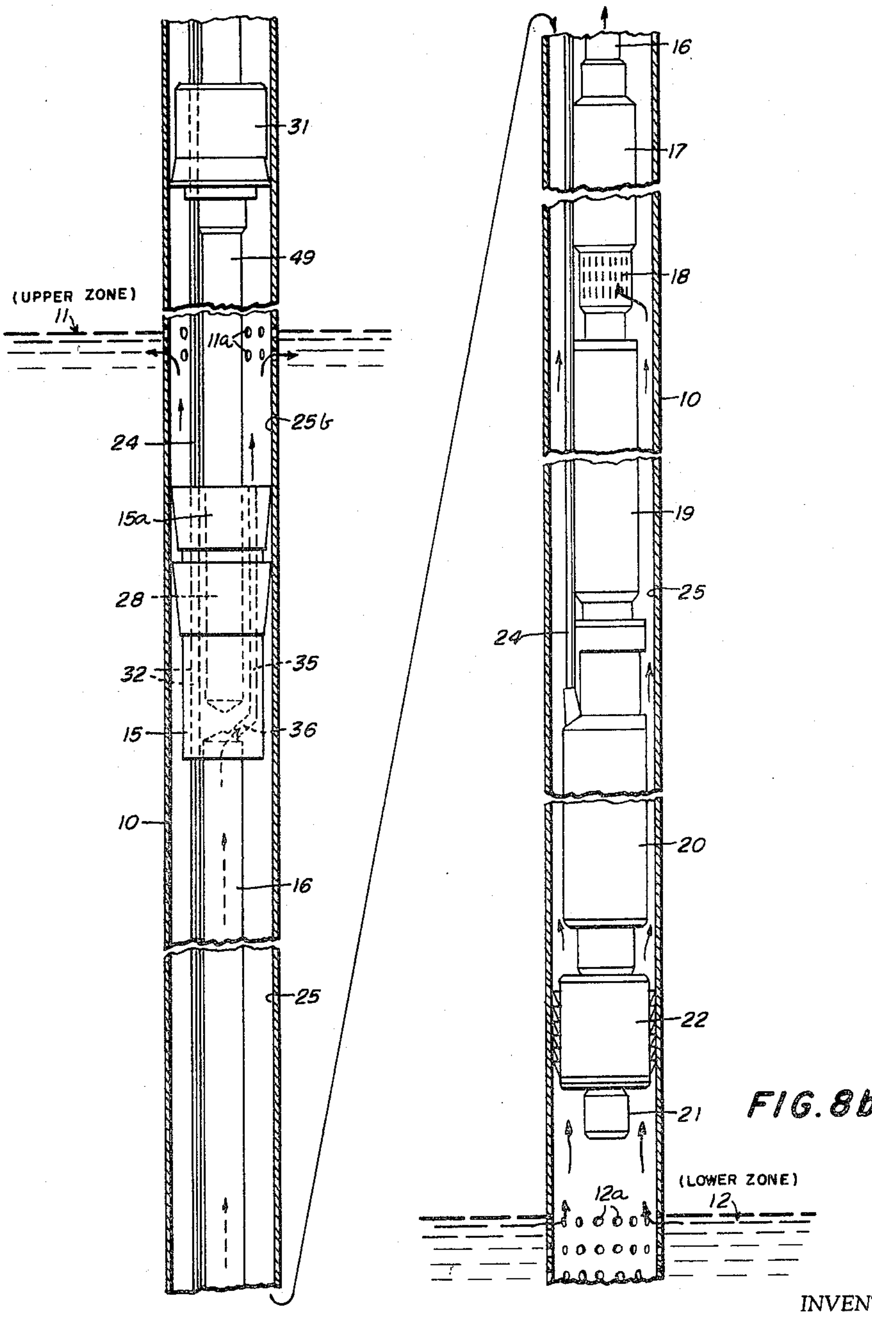

FIG. 8a

FIG. 8b

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DUAL-FLOW TRANSFER ASSEMBLY

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5 Claims. (Cl. 166—65)

This invention relates to oil producing equipment of the type embodying a well casing which extends through and communicates with separate producing zones through suitable perforations in the casing, separate pumping mechanisms being employed for simultaneously delivering fluid from the respective zones. More particularly, the invention consists in new and useful improvements in a dual-flow transfer assembly adapted for use in connection with said producing equipment and designed to seal the well casing between the two pump mechanisms and, at the same time, to isolate the fluid produced from the separate zones and direct its flow to separate points of delivery

In operations of this character, the fluid from the uppermost zone is usually delivered by a rod actuated plunger type pump located above the upper zone, and the fluid from the lower zone is produced by a separate submergible electric pump and motor unit located in the lower portion of the casing In order to maintain the isolation of the fluids produced from the upper and lower zones, all of which enters through respective perforations in the main casing, it is necessary to seal the casing above the upper zone and provide means for simultaneously conducting to the surface, the fluids produced from the respective zones through entirely separate passageways within the casing.

It is therefore the primary object of the present invention to provide a dual flow transfer assembly adapted to divert fluid being discharged through the tubing connected to the lower pump, to the annular passageway surrounding the tubing containing the upper pump, and to simultaneously divert the fluid entering the casing from the upper zone to the central tubing connected to the upper pump.

In equipment of this type which requires the lowering of a cable to the motor of the submergible pump, the handling and disposition of the cable have been a considerable problem because of the pressure differentials encountered and the necessity of cutting and splicing the cable during installation. It is therefore another object of the invention to provide an assembly such as referred to, having novel means for accommodating the cable regardless of the vertical location of the transfer assembly and without the necessity of cutting the cable during installation or if the location of the transfer assembly requires a change.

Another object of the invention is to provide a flow transfer assembly which is not only adapted for use in the dual completion of a well, but which may be used with equal effect when it is desired to withdraw fluid from a lower zone for example, and re-introduce it into an upper zone. In such latter use, the transfer assembly acts as a connector or support for the string of tubing extending into the well and also serves the added purpose of diverting the flow of fluid produced through the tubing from the submergible pump adjacent the lower zone, to the casing surrounding the tubing above the packer assembly, from whence it is re-introduced into the upper zone under the full pressure of the electrically driven pump, the casing above said upper zone being suitably sealed for the maintenance of the necessary pressure.

In some instances, the vertical distance between two producing zones is insufficient to accommodate the length

of the submergible motor and pump assembly required for delivering fluid from the lower zone. It is therefore a further object of this invention to provide means for adapting the assembly for use in separately delivering fluids from relatively close upper and lower producing zones, and, at the same time, to accommodate the length of the conventional submergible electric motor and pump unit.

Naturally, when the fluids from two separate producing zones are to be delivered to the surface separately, it is necessary to employ two pumping systems, and with conventional equipment, the lowering of the separate pumping systems into a well casing and the relationship of the two systems in the well casing present something of a problem. It is therefore another object of the invention to accomplish this separate delivery of fluids from two producing zones in a practical and economical manner utilizing conventional tubing and concentrically arranged elements supported by the tubing, which greatly facilitates installation and removal of the apparatus and requires a minimum of maintenance.

With the above and other objects in view which will appear as the description proceeds, the invention consists in the novel features herein set forth, illustrated in the accompanying drawings and more particularly pointed out in the appended claims.

Referring to the drawings in which numerals of like character designate similar parts throughout the several views:

FIGURES 1A and 1B jointly illustrate an installation embodying the present invention for separately delivering to the surface, fluids from upper and lower producing zones;

FIGURE 2 is an enlarged vertical sectional view of the dual-flow transfer unit;

FIGURE 3 is a top plan view of the assembled unit shown in FIGURE 2;

FIGURE 4 is an exploded top plan view of the same;

FIGURE 5 is a vertical sectional view taken on line 5—5 of FIGURE 3;

FIGURE 6 is a similar view taken on line 6—6 of FIGURE 3;

FIGURE 7 is a view generally similar to FIGURES 1A and 1B, illustrating the modification of the assembly adapted for use in connection with the separate delivery of fluids from two relatively close producing zones; and

FIGURES 8A and 8B jointly illustrate an installation embodying the flow transfer unit of the present invention for the re-introduction of fluid produced in a lower zone into an upper zone.

In the drawings, referring first to FIGURES 1A and 1B, the usual well casing **10** extends from the surface into a drilled well and communicates with upper and lower producing zones **11** and **12** respectively, through suitable perforations **11***a* and **12***a* in the wall of the casing. A delivery tube **13** at the upper end of the casing **10** is connected at the surface to a suitable reservoir or distribution system (not shown) and concentrically supports a conventional rod-actuated plunger-type pump **14**, the lower end of which is connected to the central passageway of the flow-transfer unit **15** of the present invention which will be described in detail later on. The unit **15** concentrically supports a string of tubing **16** from the lower end of which is suspended a conventional submergible electric motor and pump assembly comprising a centrifugal pump **17** having radial inlets **18**, a motor protecting unit **19** and an electric motor **20**, all concentrically connected in the usual manner.

A conventional expandible anchor device **22** comprising a combination of anchor and packer means is provided at the lower extremity of the installation for engagement with the casing **10** to prevent the up and down movement of motor-pump assembly due to up and down movement of the rod of pump **14**, and at a suitable point between the upper and lower producing zones **11** and **12**, the tubing **16** is provided with a packer **23** which seals the periphery of the tubing **16** with respect to the inner periphery of the casing **10**. The conventional electric cable **24** extends downwardly in the casing **10** alongside the tubing for connection to the motor **20** and, as will later appear, means are provided in both the flow transfer unit **15** and the packer **23** to accommodate this cable.

As will be seen in FIGURES 1A and 1B of the drawings, the submergible motor and pump assembly **17–20** is arranged in spaced relation to the inner periphery of the casing **10**, thus providing an annulus **25** surrounding the central tubular passageway formed by the delivery tube **13**, the rod actuated pump **14** and the string of tubing **16**. The annulus **25** is sealed by the packer **23** which thereby isolates the fluids entering the casing **10** from the upper and lower zones **11** and **12**. The area of the casing **10** above the packer **23** forms an annular passageway **25*a*** surrounding the tubing **16** and communicates with the upper zone **11** through perforations **11*a*** and the upper end of passageway **25*a*** is sealed around the flow transfer unit **15** by packing rings **15*a*** surrounding the upper portion of unit **15**, as will be later described, thereby providing a combined transfer unit and packer.

Thus, the packing rings **15*a*** further separate the annulus **25** into another annular passageway **25*b*** surrounding the delivery tube **13** and plunger-type pump **14**, said last-named passageway leading to the surface where it is connected to a separate receiving means or distribution system (not shown). Likewise, the central passageway formed by the tubing is divided into two sections by the transfer assembly **15**, the first section **26** terminating at the upper end of the tubing **16**, and the other section **26*a*** comprising the cylinder or pump **14** and the delivery tube **13** above the transfer unit **15**.

The flow transfer unit per se will be best understood by reference to FIGURES 2 to 6 inclusive, where it will be seen that the unit comprises a main body **27** which is cylindrical in form and provided with an upper central longitudinal bore **28** internally threaded at its upper extremity as at **29** to receive the lower end of the cylinder of the upper pump **14**, the latter including the usual ball valve or the like **30**. The lower end of the bore **28** is closed within the body **27** and the interior of the bore communicates with the exterior of the body **27** through a series of radial ports **32**. As will be seen from FIGURE 1A, the outer periphery of the body **27** of unit **15** is spaced inwardly from the inner walls of the casing **10**, thereby establishing communication of the annular passageway **25*a*** with the upper central bore **28** through ports **32**.

The lower end of the body **27** is provided with a short lower vertical bore **33** which is concentric with bore **28** and internally threaded as at **34** to receive the complementary threads of the tubing **16**. The lower bore **33** communicates with a series of vertical channels **35** in the body **27** through a corresponding series of inclined radial ducts **36**, the upper extremities of the channels **35** opening into the upper annular passageway **25*b*** as seen in FIGURE 1A.

Thus, by considering FIGURES 1A and 1B together with FIGURE 2, for example, it will be seen that the installation provides a main annulus **25** into which fluid from the lower zone **12** is drawn by the submergible pump **17** from which it is discharged centrally through the tubing **16**, said annulus **25** being sealed below the upper zone **11** by the packer **23** as previously explained, to isolate the fluids from the tube producing zones. Above the packer **23**, the annular passageway **25*a*** surrounding unit **15**, receives the fluid from the upper zone **11** through the perforations **11*a***, and from the passageway **25*a***, the upper zone fluid enters the upper central bore **28** of unit **15** through radial ports **32** under the influences of the plunger-type pump **14** which delivers it through tubing **13** to the surface. Simultaneously, the fluid from the lower zone **12** being pumped by submergible pump **17**, passes through the lower section of tubing **16**, through the packer **23** and into the vertical channels **35** of the unit **15** through ducts **36**, and thence into the upper annular passageway **25*b***, from whence it is delivered to the surface. In other words, the fluid from the lower zone is first introduced into the casing and conducted through an annular passageway to the pump **17** which discharges it centrally to the flow transfer unit **15**, which, in turn, diverts the fluid to the upper annular passageway **25*b***, while the fluid from the upper zone is also introduced into the casing into an annular passageway **25*a*** which delivers it to the transfer unit **15** through the radial ports therein, where it is diverted to the central discharge tube of pump **14**. During this entire operation, it will be seen that by diverting the flow of fluids from the separate zones as described, they remain isolated from one another and are separately delivered to the surface.

In this connection, it may be stated that the described isolation of the fluids from the two separate zones is important when the two zones are producing fluids of different character and gravity, the mixture of which is undesirable, and it is also desirable for facilitating the control of the volume of production from the respective zones.

Returning to the specific structure of the flow transfer device **15** as illustrated in FIGURES 2 to 6, and with particular reference to FIGURE 2, it will be seen that the upper portion of the periphery of the body **27** is recessed as at **37** to accommodate preferably a pair of annular rubber packing rings **15*a*** shown in FIGURE 1A. Obviously, these packing rings **15*a*** close off the upper portion of the lower annular passageway **25*a*** and prevent the fluid therein from passing into the upper annular passageway **25*b***, so as to insure its entry into the radial ports **32** leading to the upper central bore **28** in the body **27**.

As previously stated, the flow transfer unit **15** is designed to accommodate an electric cable leading to the submersible electric motor **20**. As best seen in FIGURES 3 and 4, this is accomplished by providing a removable portion **27*a***, longitudinally separated from the main body **27** along a line **27*b*** which forms a chord with respect to the circumference of the cylindrical body **27**. Longitudinally extending grooves **38** are formed in the respective sections **27** and **27*a*** which, when the sections are bolted together by suitable bolts **39**, jointly form a bore to receive the cable **24**. A split packing gland **40** fits in the upper end of the bore **38** to prevent leakage of fluid through the passageway. This gland is made in two pieces as seen in FIGURE 4, jointly forming a depending annular sleeve **40*a*** which, after being applied to opposite sides of the cable, fits into the slightly enlarged opening at the upper end of the joined grooves **38** and is held in sealing engagement with the cable by the pressure applied to the bolts **39** which secure the two sections of the body **27** together. The upper extremities of the sleeve sections **40*a*** terminate in complementary flange members **40*b*** adapted to diagonally overlie the junction **27*b*** of the main and separable portions of the body **27**. Diagonally opposed apertures **41** are provided in the adjacent end faces of the body sections **27** and **27*a*** to receive bolts **42** extending through the joined sections of the flange **40*b***. Thus, the gland **40** is securely connected to both of the separable portions of the fluid transfer body **27**.

It may also be seen in FIGURE 1A that the packer **23** is split longitudinally at spaced points around its periphery to provide a removable section **23*a*** secured in place by bolts **23*b*** to accommodate that portion of the cable **24** which extends below the flow transfer unit **15**, the separable parts of the packer **23** being provided with coacting grooves in a manner similar to grooves **38** in the unit **15**. The packer **23** is preferably of the type which includes a split packer cup 23c, the lower portion of which is tapered to fit in a suitable recess (not shown) in the packer body and is held in wedging engagement with the interior thereof, by a complementary split adaptor 23d. Thus, upon removal of the split section 23a, the split cup and split adaptor may be removed and replaced after the cable 24 is installed.

As previously explained, in some instances the upper and lower producing zones are vertically spaced in a relatively short distance which is insufficient to accommodate the length of the pump, protector and motor assembly 17, 19 and 20, and in such a situation the embodiment of the invention illustrated in FIGURE 7 is employed. Here it will be seen that the assembly functions much in the same manner as that just described, with the exception that an auxiliary casing 43 houses the submergible pump and motor assembly and is suspended by threaded connection 44 from the lower extremity of the flow transfer unit 15.

The auxiliary casing 43 is spaced inwardly from the outer casing 10 and as in the embodiment shown in FIGS. 1a and 1b, in order to properly isolate the two zones 11 and 12, the surrounding passageway 48 is provided with any suitable packing 48a at a point between zones 11 and 12. This casing 43 is also radially spaced outwardly from the pump and motor assembly 17–20, its lower extremity having a reduced neck 45 which extends through the anchor device 22 and terminating in an open inlet end 46 which communicates with the interior of the outer casing 10 adjacent the perforations 12a in the vicinity of the lower producing zone 12. Thus, the interior of the auxiliary casing 43 provides an annular passageway 47 fed from the inlet 46, which, under the force of the submergible pump 17, delivers fluid from the lower zone 12 to the central tube 16, and thence to the radially offset channels 35 in the flow transfer unit 15 which in turn deliver the fluid to the upper annular passageway 25b which conducts it to the surface collection or distribution point. Similarly, the auxiliary casing 43, together with the outer casing 10, provides an outer concentric annular passageway 48 which communicates with the upper producing zone 11 through perforations 11a. This outer passageway 48 delivers the fluid from zone 11 through the radial ports 32 and into the upper central bore 28 of the flow transfer unit 15, from whence it is delivered under the action of the upper pump 14, to a separate collection or distribution point.

With this arrangement, it will be seen that the auxiliary casing 43 coacts with the outer casing 10 to compensate for the reduced vertical spacing of the producing zones 11 and 12, and, at the same time, to effect isolation of the fluids produced from these separate zones.

While the flow transfer unit of the present invention is primarily designed for use in the dual completion of wells by the separate delivery and isolation of the fluids produced from upper and lower producing zones, it may also be effectively used where it is desired to re-introduce fluid produced from a lower zone, for example, into the strata of an upper zone for the purpose of supplementing the pressure in the upper zone, such as by water flooding, to facilitate production from an adjacent well. Such an adaptation of the invention is shown in FIGURES 8A and 8B where it will be seen that installation is substantially the same as that shown in FIGURES 1A and 1B with the exception that instead of providing a packer 23 below the flow transfer unit 15 as in FIGURE 1A, a packer 31 is installed above the flow transfer unit 15 to seal the casing 10 above the upper zone 11. Also, there being no need for a second pump such as 14 in FIGURE 1A, a supporting tube 49 extends from the surface through packer 31 with its lower end connected to and suspending the flow transfer unit 15 and string of tubing 16.

In this re-injection operation, the fluid from the lower zone 12 enters annulus 25 in casing 10 through perforations 12a and is drawn into the submergible pump 17 through inlets 18. The pump 17 forces the fluid upwardly through tubing 16 until it reaches the flow transfer unit 15 where it is diverted from the central tube through ducts 36 and vertical offset channels 35 for introduction into the annular passageway 25b. This passageway being sealed above the upper producing zone 11 by packer 31, the fluid introduced into passageway 25b is forced under the pressure of pump 17 into the upper zone 11 through perforations 11a, thus supplementing the pressure of the upper zone to facilitate production by adjacent wells.

In the re-injection installation just described, the central bore 28 and connecting radial ports 32 in the flow transfer unit 15 perform no function insofar as the diversion of fluid is concerned, but they in no way hinder that operation. In fact, they can serve a useful purpose in facilitating the observation of the fluid level in the central tube 49 which is connected to bore 28, and thus communicates with the casing 10 below the transfer unit 15. It will thus be apparent that a standard dual flow transfer unit such as embodied in the present invention is adaptable without change to various types of installations.

From the foregoing, it is believed that the invention may be readily understood by those skilled in the art without further description, it being borne in mind that numerous changes may be made in the details disclosed without departing from the spirit of the invention as set forth in the following claims.

I claim:

1. A dual-flow transfer unit for isolating and separately directing the flow of fluids fed from separate producing zones into a common well casing, comprisng a cylindrical body insertible in concentric spaced relation in said casing, an upper central longitudinal bore in said body, at least one radial inlet port placing said upper bore in communication with the annular area in said casing surrounding said body, a central discharge opening at the upper end of said upper bore connected to a central discharge tube extending upwardly through said casing, peripheral sealing means on said body above said inlet port isolating said annular area from the upper portion of said casing, at least one longitudinally extending, laterally offset channel in said body, discharging at its upper end into said isolated upper area of the casing, a lower central longitudinal bore in said body, a duct connecting said last-named bore to the lower end of said channel, and a central inlet tube connected into said lower bore, whereby fluids fed centrally through said lower bore are diverted laterally and discharged through the upper area of said casing, and fluids fed from the annular area surrounding the periphery of said body through said radial inlet port, are diverted axially and discharged through said central discharge tube, said body being divided longitudinally into separable sections, the abutting faces of which are provided with complementary recesses which, when assembled, jointly form a common cable receiving bore.

2. A transfer device as claimed in claim 1, including a separable gland insertable in one end of said cable bore for sealing a cable extending through the latter, and means for securing said gland to respective separable sections.

3. A device as claimed in claim 1, including a gland for sealing a cable extending through said cable bore, said gland comprising a cylindrical central sleeve adapted to fit in said cable bore, a flange integral with said sleeve adapted to overlie the junction of said separable sections, and having diagonally opposed apertures respectively overlying said separable sections for receiving securing bolts.

4. In a well casing having a string of tubing, an electrically driven submergible pump operatively connected to said tubing, a cable leading from an external source of power to said pump, a cable accommodating packer assembly adapted for selective location in said casing, said assembly comprising a cylindrical body having a separable, parti-cylindrical portion an open cable receiving

bore formed jointly in the adjacent flat faces of said body and separable portion, means for securing said separable portion to said body, a separable gland insertable in one end of said bore for sealing a cable extending through the latter, and means for securing said gland to respective body portions.

5. A dual-flow transfer assembly for isolating and separately delivering fluids fed from relatively closely spaced upper and lower producing zones into a common well casing, perforated to communicate with respective zones, said assembly comprising a cylindrical transfer body insertable in said well casing, an auxiliary casing concentrically suspended from the lower end of said body , said body and said auxiliary casing being concentrically spaced from said well casing to provide a first annnular passageway communicating with said upper zone, an upper central tube concentrically connected to the upper end of said body in spaced relation to said well casing to provide a second annular passageway, means sealing said well casing between said passageways, a lower central tube connected to the lower end of said body and spaced inwardly from said auxiliary casing, said auxiliary casing being open at its lower extremity for communication with said lower zone through said well casing, an upper pump connected to said upper central tube, a lower pump disposed in said auxiliary casing and connected to the lower central tube with its intake communicating with the interior of said auxiliary casing, and separate ducts in said transfer body respectively connecting said upper central tube to said first annular passageway and said lower central tube to said second annular passageway, whereby, fluid pumped from said upper zone into said first annular passageway is diverted for delivery through said upper central tube and fluid pumped from said lower zone into said lower central tube through said auxiliary casing, is diverted for delivery through said second annular passageway.

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